

**DIVISION OF
PHYSICAL SCIENCES**

LIST OF NEW COURSES

S. No	Course Code	Course Title	Credits			
Courses for B.Sc., Forensic Science						
			L	T	P	C
1	23CH2003	Organic Chemistry for Forensic Science	3	0	0	3
2	23CH2004	Forensic Chemistry	3	0	0	3
3	23CH2005	Forensic Toxicology	3	0	0	3
4	23CH2008	Organic Chemistry Laboratory	0	0	3	2
5	23CH2009	Analytical Chemistry Laboratory	0	0	3	2
6	23CH2010	Forensic Toxicology Laboratory	0	0	3	2
7	23CH2011	Analytical Chemistry for Forensic Science	3	0	0	3
8	23CH2012	Instrumental methods of Analysis	3	0	0	3
9	23CH2013	Biochemistry	3	0	0	3
10	23CH2014	Nano chemistry for Forensic Science	3	0	0	3
11	23CH2015	Modern Instrumental methods in Forensic Science	3	0	0	3
12	23CH2016	Chemistry in Everyday Life	3	0	0	3
13	23FS2004	Crime and Society	3	0	0	3
14	23FS2005	Crime Scene Investigation	3	0	0	3
15	23FS2006	Finger Print Analysis	3	0	0	3
16	23FS2007	Basic Biology for Forensic Science	3	0	0	3
17	23FS2008	Questioned Documents	3	0	0	3
18	23FS2009	Forensic Ballistics	3	0	0	3
19	23FS2010	Forensic Psychology	3	0	0	3
20	23FS2011	Forensic Biology	3	0	0	3
21	23FS2012	Cyber Forensics	3	0	0	3
22	23FS2016	Forensic Dermatoglyphics Laboratory	0	0	3	2
23	23FS2017	Moot court for Forensic Science	0	0	3	2
24	23FS2018	Questioned Documents Laboratory	0	0	3	2
25	23FS2019	Forensic Ballistics Laboratory	0	0	3	2
26	23FS2020	Forensic Psychology Laboratory	0	0	3	2
27	23FS2021	Forensic Biology Laboratory	0	0	3	2
28	23FS2022	Cyber Forensics Laboratory	0	0	3	2
29	23FS2023	Foundation Course on Computer Fundamentals and Office	3	0	0	3
30	23FS2024	Forensic Medicine	3	0	0	3
31	23FS2025	Accident Investigation	3	0	0	3
32	23FS2026	DNA Typing	3	0	0	3
33	23FS2027	Fundamentals of Forensic Anthropology and Odontology	3	0	0	3
34	23FS2028	Digital and Multimedia forensics	3	0	0	3
35	23FS2029	Forensic Statistics	3	0	0	3
36	23FS2030	Introduction to Environmental Forensic Science	3	0	0	3
37	23FS2031	Forensic Data Science	3	0	0	3
38	23FS2032	Introduction to Forensic entomology	3	0	0	3
39	23FS2033	Introduction to Forensic engineering	3	0	0	3
40	23FS2035	Microscopy in Forensic Science	3	0	0	3
Professional Elective Course for MSc Forensic Science						
1	23CA3015	Artificial Intelligence Security	3	0	0	3
2	23CA3010	Network Forensics	3	0	0	3
3	23CA3014	Forensics of Embedded System	3	0	0	3
4	23CA3019	Ethical Hacking	3	0	0	3
5	23CA3021	Social Media Crimes	3	0	0	3
6	23CA3020	Ethical Hacking Lab	0	0	3	2

S. No	Course Code	Course Title	Credits			
			L	T	P	C
1	24PH1001	Applied Physics for Biotechnology Engineering	2	0	2	3
2	24PH2001	Introduction to Quantum Computing	3	0	0	3
3	24PH2002	Introduction to Astronomy and Space Science	3	0	0	3
4	24PH3001	Nano-Materials for Biomedical Applications	4	0	0	4

Syllabus for B.Sc., Forensic Science (for II and III year – 2023-24 batch onwards)

Course Code	ORGANIC CHEMISTRY FOR FORENSIC SCIENCE	L	T	P	C
23CH2003		3	0	0	3

Course Objectives:

Enable the student to

1. Acquire adequate knowledge on the chemical reactions and their mechanism to synthesize compounds
2. Apply the mechanistic aspects in solving the structures of organic compounds
3. Employ the concepts of stereochemistry in organic compounds and biological molecules during the forensic investigations

Course Outcomes:

Student will be able to

1. Interpret the chemical structures and its bonding characteristics
2. Predict the type of organic reaction mechanisms
3. Assess the structures of heterocyclic compounds during the crime scene investigations
4. Envisage the reaction intermediates
5. Apply the principles of stereochemistry in analyzing organic compounds of forensic importance
6. Recommend the nature of the compounds as evidences during forensic investigations

Module: 1	Electronic Effects and Hybridization	9 Hours
Nature of bonds, Homolysis and heterolysis of bonds, Hybridization in organic molecules – sp, sp ² , sp ³ , sp ^{3d} and sp ^{3d²} . Electron displacement in organic compounds – Inductive, Electronic and Mesomeric effects- Hyperconjugation and Steric effects.		
Module: 2	Aromaticity, Reactive Intermediates and Aromatic Heterocyclic Compounds	9 Hours
Reactive intermediates-carbocation, carbanions, free radicals, carbenes and Nitrenes - Aromaticity and Huckel's rule, Non-benzenoid aromatic compounds. Heterocyclic compounds- structures of pyrrole, furan, pyran, thiophene, pyrazole, pyridine, pyrimidine, indole, imidazole and Quinoline- Forensic Applications of Heterocyclic compounds. Case studies.		
Module: 3	Addition, Substitution and Elimination Reaction Mechanisms	9 Hours
Nucleophilic substitution of alkyl halides: S _N 1 and S _N 2 mechanisms- Walden inversion. Electrophilic addition to ethane and propene- Markownikoff's rule, free radical addition, and peroxide effect. Elimination reactions- E1 and E2 mechanism- Mechanisms of dehydrohalogenation of alkyl halides, Aromatic Electrophilic substitution – mechanism of Nitration, Bromination, Sulphonation and Fridel Crafts reactions- Aromatic nucleophilic substitution.		
Module: 4	Stereochemistry for Forensic Importance	9 Hours
Introduction, types of Isomerism, Conformation and configuration, Rotation about carbon-carbon single bond, conformation of ethane and cyclohexane. Geometrical isomerism: Explanation taking 2-butene, maleic, and fumaric acid as examples. Optical isomerism- Optical activity, Chirality, racemization, and resolution (Lactic acid and tartaric acid examples). Isomers in drugs of Forensic importance.		
Module: 5	Biomolecules	9 Hours

Amino acids – classification and properties. Peptides and proteins - peptide linkage, primary, secondary, tertiary and quaternary structure of proteins, test for proteins. Nucleic acids, structure of DNA and RNA differences, Functions. Enzymes, characteristics, catalytic action, Michaelis-Menten theory- Classification and properties of carbohydrates and lipids. Importance of biomolecules in Forensic Science. Case studies.

Total Lectures	45 Hours

Text Books

1	M.K. Jain, S.C. Sharma. (2019), <i>Modern Organic Chemistry</i> , Vishal Publishing Co.
2	Bahl Arun and Bahl B.S. (2016), <i>Text book of Organic Chemistry</i> , S Chand & Company.
3	I.L Finar. (2002), <i>Organic chemistry – Vol I and II, (6th Ed)</i> . Pearson Education, India.

Reference Books

1	Peter Sykes. (2003), <i>A guide book to mechanism in organic chemistry, (6th Ed)</i> , Pearson Education.
2	C.N. Pillai. (2008), <i>Organic chemistry for undergraduates</i> , Universities Press (India) Pvt Ltd.
3	Tiwari, Mehrothra and Vishnoi. (2017), <i>Text book for Organic Chemistry, (4th Ed)</i> , Vikas Publishing House Pvt. Ltd. New Delhi.
4	Michael B. Smith, Jerry March, (2006), <i>Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, (6th Ed)</i> , John Wiley & Sons, Inc.

Recommended by Board of Studies	13 Feb 2024

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Course Code	FORENSIC CHEMISTRY	L	T	P	C
23CH2004		3	0	0	3

Course Objectives:

Enable the student to

1. Obtain knowledge about petroleum products.
2. Experience the methods of searching and analyzing arson evidence etc.
3. Comprehend the classification of explosives and bomb scene management

Course Outcomes:

Student will be able to

1. Identify the basic properties of Petroleum products.
2. Interpreting the methods of analyzing trace amounts of petroleum products in crime scene evidence.
3. Determining the method of searching, collecting, preserving and analyzing arson evidence.
4. Explain the process of post-fire analysis of materials.
5. Realize the classification of explosives, including the synthesis and characterization of representative analogs.
6. Apply the techniques of locating hidden explosives and directing the significance of bomb scene management.

Module: 1	Petroleum and Petroleum Products	9 Hours

Introduction to Petroleum Products, Properties of Petroleum Products, Origin, Composition, Refining, Reforming, Fractionation, Cracking, Knocking, Octane number, Cetane number, Adulteration of petroleum products, Analysis of Dyes in petroleum products, Forensic exhibits, characterization of petroleum products by flash point, aniline point, cloud point, pour point, GC & GC-DHA. Chemical fingerprinting. Analysis of traces of petroleum products in forensic exhibits. Comparison of petroleum products. Adulteration of petroleum products.

Module: 2	Fire and Arson	9 Hours

Arson: Legal Definition, Arson motives, Degrees of Arson, Forensic and legal Concepts, Chemistry of Fire, Combustion reaction, Fire Triangle, Fire Tetrahedron, Conditions for fire, Backdraft, Thermo-

chemistry of Fire, Combustible and Flammable liquids, Flash point, Fire point, Ignition point, Auto Ignition point, vapor density, vapor pressure, Fire extinguisher. Determining origin and cause; Fire patterns. Case Studies.

Module: 3	Post-Fire Analysis of Materials	9 Hours

Collection/Preservation of Arson Evidences, Flashover, Live or dead at time of arson; Documenting the fire or crime scene; Scheme of analysis: Extraction of samples from debris (Direct and solvent extraction methods, Head Space method, SPME, Distillation), analysis of arson exhibits by color test, TLC, Head-space GC and GC-MS. Analysis of fire debris. Analysis of ignitable liquid residue. Post-flashover burning. Scientific investigation and evaluation of clue materials. Information from smoke staining.

Module: 4	Explosives	9 Hours

Classification of explosives – low explosives and high explosives –Homemade explosives – Military explosives – Blasting agents - detonators - Synthesis and characteristics of TNT, PETN and RDX. IEDs – different types of IEDs. Explosion process. Blast waves. Bomb scene management. Searching the scene of explosion. Mechanism of explosion. Post blast residue collection and analysis. Blast injuries. Detection of hidden explosives. Case Studies.

Module: 5	Analysis of Cement and Construction Materials	9 Hours

Cement, Mortar and Concrete – Composition and types of cement – other building materials – Sampling – methods of analysis of cement, mortar, and concrete – Alternative method. Case Studies.

Total Lectures	45 Hours

Text Books

1	S. Ballou, M. Houck, J.A. Siegel, C.A. Crouse, J.J. Lentini and S. Palenik. (2013), <i>Forensic Science</i> , D.H. Ubelaker (Ed.), Wiley-Blackwell, Chichester.
2	W.J. Tilstone, M.L. Hastrup and C. Hald. (2013), <i>Fisher's, Techniques of Crime Scene Investigation</i> , CRC Press, Boca Raton.
3	J.D. DeHaan. (1991), <i>Kirk's Fire Investigation</i> , (3 rd Ed), Prentice Hall, New Jersey.

Reference Books

1	A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau. (1995), <i>Scientific Evidence in Civil and Criminal Cases</i> , (4 th Ed), The Foundation Press, Inc., New York.
2	R. Saferstein. (2004), <i>Criminalistics</i> , (8 th Ed), Prentice Hall, New Jersey.

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Course Code	FORENSIC TOXICOLOGY	L	T	P	C
23CH2005		3	0	0	3
Course Objectives:					
Enable the student to: 1. Analyze toxic elements 2. Classify and characterize of the narcotics, drugs and psychotropic substances 3. Execute the analysis of pharmacokinetics of drugs in regard of forensic importance					
Course Outcomes:					
The student will be able to: 1. Define the properties of Narcotics, Drugs and Psychotropic Substances 2. Classify the various types of toxins and their analysis as per the nature of crime. 3. Summarize the medicolegal importance of the narcotic drugs and psychotropic substances 4. Identify the post-mortem findings for different poisons 5. Evaluate the forensic identification of illicit liquors. 6. Speculate drugs using various methods					
Module: 1	Narcotics, Drugs and Psychotropic Substances				7 Hours

Broad classification Narcotics, stimulants, depressants, and hallucinogens. General characteristics and classification; Postmortem changes affecting the analysis. Natural, synthetic, and semi-synthetic narcotics drugs and psychotropic substances. Collection and preservation of drug evidence. Presumptive and screening tests for narcotics, drugs and psychotropic substances in breast milk, saliva, urine, hair; antemortem blood and postmortem blood. Dope tests. Instrumental methods- thin layer chromatography, gas – liquid chromatography and high-performance liquid chromatography.

Module: 2	Alcoholic Beverages	9 Hours

Introduction, Definition of alcohol and illicit liquor, Alcoholic and non-alcoholic beverages and their composition, Proof spirit, absorption, de-toxication and excretions of alcohol, Consequences of drunken driving, Estimation of ethyl alcohol in blood and urine, Analytical techniques in the analysis of alcohol and other articles, Crime scene management in illicit liquor cases.

Module: 3	Basics of Toxicology and Poisons	12 Hours

Classification of poisons - Plant Poison, Animal Poison, Metallic Poison, Physico-chemical characteristics, and mode of action of poisons. Animal poisons. Snake venom. Mode of action. Carbon monoxide poisoning. Significance of toxicological findings. Extraction of poisons from viscera. Dose-response relationship.

Module: 4	Drug Dependence and Drug Abuse	9 Hours

Drug Dependence - Drug Addiction - Drug Habituation - Drug Abuse - Aetiology of Drug Dependence - Drug addicts and crimes-Tolerance, addiction and withdrawal symptoms of NDPS – treatment of addiction – NDPS act.

Module: 5	Food Poisoning and Poisonous Foods	8 Hours

Bacterial Food Poisoning - Poisonous Foods – Mushrooms - Metallic Contamination of Food – Symptoms, Diagnosis, Treatment – Food allergy. Case Studies.

Total Lectures	45 Hours

Text Books

1	A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau. (1995), <i>Scientific Evidence in Civil and Criminal Cases</i> , (4 th Ed), The Foundation Press, Inc., New York.
2	R. Saferstein. (2004), <i>Criminalistics</i> , (8 th Ed), Prentice Hall, New Jersey.
3	W.J. Tilstone, M.L. Hastrup and C. Hald. (2013), <i>Fisher's, Techniques of Crime Scene Investigation</i> , CRC Press, Boca Raton.

Reference Books

1	F.G. Hofmann. (1983), <i>A Handbook on Drug and Alcohol abuse</i> , (2 nd Ed), Oxford University Press, New York.
2	S.B. Karch. (1996), <i>The Pathology of Drug Abuse</i> , CRC Press, Boca Raton.
3	<i>Laboratory procedure Manual</i> . (2005), Forensic Toxicology: DFS.
4	A. Poklis. (2009), <i>Introduction of Forensic Sciences</i> , (2 nd Ed).

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Course Code	ORGANIC CHEMISTRY LABORATORY	L	T	P	C
23CH2008		0	0	3	2
Course Objectives:					
Enable the student to					
1. Acquire the relevant technical skills in organic preparations.					
2. Apply the purification techniques to get pure organic compound.					
3. Develop skills to prepare various novel organic compounds.					

Course Outcomes:	
Student will be able to	
1. Design and prepare organic compounds. 2. Purify the prepared organic compound and check the purity. 3. Setup the apparatus for various preparative techniques and synthetic conditions. 4. Predict the mechanism of various synthetic methods. 5. Recognize the importance of distillation, refluxing and recrystallization techniques. 6. Employ various types of reaction to prepare organic compounds.	
List of Experiments	
1. Preparation of Acetanilide from aniline 2. Preparation of <i>p</i>-bromo and <i>p</i>-nitro acetanilide from acetanilide 3. Preparation of 4-Nitrobenzanilide from Aniline 4. Preparation of 2,4,6-tribromo aniline from aniline 5. Preparation of Aspirin from methyl salicylate 6. Extraction and Identification of Caffeine 7. Extraction and Identification of Nicotine 8. Identification of Alkaloids 9. Identification of Basic drugs 10. Identification of volatile organic poisons	
Text Books	
1	A.I. Vogel. (1989), <i>Text book of practical organic chemistry, (5th Ed)</i> , ELBS, London.
2	B.B. Dey and M.V. Sitharaman. (1992), <i>Laboratory manual of Organic Chemistry Revised by T.R. Govindachari, (4th Revised Ed)</i> , Allied Publishers Ltd., New Delhi.
Reference Books	
1	Daniel R. Palleros. (2000), <i>Experimental Organic Chemistry</i> , John Wiley & Sons, Inc., New York.
2	B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell. (1994), <i>Text book of Practical Organic Chemistry</i> , LBS, Singapore.
3	Gnanapragasam N.S., Ramamurthy G. (2011), <i>Organic Chemistry Lab Manual, revised Edition</i> , S. Viswanathan printers and publishers Pvt. Ltd., Chennai, Reprinted.
Recommended by Board of Studies	
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Course Code	ANALYTICAL CHEMISTRY LABORATORY	L	T	P	C
23CH2009		0	0	3	2
Course Objectives:					
Enable the student to					
1. Acquire knowledge on the analytical technique experiments					
2. Recall the fundamentals of colorimetric analysis and chromatography					
3. Explore the crime scene photography and videography					
Course Outcomes:					
Student will be able to					
1. Experiment thin layer chromatography of ink samples					
2. Do the separation of organic compounds by paper chromatography					
3. Examine the crime scene exhibits by photography and videography					
4. Work out problems related to mean, media and standard deviation					
5. Assess the data obtained and report					
6. Apply the analytical techniques in identification of compounds of forensic importance					
List of Experiments					
1. To carry out thin layer chromatography of ink samples					
2. To prepare accurate solutions (Normality, Molarity etc)					
3. Soil comparison analysis. This includes microscopy, pH, color, and density gradient					

measurements.	
4. Analysis of Food - To introduce the student to common UV-Visible spectroscopy as applied to the analysis of food dyes.	
5. Analysis of Synthetic Fiber – To introduce multiple instrumental methods to analyze a synthetic fiber. UV-Vis analysis for Dyes, Microscopy for fiber length and twist, and Fourier Transform Infrared Spectroscopy (FTIR) for synthetic composition will be employed to isolate the fiber sample.	
6. Analysis of Drugs and Pharmaceuticals	
7. Forensic analysis of oils and fats	
8. Forensic Analysis of forensically important cosmetics	
9. To determine the concentration of a colored compound by colorimetry analysis	
10. To carry out separation of organic compounds by paper chromatography	
11. To identify Caffeine samples using UV – visible spectroscopy	
12. To identify Curcumin samples using UV – visible spectroscopy	
13. Forensic analysis of Cement	
14. Work out the problems related to mean, median, mode, standard deviation, probability, Chi-square test, t-test and correlation	
15. Familiarize the technique of data representation (tables, bar-diagram, histogram, pie- diagram and frequency curve (manual and using computer)	
16. Applications of mass spectrometry in forensic science (Minimum 10 Experiments to be conducted)	
Text Books	
1	Frank Lundquist. (1962), <i>Methods of Forensic Science</i> , Vol. 1, New York, Interscience.
2	Frank A. Settle. (1997), <i>Handbook of Instrumental Techniques for Analytical Chemistry</i> , Prentice Hall, Upper Saddle River.
Reference Books	
1	S.H. James and J.J. Nordby. (2005), <i>Forensic Science: An Introduction to scientific and Investigative Techniques</i> , (2 nd Ed), CRC Press, Boca Raton.
2	Thomas Catalano. (2014), <i>Good Laboratory Practices for Forensic Chemistry</i> , Springer.
3	Thomas Kubic and Nicholas Petraco. (2009), <i>Forensic Science Laboratory Manual and Workbook</i> , CRC Press.
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Course Code	FORENSIC TOXICOLOGY LABORATORY	L	T	P	C
23CH2010		0	0	3	2
Course Objectives:					
Enable the student to					
1. Understand the application of forensic in the analysis of traces of drugs and poison					
2. Analyze poisons using screening tests					
3. Classify and characterize the narcotics, drugs and psychotropic substances.					
Course Outcomes:					
Student will be able to					
1. Understand the methods used in the analysis of pesticides					
2. Enumerate screening tests used for the analysis of drugs					
3. Choose an accurate extraction method for the extraction of poison from viscera					
4. Speculate techniques for the identification of poison					
5. Analyze adulterations in food samples					
6. Identify drugs samples using instrumental methods					
List of Experiments					
1. To identify biocides.					
2. To identify metallic poisons.					

- To identify organic poisons. - To identify ethyl alcohol. - To identify methyl alcohol. - To carry out quantitative estimation of ethyl alcohol. - To prepare iodoform. - To identify drugs of abuse by spot tests. - To perform color tests for barbiturates. - To separate drugs of abuse by thin layer chromatography. - To identify toxic anions by color tests - To detect adulterations in milk using color tests (Minimum 10 experiments to be conducted)	
Text Books	
1	R. Saferstein. (2004), <i>Criminalistics</i> , (8 th Ed), Prentice Hall, New Jersey.
2	F.G. Hofmann. (1983), <i>A Handbook on Drug and Alcohol Abuse</i> , (2 nd Ed), Oxford University Press, New York.
Reference Books	
1	S.B. Karch. (1996), <i>The Pathology of Drug Abuse</i> , CRC Press, Boca Raton.
2	A. Poklis. (1997), <i>Forensic toxicology in, Introduction to Forensic Sciences</i> , (2 nd Ed), W.G. Eckert (Ed.), CRC Press, Boca Raton.
3	A.W. Jones. (1988), <i>Enforcement of drink-driving laws by use of per se legal alcohol limits: Blood and/or breath concentration as evidence of impairment, Alcohol, Drug and Driving</i> .
4	W.J. Tilstone, M.L. Hastrup and C. Hald. (2013), <i>Fisher's, Techniques of Crime Scene Investigation</i> , CRC Press, Boca Raton.
5	DFS Manual Narcotics. (2021).
6	DFS Manual Chemistry. (2021).
7	DFS Manual Toxicology. (2021).
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Course Code	ANALYTICAL CHEMISTRY FOR FORENSIC SCIENCE	L	T	P	C
23CH2011		3	0	0	3
Course Objectives:					
Enable the student to					
1. Acquire knowledge about the procedure for handling chemicals and analysis					
2. Analyze the general purification techniques and titrimetric methods					
3. Assess the general separation techniques and thermo analytical methods					
Course Outcomes:					
Student will be able to					
1. Choose the methodology to handle chemicals, heating methods and error analysis					
2. Interpret the principle of techniques used for the purification of compounds					
3. Explore the importance of various titrimetric methods					
4. Get knowledge about solubility criteria, precipitation titrations and gravimetric analysis					
5. Demonstrate the importance of thermo gravimetric, differential thermal and electrogravimetry analysis					
6. Recommend the tools in analytical chemistry for application in forensic science					
Module: 1	Handling of Chemicals and Analysis				9 Hours
Safety and hygiene in the Chemistry lab- Storage and handling of chemicals, handling of acids, ethers, toxic and poisonous chemicals, antidotes, threshold vapor concentration and first aid procedure – Heating methods, stirring methods, filtration techniques – Error in chemical analysis – Accuracy, precision, types of error-absolute and relative error, methods of eliminating or minimizing errors – Methods of expressing precision: mean, median, deviation, average deviation and coefficient of variation – Significant figures and its application with respect to the glassware used - Normal error curve and its importance.					

Module: 2	General Purification Techniques	9 Hours
Purification of solid organic compounds, recrystallization, use of miscible solvents, use of drying agents and their properties, sublimation - Purification of liquids - Experimental techniques of distillation, fractional distillation, distillation under reduced pressure. Extraction, use of immiscible solvents, solvent extraction - Chemical methods of purification and test of purity.		
Module: 3	Titrimetric Methods	9 Hours
General principle - Types of titrations - Requirements for titrimetric analysis - Concentration systems: Molarity, formality, normality, wt%, ppm, milliequivalence and millimoles-problems - Primary and secondary standards, criteria for primary standards – preparation of standard solutions, standardization of solutions - Limitation of volumetric analysis, endpoint and equivalence point - Acid-base equilibria - pH of strong and weak acid solutions - Buffer solutions - Henderson equations - Preparation of acidic and basic buffers. Relative strength of acids and bases from K_a and K_b values - Neutralisation-titration curve, theory of indicators, choice of indicators - Use of phenolphthalein and methyl orange - Complexometric titrations - Stability of complexes, titration involving EDTA - Metal ion indicators and characteristics - Problems based on titrimetric analysis.		
Module: 4	Solubility Equilibria	9 Hours
General separation techniques -Solubility and solubility products, expressions for solubility products - Determination of solubility from solubility products - Precipitation titrations -Argentometric titrations, indicators for precipitation titrations involving silver - Determination of chloride by Volhard’s method - Adsorption indicators - Gravimetric methods of analysis - Separation by precipitation, factors affecting solubility, gravimetric factor. Purity of precipitates, von Weiman ratio - Co-precipitation, post precipitation.		
Module: 5	Thermoanalytical Methods	9 Hours
Thermoanalytical methods - principle involved in thermogravimetric analysis and differential thermal analysis - characteristics of TGA and DTA - thermograms – factors affecting TGA and DTA curves - discussion of various components of the instrument with block diagrams - Applications of thermogravimetry - Applications of DTA - thermometric titration - Electrogravimetry - principle and applications.		
Total Lectures		45 Hours
Text Books		
1	D.A. Skoog, D.M. West and F.J. Holler. (1990), <i>Analytical Chemistry: An Introduction</i> , (5 th Ed), Saunders college publishing, Philadelphia.	
2	U.N. Dash,. (1995), <i>Analytical Chemistry: Theory and Practice</i> , Sultan Chand and sons Educational Publishers, New Delhi.	
Reference Books		
1	R.A. Day Jr. and A.L. Underwood. (1988), <i>Quantitative Analysis</i> , (5 th Ed), Prentice Hall of India Private Ltd., New Delhi.	
2	R. Gopalan, PS Subramanian and K. Rengarajan. (2004), <i>Elements of Analytical Chemistry</i> , S. Chand and Co., New Delhi.	
3	Gurdeep R. Chatwal and Sham K. Anand. (2018), <i>Instrumental Methods of Chemical Analysis</i> , (5 th Ed), Himalayas Publishing House.	
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Course Code	INSTRUMENTAL METHODS OF ANALYSIS	L	T	P	C
23CH2012		3	0	0	3
Course Objectives:					
Enable the student to					
1. Summarize the basic concepts of spectroscopy					

2. Interpret the principles of vibration and electronic spectroscopy		
3. Integrate the principles of radiochemical methods and electrochemical methods		
Course Outcomes:		
The student will be able to		
1. Memorize the principles of atomic spectroscopy		
2. Differentiate between IR and Raman Spectroscopy		
3. Apply the principles of electronic spectroscopy		
4. Infer the principles of NMR spectroscopy		
5. Evaluate the importance of radiochemical methods in forensic science		
6. Adapt electrochemical methods in forensic science		
Module: 1	Basic Concept of Atomic Spectroscopy	10 Hours
Electromagnetic spectrum, various sources of radiation, utility and limitations. Interaction of radiation with matter - Detection of radiation -Atomic Spectrometry – General properties of Electromagnetic Radiation – Atomic Absorption Spectrometry, FAAS- Atomic Fluorescence Spectrometry – Atomic Emission Spectrometry – Atomic Mass Spectrometry - Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES)- Applications		
Module: 2	Principles of UV-Visible Spectroscopy	9 Hours
Molecular Spectroscopy – Introduction to UV-Visible Spectroscopy –Measurement of Transmittance and Absorbance – Beer’s Law and its deviations– Instrumentation – Absorbing Species – Application to Qualitative Analysis – Quantitative Analysis–Molecular Luminescence Spectroscopy– Theory of Fluorescence and Phosphorescence – Instrumentation – Applications of Photoluminescence methods.		
Module: 3	Principles of IR and Raman Spectroscopy	9 Hours
Infrared Spectroscopy– Theory – Infrared Sources and Transducers – Instrumentation –Dispersive and FT instruments - Techniques and Applications – Mid IR Absorption, Mid IR Reflection and Photoacoustic IR Spectroscopy – Near and Far IR Spectroscopy – IR Micro Spectroscopy – Forensic Applications of IR Spectroscopic methods- Raman Spectroscopy – Principles – Instrumentation – Techniques - Applications- FTIR		
Module: 4	Principles of NMR Spectroscopy	8 Hours
Nuclear Magnetic Resonance Spectrometry – Principles, Instrumentation, Techniques (Proton NMR, 13 Carbon NMR, FT- NMR, Magnetic Resonance Imaging-2D NMR and Forensic Applications		
Module: 5	Thermal and Radiochemical Methods	9 Hours
Radiochemical Methods – Radioactive Isotopes - Principles, Instrumentation, Techniques and Application of Neutron Activation Analysis and Isotope Dilution Methods -Application of radiochemical techniques in forensic science - Electrochemical techniques: General principles Electron transport process, Principles, instrumentation, techniques and Thermal analysis techniques such as differential scanning calorimetry (DSC), thermogravimetric analysis (TGA)		
Text Books		
1	P.W. Atkins. (2006), <i>Physical Chemistry</i> , (8 th Ed), Oxford University Press.	
2	Barrow, G. M. (1988), <i>Introduction to Molecular Spectroscopy</i> , McGraw-Hill Inc., USA, ISBN-10: 0070038708, ISBN-13: 978-0070038707	
3	Haswell, S. J. (1991), <i>Atomic Absorption Spectrometry</i> , Elsevier, ISBN:9780444882172.	
4	R M. Silverstein, F. X. Webster, D. J. Kiemle. (2005), <i>Spectrometric identification of organic compounds</i> , (7 th Ed), John Wiley.	
Text Books		
1	Sane, R.T. and Joshi, A.P. (1999), <i>Electroanalytical Chemistry: Theory and Applications</i> , Quest Publications.	
2	Lajunan, L. H. J. (2005), <i>Spectrochemical Analysis by Atomic Absorption and Emission</i> , Royal Society of Chemistry. ISBN-10: 0854046240 ISBN-13: 978-0854046249.	

3	Sharma, B. K. (2011), <i>Instrumental Methods of Chemical Analysis</i> , Krishna Prakashan Media p Ltd, ISBN-10: 8182830990; ISBN-13: 978-8182830998.	
4	Verma, R. M. (1994), <i>Analytical Chemistry, Theory and Practice, (3rd Ed)</i> , CBS.	
5	Skoog D. A, West D. M, Holler F. J & Crouch S. R. (2004), <i>Fundamentals of Analytical Chemistry, 8th Ed</i>), Cengage Learning India Pvt. Ltd”, New Delhi, India,	
6	Day R. A.& Underwood A. L. (2006), <i>Quantitative Analysis, (6th Ed)</i> , Printice Hall of India Pvt Ltd, New Delhi.	
Recommended by Board of Studies		13 Feb 2024
Approved by Academic Council		24 Feb 2024

Course Code	BIOCHEMISTRY	L	T	P	C
23CH2013		3	0	0	3
Course Objectives:					
Enable the student to: 1. Outline the basic concepts of biochemistry 2. Summarize the role of biomolecules 3. Infer the importance of electrophoresis					
Course Outcomes:					
The student will be able to: 1. Identify the various types of biomolecules 2. Review the role of biomolecules such as amino acids and proteins 3. Relate to concepts of enzyme kinetics. 4. Illustrate antigen- antibody interactions. 5. Differentiate techniques based on application. 6. Assess the role of electrophoretic techniques.					
Module: 1	Nucleic Acids				9 Hours
Basic elements of life - Biomolecules and cells. Hierarchy of molecular organization of cells Biomolecules and cell organelles- Structural organization of cells. Replication. Nitrogenous bases, Nucleotides, Nucleic acids –types of nucleic acids. physical- chemical basis for the structures of nucleic acids, proteins, and carbohydrates.					
Module: 2	Amino Acids				9 Hours
mRNA- Transcription- Amino acids — Essential and non-essential amino acids- Physicochemical properties – Absorption spectra – Chemical reactions– Analysis of amino acid mixtures – Complete hydrolysis of polypeptide chains and determination of amino acid composition –N-terminal and C-terminal residues of peptides.					
Module: 3	Proteins				9 Hours
Translation - tRNA - Mutation – Structure of peptides– Composition of proteins – Estimation of proteins. Sequence isomerism in polypeptide chains– Optical and chemical properties of peptides. General metabolism of carbohydrates, fats, and nitrogen-containing materials such as amino acids, proteins.					
Module: 4	Enzymes				9 Hours
Enzymes – Definition, types and classification - Biological activities – Kinetics – Inhibition - Types of inhibition – Micheles-Mentor’s equation – Enzyme polymorphism – Purification of proteins and enzymes – Enzyme assay techniques: UV-Vis, Luminescence, Radio isotope and immunochemical methods – Automated enzyme analysis – Immobilized enzymes.					
Module: 5	Techniques				9 Hours
Chemistry and functions of constituents of cells and tissues. Cell fractionation- pH and buffers - Biochemical techniques - determination of amino acid sequence – Sequence analysis of peptide fragments – Forensic Application of electrophoresis. Case study.					
Total Lectures					45 Hours
Text Books					
1	Lodish, H., Berk, A., Kaiser, C. A., Kaiser, C., Krieger, M., Scott, M. P., & Matsudaira, P. (2019), <i>Molecular cell biology</i> , (9 th Ed), Macmillan.				
2	Nelson, D. L., and Cox, M. M. (2000), <i>Lehninger Principles of Biochemistry</i> , (3 rd Ed), Macmillan Worth.				

Reference Books	
1	Berg M, Stryer. L, Tymczko. (2019), <i>Biochemistry</i> , (9 th Ed), WH Freeman.
2	Voet, D. and Voet, J.G. (1995), <i>Biochemistry</i> , (2 nd Ed), John Wiley.
3	Turner, P.C, McLennan, A. G., Bates, A. D., and White, M. R. H. (2001), <i>Molecular Biology</i> , (2 nd Ed), BioScientific/Viva Books.
4	Rao, P. Gundu. (1995), <i>Biochemistry</i> , Vallabh Prakashan.
Recommended by Board of Studies	
13 Feb 2024	
Approved by Academic Council	
24 Feb 2024	

Course Code	NANOCHEMISTRY FOR FORENSIC SCIENCE	L	T	P	C
23CH2014		3	0	0	3

Course Objectives:

Enable the student to:

1. Acquire knowledge about the science of nanomaterials
2. Explore the synthesis of nanomaterials
3. Apply the use of nanomaterials in Forensic Science

Course Outcomes:

The student will be able to:

1. Identify the evolution of nanotechnology
2. Understand the classification of nanomaterials
3. Interpret the various types and synthesis of nanomaterials
4. Characterize the nano-sized materials
5. Evaluate the applications of nanomaterials
6. Recommend and utilize nanomaterials in forensic science

Module: 1	Basics of Nanotechnology	9 Hours
Historical landmarks - terminology-scales. Classification of nanomaterials based on dimension - Top-down and bottom-up approaches - Comparison – Challenges in nanotechnology - Top-down methods – Core-shell nanomaterials – Toxic effect of nanomaterials- Existing laws and regulations of nanotechnology- regulatory agencies- - green nanotechnology- Nano ethics - future of nanotechnology.		
Module: 2	Synthesis of Nanomaterials	9 Hours
Synthesis of metallic, semiconductor, and oxide nanoparticles - sol-gel- method – Synthesis by reduction - One-dimensional nanoparticles - nanowires and nanorods – VLS method – electrospinning – Lithography – Two-dimensional nanomaterials – PVD – Molecular beam epitaxy - CVD - Self Assembly		
Module: 3	Special Nanomaterials and Methods	9 Hours
Fullerenes – types - carbon nanotubes – types - Micro and mesoporous nanomaterials – Soft lithography - Dip pen nanolithography.		
Module: 4	Applications of Nanotechnology-I	9 Hours
Applications of nanotechnology in various fields – Electronics, Catalysis, and Biology - Nanobiology and its applications- Nanomedicines- immuno targeted drug delivery-- nanoparticle drug systems for oral, nasal, and ocular administration- nanomaterials in medical diagnosis - therapeutic applications. Nanosensors- smart dusts.		
Module: 5	Applications of Nanotechnology-II	9 Hours
Utilization of nanotechnology in the analysis of physical evidence, and selectivity of nanoparticles with compatibility and feasibility. Applications of nanotechnology in forensic evidence analysis- Forensic Applications: Collection and analysis of evidence of different types of crime scenes including drugs, DNA analysis, blood splattering, serology, toxicology.		
Total Lectures		45 Hours

Text Books

- 1 Guozhong Cao. (2004), *Nanostructures and Nanomaterials: Synthesis, Properties and Applications*, Imperial press.
- 2 Pradeep. (2007), *Nano: The Essentials*, Mc Graw Hill Publishing Company, New Delhi.

Reference Books

- 1 V. S. Muraleedharan and A. Subramani. (2009), *Nanoscience and nanotechnology*, Ane Books Pvt. Ltd. New Delhi.

2	Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse. (2005), <i>Nanotechnology: Basic Science and Emerging Technologies</i> , Overseas Press.
3	CNR Rao. (2006), <i>The Chemistry of Nanomaterial: Synthesis, Properties and Applications, Vol. I and II</i> , Springer.
4	L. E. Foster, (2008). <i>Nanotechnology: Science, Innovation and Opportunity</i> , Pearson Education.
5	K. J. Klabunde. (2009), <i>Nanoscale materials in chemistry</i> , John Wiley and Sons.
6	R. Booker, E. Boysen. (2008), <i>Nanotechnology</i> , Wiley India Pvt Ltd.
Recommended by the Board of Studies	13 Feb 2024
Approved by Academic Council	24 Feb 2024

Course Code	MODERN INSTRUMENTAL METHODS IN FORENSIC SCIENCE	L	T	P	C
23CH2015		3	0	0	3

Course Objectives:

Enable the student to

1. Acquire knowledge on the concepts of absorption and emission spectroscopic techniques
2. Integrate the importance of electrochemical techniques in forensic investigation
3. Apply the radio analytical techniques and sensors

Course Outcomes:

Student will be able to

1. Employ the principles and application of IR and NMR spectroscopy techniques
2. Interpret the forensic applications of UV and visible spectroscopic techniques
3. Identify the principle and instrumentation of fluorescence and phosphorescence spectrophotometry
4. Distinguish various electrochemical techniques in forensic science
5. Evaluate the principle of radio analytical techniques
6. Predict concepts and forensic applications of advanced techniques

Module: 1	Introduction to IR and NMR Spectroscopy	9 Hours
Introduction – Properties of light, interaction of matter and light - Electromagnetic spectrum – Infrared (IR) spectroscopy, theory, Sample preparation techniques, instrumentation, and its application in forensic Science –Nuclear magnetic resonance (NMR) spectroscopy, theory, Chemical shift, instrumentation and its application in forensic science.		
Module: 2	Ultraviolet and Visible Spectroscopy	9 Hours
Ultra violet (UV) and visible spectrophotometry – Types of sources and stability, wavelength selection, filters – cells and sampling devices, detectors, resolution, qualitative detection and quantitative measurements – Applications in studying reaction kinetics and dynamic processes in forensic samples.		
Module: 3	Fluorescence and Phosphorescence Spectrophotometry	9 Hours
Fluorescence and phosphorescence spectrophotometry – Types of sources, structural factors, instrumentation – Jablonski Diagram – factors affecting Fluorescence - Advanced Fluorescence Techniques: Fluorescence lifetime imaging microscopy (FLIM) - application in forensic science. Case Studies.		
Module: 4	Electrochemical Methods	9 Hours
Electrochemical techniques – Introduction – Principles, instrumentation, techniques and applications of potentiometry, coulometry, polarography and ion selective electrodes - Case Studies.		
Module: 5	X-Ray Spectrometry and Sensors	9 Hours
X-ray spectrometry - Electrophoresis – fundamental principles and forensic applications – Advanced Applications of X-ray Spectrometry: X-ray fluorescence (XRF) and X-ray diffraction (XRD) in forensic material analysis – Introduction to sensors – Biosensors and chemosensors.		

Total Lectures		45 Hours
Text Books		
1	D.A. Skoog, D.M. West and F.J. Holler. (1990), <i>Analytical Chemistry: An Introduction, (5th Ed)</i> , Saunders college publishing, Philadelphia.	
2	F.A. Settle. (1997), <i>Handbook of Instrumental Techniques for Analytical Chemistry</i> , Prentice Hall.	
3	James W. Robinson. (1996), <i>Atomic spectroscopy, (2nd Ed)</i> , Marcel Dekkar, Inc., NY.	
Reference Books		
1	S.H. James and J.J. Nordby. (2003), <i>Forensic Science – An introduction to scientific and investigative techniques</i> , CRC press, USA,	
2	Gurdeep R Chatwal & Sham K. Anand (2004), <i>Instrumental methods of chemical analysis</i> , Himalaya Publishing House.	
Recommended by Board of Studies		13 Feb 2024
Approved by Academic Council		24 Feb 2024

Course code	CRIME AND SOCIETY	L	T	P	C
23FS2004		3	0	0	3

Course Objectives

Enable the students to:

1. Acquire the knowledge about fundamentals of Crime in society.
2. Discuss various crimes and its causes.
3. Explore different theories of criminology.

Course Outcomes

The student will be able to:

1. Examine all types of crime in society
2. Identify the potential applications of Forensic Science in prevention of crime
3. Summarize the different theories of crime and criminal justice
4. Infer the principles of IPC, CrPC.
5. Evaluate the various types of offenses.
6. Report the consequences of crime in society.

Module: 1	Concepts and Theories of Crime	9 Hours
Crime: Nature and definition - Characteristics of crime in modern society - Causes of crime (social, economic, political and cultural) - Theories of Criminology–Rational Choice Theory - Biological Theory - Positive School of Theory - Chicago School of Thoughts - Social Learning/Differential Association Theory - Juvenile Delinquency Theory – Conflict Theory - Critical Theory - Labeling Theory- Multiple Causation Approach—Sociological aspects of crime and criminals in society.		
Module: 2	Forms of Crime	9 Hours
Types of crime and its causes – property crimes, public order crimes, violent crimes, cyber-crimes, juvenile delinquency–Crime against Women: Meaning, forms and causes (Sex selective abortions, domestic violence, dowry deaths, sexual abuse, sexual harassment at work place, rape, violence, trafficking etc.) – White collar crimes – Organized crime– Terrorism– Custodial crime: Meaning and features– Case study regarding all types of crime.		
Module: 3	Emerging Crimes	9 Hours
Corporate crime - Human rights violation: Genocide, Torture, and Human Trafficking- Cybercrime: Phishing, Social Engineering, and Data Manipulation- Criminalization of politics - Environmental crimes - International crimes. Psychological Factors Influencing Criminal Behavior in Youth– Case studies.		
Module: 4	Crime Prevention and Punishment	9 Hours
Different agencies involved in crime detection and prevention- Deterrent Theory - Preventive theory - Reformatory theory - Punishment, prison (Central jail and lock-up system in Police stations) and		

alternative imprisonment (open prison, probation, parole) - Rehabilitation of prisoners - Human right perspective - Crime and the role of media.

Module: 5	Introduction to IPC, CRPC	9 Hours
Introduction to IPC (Indian Penal Code) and CrPC– History– IPC Sections: 302, 304, 307, 376, 377, 420, 463, 354, 376A, 376AB– CrPC Sections: 154, 161, 173, 162, 164,291,292, 293–Court Testimony-admissibility of expert testimony, Examination in chief, Cross Examination and Re-examination.		
Total Lectures		45 Hours
Text Books		
1	Ahuja Ram. (2000), <i>Criminology</i> , Rawat Publishers & Distributors, Jaipur.	
2	Bhosale, Smriti. (2009), <i>Female Crime in India</i> , Kalpaz Publications, New Delhi.	
3	Ahuja Ram. (1997), <i>Social Problems in India</i> , Rawat Publications, Delhi and Jaipur.	
Reference Books		
1	Gill, S.S. (1998), <i>The Pathology of Corruption</i> , HarperCollins Publishers, New Delhi.	
2	Russel, William. (1964), <i>Crime: Vol. I & II</i> , Stevens and sons, London.	
3	Tapas K. Banarjee. (1963), Background to Indian Criminal Law, Cambray, Kolkata.	
4	Goel, Rakesh and Manohar Powat. (1994), <i>Computer Crime: Concept, Control and Prevention</i> . Saymson Computers Pvt. Ltd., Bombay.	
Recommended by Board of Studies		13 Feb 2024
Approved by Academic Council		24 Feb 2024

Course Code	CRIME SCENE INVESTIGATION	L	T	P	C
23FS2005		3	0	0	3

Course Objectives:

Enable the student to

1. Compare the concepts of crime and crime scene
2. Demonstrate the documentation of the crime scene
3. Assess the preservation method of evidence.

Course Outcomes:

Student will be able to

1. Enumerate the reasons for committing crime and types of crime scenes
2. Appraise the objectives of documentation and evidence classification
3. Sketch the methods relevant to crime scene documentation
4. Explain the methodology of collecting, packaging and preservation of evidences
5. Analyze the concepts of crime scene reconstruction
6. Evaluate the stages of crime scene reconstruction

Module: 1	Crime and Crime Scene - I	9 Hours
Definition of crime - IPC and crime – Factors involved in Crime (Mens Rea, etc) - reasons for committing crime in India and worldwide - Crime scene, Types of crime scenes: primary, secondary, indoor, outdoor, Macroscopic, Microscopic - Role of medico legal experts, judicial officers, Case studies.		
Module: 2	Crime and Crime Scene - II	9 Hours
Actions of First responding officer, Evidence- Definition– evidence classification - direct, circumstantial physical, biological, corroborative, conclusive, trace, and testimonial. Report writing, chain of custody, brief knowledge about detective and detective agencies in India, overview of criminal profiling, famous case studies solved with the help of criminologists.		
Module: 3	Documenting Crime Scene	9 Hours
Documentation method of Crime Scene: crime scene photography, crime scene notes - Crime scene sketching: indoor and outdoor, triangulation method, baseline method, polar coordinate method - Searching method: objectives search patterns - strip method, grid method, zone/quadrant method spiral method (inward and outward), point to point method, wheel method, Surveillance and its importance		

Module: 4	Preservation of Evidences	9 Hours
Collection, packaging, Sealing and preservation of evidences and general considerations for collection - Physical evidences: fingerprints, impressions (tire prints, footprints, lip prints, bite marks), fiber, trace evidences (glass, soil, paint) firearms and tool marks, explosive materials, questioned documents Biological evidences: body fluids (blood, urine, semen, and secretions), tissue, hair, and nail.		
Module: 5	Interrogation and its Importance	9 Hours
Interrogation, process, types of interrogation, four parts of interrogation, structure of an interrogation, interpretation of verbal and physical behavior. Interviewing, preplanning the interview, supporting tactics, structure of an investigative interview, specialized investigative techniques-polygraph, voice stress analysis.		
Total Lectures		45 Hours
Text Books		
1	Barry A. J. Fisher, Barry A. J. Fisher, David R. Fisher, David R. Fisher. (2012), <i>Techniques of crime scene investigation</i> , CRC Press.	
2	Tom Bevel, Ross M. Gardner. (2008), <i>Bloodstain Pattern Analysis with an Introduction to Crime Scene Reconstruction</i> , (3 rd Ed), CRC Press.	
Reference Books		
1	Suzanne Bell. (2019), <i>Forensic Science: An Introduction to Scientific and Investigative Techniques</i> , (5 th Ed), CRC Press, 2019.	
2	Stuart H James and Jon J Nordby. (2007), <i>An Introduction to Forensic Scientific and Investigative Techniques</i> , (3 rd Ed), CRC Press.	
Recommended by Board of Studies		13 Feb 2024
Approved by Academic Council		24 Feb 2024

Course Code	FINGER PRINT ANALYSIS	L	T	P	C
23FS2006		3	0	0	3
Course Objectives:					
Enable the student to					
1. Attain knowledge on types and importance of fingerprinting					
2. Gain insight of methods to develop the fingerprints					
3. Explore other types impressions in the crime scene region					
Course Outcomes:					
Student will be able to					
1. Determine the fundamental principles on which the science of fingerprinting is based.					
2. Interpret the importance of fingerprints					
3. Examine the methods of recording fingerprints					
4. Asses the methods of classifying criminal records by fingerprints					
5. Explain the ways of physical and chemical techniques of developing fingerprints on crime scene evidence.					
6. Establish the significance of foot, palm, ear and lip prints obtained from the crime scenes					
Module: 1	Basics of Fingerprinting				9 Hours
Introduction and history, with special reference to India. Biological basis of fingerprints. Formation of ridges. Fundamental principles of fingerprinting. Types of fingerprints. Fingerprint patterns. Fingerprint characters. Plain and rolled fingerprints. Classification					
Module: 2	Recording Fingerprint				9 Hours

Procedure and module for fingerprint recording. Automated Fingerprint Identification System. Classification of fingerprints. Significance of poroscopy and edgeoscopy.		
Module: 3	Development of Fingerprints	9 Hours
Latent prints. Constituents of sweat residue. Latent fingerprints’ detection by physical and chemical techniques. Mechanism of detection of fingerprints by different developing reagents.		
Module: 4	Advance Methods of Fingerprint Development	9 Hours
Application of light sources in fingerprint detection. Preservation of developed fingerprints. Digital imaging for fingerprint enhancement. Fingerprinting the deceased. Developing fingerprints on gloves.		
Module: 5	Foot Prints and Other Impressions	9 Hours
Importance of footprints. Casting of foot prints, Electrostatic lifting of latent foot prints. Palm prints - Lip prints – Nature, location, collection and examination of lip prints. Ear prints and their significance. Palm prints and their historical importance		
Total Lectures		45 Hours
Text Books		
1	J.E. Cowger. (1983), <i>Friction Ridge Skin</i> , CRC Press, Boca Raton.	
2	D.A. Ashbaugh. (2000), <i>Quantitative-Qualitative Friction Ridge Analysis</i> , CRC Press, Boca Raton.	
Reference Books		
1	C. Champod, C. Lennard, P. Margot an M. Stoilovic. (2004), <i>Fingerprints and other Ridge Skin Impressions</i> , CRC Press, Boca Raton.	
2	Lee and Gaensleen’s. (2013), <i>Advances in Fingerprint Technology</i> , (3 rd Ed), R.S. Ramotowski (Ed.), CRC Press, Boca Raton.	
Recommended by Board of Studies		13 Feb 2024
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Course Code	BASIC BIOLOGY FOR FORENSIC SCIENCE	L	T	P	C
23FS2007		3	0	0	3
Course Objectives:					
Enable the student to: 1. Gain knowledge on the concepts of cell biology. 2. Relate plant and human physiology 3. Explore the basics of biology to Forensics.					
Course Outcomes:					
The student will be able to: 1. Adapt the concepts of cell biology 2. Infer the physiology of plants. 3. Asses the forensics aspects of human physiology. 4. Interpret Antigen antibody interactions 5. Relate antigen antibody interactions to serology 6. Justify the role of microbiology in forensics.					
Module: 1	Cell Biology				9 Hours
Origin of life and theories of evolution, geological time scale, Discovery of cell, The cell theory, Ultra structure of prokaryotic & eukaryotic cell-(both plant and animal cells), Structural organization and functions of plasma membrane and cell wall of prokaryotes & eukaryotes. Cellular Organelles and Cytoskeleton structures.					
Module: 2	Plant Physiology				9 Hours

Plant anatomy, morphology of leaves, stem, flowers, roots, classification and taxonomy and system of classification of angiosperms (Bentham and Hooker) and Gymnosperms (chamberlain) scale. Mechanical and conducting tissue systems in plants.		
Module: 3	Human Physiology	9 Hours
Introduction to Nervous system, respiratory system, digestive system, circulatory system, endocrine system, blood and its function, composition of blood, formation of blood cells, types of blood cells, and blood groups		
Module: 4	Immunity	9 Hours
Definition, types-natural, acquired, active, passive. Antigens-Definition, types of antigens, Factors influencing antigenicity; Antibody-Definition, structure, types, properties and functions of Immunoglobulin, Agglutination, Precipitation.		
Module: 5	Basics of Microbiology	5 Hours
Concept of pure culture technique, stains and staining techniques, Control of Microorganisms: Physical & Chemical methods of control, microscopy principle and types of Microscopy, Broad classification of microorganisms. Case study.		
Total Lectures		45 Hours
Text Books		
1	P.K Gupta. (2012), <i>Cell and molecular biology (3rd Ed)</i> Rastogi publications	
2	Prescott. (2008), <i>Harley Klein's Microbiology</i> , Willey, Sherwood, Mc-Graw Hill.	
Reference Books		
1	Pelczar. (1993), <i>Microbiology</i> , Tata McGraw-Hill Education.	
2	Watson, Baker. (2017), <i>Molecular Biology of Gene (5th Ed)</i> Pearson.	
3	Goldsby, Kindt, Osborne. (2019), <i>Kuby's Immunology (6th Ed)</i> , W.H Freeman and company, NewYork.	
4	Daniel Chiras. (2018), <i>Human biology (5th Ed)</i> , Jones and Bartlett publishers	
Recommended by Board of Studies		13 Feb 2024
Approved by Academic Council		24 Feb 2024

Course Code	QUESTIONED DOCUMENT	L	T	P	C
23FS2008		3	0	0	3
Course Objectives:					
Enable the student to:					
1. Explore the intricacies of analyzing questioned document using various detection apparatus					
2. Identify the forgery by comparing documents					
3. Analyze security documents					
Course Outcomes:					
The student will be able to:					
1. Identify the correct method to examine the questioned documents					
2. Apply various method to analyze questioned documents					
3. Compare the questioned documents with standards					
4. Adopt appropriate methods to analyze the questioned documents of various types					
5. Assess the security features of security documents					
6. Recommend innovative techniques to analyze counterfeited documents					
Module: 1	Nature and Scope of Questioned Documents			7 Hours	
Definition of questioned documents - Types of questioned documents - Preliminary examination of documents - Basic tools needed for forensic documents - Relevant Provisions of related laws.					
Module: 2	Examination of Questioned Documents			9 Hours	
Examination - ultraviolet, visible, infrared and fluorescence spectroscopy, photomicrography, microphotography, visible spectral comparator, electrostatic detection apparatus, stereo microscope, comparison microscope, polarizing microscope - Spectrographic analysis of metals in ink - Electrophoresis, Image enhancement using photography and scanning method					
Module: 3	Comparison of Documents			12 Hours	

Principles of identification of handwriting. Individual characteristics & Factors affecting handwriting - Physiology of writing: Rules and physiological principles of handwriting - Definition & different handwriting systems - Normal variations and fundamental divergences in handwritings - Class and individual characteristics - Merits and demerits of exemplar and non-exemplar samples during comparison of handwriting - Methods of collecting standards for comparison, Standards for comparison of handwriting.

Module: 4	Forgeries	9 Hours

Alterations in documents, including erasures, additions, over-writings and obliterations - Indented and invisible writings - Charred documents - Disguised writing and methods of identification Determining the age and relative age of documents.

Module: 5	Examination of Forgery	8 Hours

Examination of counterfeit Indian currency notes, passports, visas and stamp papers - Disguised writing and anonymous letters - Examination of paper, ink, printed documents, typed documents, Xeroxed documents, Examination of rubber stamps, seals and mechanical impressions.

Total Lectures	45 Hours

Text Books

1	O. Hilton. (1982), <i>Scientific Examination of Questioned Documents</i> , CRC Press, Boca Raton.
2	A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau. (1995), <i>Scientific Evidence in Civil and Criminal Cases</i> , (4 th Ed), Foundation Press, New York.

Reference Books

3	R.N. Morris. (2000), <i>Forensic Handwriting Identification: Fundamental Concepts and Principles</i> , Academic Press, London.
4	E. David. (1997), <i>The Scientific Examination of Documents – Methods and Techniques</i> , (2 nd Ed), Taylor & Francis, Hants.

Recommended by Board of Studies	13 Feb 2024

Approved by Academic Council	24 Feb 2024

Course Code	FORENSIC BALLISTICS	L	T	P	C
23FS2009		3	0	0	3

Course Objectives:

Enable the student to

1. Identify firearms and their classification
2. Analyze ammunition and fire marks.
3. Validate the nature of fireman injuries.

Course Outcomes:

Student will be able to

1. Assess the detailed classification of firearms.
2. Distinguish types of ammunition and headstamp markings on ammunition.
3. Examine various kinds of firing marks.
4. Evaluate the types of firearm evidences
5. Predict the mechanism of formation of gunshot residues
6. Infer the nature of fireman injuries.

Module: 1	Firearms	10 Hours

History, development and classification of firearms - Weapon types and their operation - Internal ballistics - Definition, ignition of propellants, shape and size of propellants, manner of burning, and factors affecting the internal ballistics: lock time, ignition time, barrel time, erosion, corrosion and gas cutting.

External Ballistics - Vacuum trajectory, effect of air resistance on trajectory, base drag, drop, drift, yaw, shape of projectile and stability, trajectory computation, ballistics coefficient and limiting velocity, Measurements of trajectory parameters-Ballistic Table.

Terminal Ballistics - Effect of projectile on hitting the target: function of bullet shape - Influence of range
 Cavitations - Temporary and permanent cavities, tumbling of bullets, Illegal firearms - Assault Rifles - Ricochet and its effects, stopping power.

Module: 2	Ammunition and Firing Marks	12 Hours

Types of ammunition-classification and constructional features of different types of cartridges and bullets-Primers and priming compounds. Projectiles. Headstamp markings on ammunitions - Various kinds of firing marks - rifling marks, base marking, chamber marking, extraction and Ejection marking-Stereo- Comparison microscope – instrumentation

Module: 3	Firearm Evidence	7 Hours

Matching of bullets and cartridge cases in regular firearms. Identification of bullets, pellets and wads fired from improvised, country made firearms - BDAS, IBIS - Determination of range of fire and time of fire.

Module: 4	Gunshot Residues	7 Hours

Composition of GSR, Location & Collection, Mechanism of formation - Instrumental techniques involved in analysis

Module: 5	Identification and Nature of Fireman Injuries	9 Hours

Identification and nature of fireman injuries, Shotgun, pistol, revolver, rifle, air guns. Bullet and shot hole examinations - entry and exit hole determination - Estimation of caliber from bullet holes - Wave and cavitation effect - Bullet and trajectory through glass and other targets - Reconstruction with respect to accident, suicide, murder and self-defense.

Total Lectures	45 Hours

Text Books

1	B.J. Heard. (1997), <i>Handbook of Firearms and Ballistics</i> , Wiley and Sons, Chichester.
2	W.F. Rowe. (2000), <i>Firearms identification, Forensic Science Handbook</i> , Vol. 2, R. Saferstein (Ed.), Prentice Hall, New Jersey.
3	A.J. Schwoeble and D.L. Exline. (2000), <i>Current Methods in Forensic Gunshot Residue Analysis</i> , CRC Press, Boca Raton.
4	J. A. Siegel, P.J. Saukko and G.C. Knupfer. (2000), <i>Encyclopedia of Forensic Science</i> , Volume 2, Academic Press, London.
5	T.J. Gardener and T.M. Anderson. (2001), <i>Criminal Evidence</i> , (4 th Ed), Wadsworth, Belmont.
6	S.H. James and J.J. Nordby. (2005), <i>Forensic Science: An Introduction to Scientific and Investigative Techniques</i> , (2 nd Ed), CRC Press, Boca Raton.

Reference Books

1	Karl G. Sellier. (2018), <i>Wound Ballistics and The Scientific Background</i> , Elsevier, London
2	W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's. (2013), <i>Techniques of Crime Scene Investigation</i> , CRC Press, Boca Raton.

Recommended by Board of Studies	13 Feb 2024

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Course Code	FORENSIC PSYCHOLOGY	L	T	P	C
23FS2010		3	0	0	3

Course Objectives:

Enable the student to

1. Gain Adequate knowledge of forensic psychology and criminal behavior.
2. Explore aspects of Psychology in forensics
3. Identify tools for narco analysis and Polygraph

Course Outcomes:		
Student will be able to		
1. Develop the basics of psychology 2. Evaluate Psychological insight in forensic science 3. Asses the significance of psychological assessment 4. Outline the principles of polygraph 5. Explore the procedures for narco analysis 6. Demonstrate brain electrical oscillation signatures.		
Module: 1	Introduction to Forensic Psychology: Investigative Psychology	9 Hours
Investigative psychology Criminal Psychological Profiling-Nature, Definition. Psychological Investigative Tools - Mental Status Examination, Psychological Testing, Polygraph Testing. Narco Analysis - Theoretical Viewpoint of Narco analysis, Procedural Requirements, Methodology and Ethical Considerations. Forensic Hypnosis, Brain Electrical Oscillation Signature Profiling - Scientific base of BEOS, Knowing and Remembrance Psychological Autopsy - Modus Operandi		
Module: 2	Criminal Behavior	9 Hours
Causes of Criminal Behavior and Psychological Therapies Major Disorders and its Symptoms and Features of ADHD, Conduct Disorder, Antisocial Personality Disorder, Substance-Use Disorder. Psychoanalytic Therapy - Free Association, Resistance, Dream Analysis, Manifest Contents, Latent Contents, Transference, Interpretation, Behavior Therapy-Systematic Desensitization, Assertive Training, Modeling, Token Economy, Aversive Conditioning. Cognitive Behavior Therapy- REBT Model, Aron Beck's Cognitive Therapy. Biofeedback		
Module: 3	Psychological Assessment	9 Hours
Psychological Assessment Tools, Detection of deception, Various methods for detection of deception, Interview, Non-verbal detection, statement assessment, Hypnosis, Psychological assessment - (Tests used in Forensic Psychology Assessment: Intelligence Tests, Achievement and Aptitude Tests, Personality Tests, MMPI Test, Rorschach Test, Thematic Apperception Test, Neuropsychological tests, Mens rea, diminished capacity, Forensic Behavioral Analysis, voice stress analyzer, Thermal imaging, Functional Magnetic Resonance study, Current research in detection of deception/truth finding mechanisms		
Module: 4	Polygraph & Narco Analysis	9 Hours
Historical aspects of Polygraph and Narco analysis, Principles of polygraph & Narco analysis, psycho physiological aspects, operational aspects, Question formulation techniques, Interviewing technique procedure, The Art - Polygraph, Legal and Ethical aspects, Human rights of individuals. Admissibility of Polygraph and Narco analysis evidence in court of law.		
Module: 5	Rehabilitation & Counseling	9 Hours
Rehabilitation- Models of Rehabilitation - Psychiatric Rehabilitation, Psychological Rehabilitation, Cognitive Rehabilitation and Social Rehabilitation. Rehabilitation of Prisoners, Rehabilitating victims of crime. Counseling - Definition, Nature of Counseling, Goals of Counseling, Levels of Counseling Techniques. Counseling Process - Relationship Establishment, Problem Identification & Exploration, Planning for Problem Solving, Solution Application & Termination. Characteristic of Counsellor, Type of counseling: Crisis, Preventive Skill to counsel criminal		
Total Lectures		45 Hours
Text Books		
1	Sharma, B.R. (2014), <i>Forensic Science in Criminal Investigation & Trials</i> , (5 th Ed), Universal Law Publishing – An imprint of LexisNexis.	
2	Weiner, I.B., Hess, A.K. (2005), <i>The Handbook of Forensic Psychology</i> , (3 rd Ed), John Wiley & Sons.	
3	O'Donohue, W., Levensky, E. (2003), <i>Handbook of Forensic Psychology</i> , Academic Press.	

4	Mukundan, C.R. (2007), <i>Brain Experience: Neuroexperiential Perspectives of Brain-Mind</i> , Atlantic.
5	Turvey, B. (2011), <i>Criminal Profiling - An Introduction to Behavioral Evidence Analysis</i> , Academic Press.

Reference Books

1	Niehaus, J. (1998), <i>Investigative Forensic Hypnosis</i> , (1 st Ed), CRC Press.
2	Matte, J.A. (1980), <i>Art and Science of the Polygraph Technique</i> .
3	Kleiner, M. (2001), <i>Handbook of Polygraph Testing</i> , Academic Press.
4	Vrij, A. (2008), <i>Detecting Lies and Deceit: Pitfalls and Opportunities</i> , (2 nd Ed), John Wiley & Sons.
5	Ramachandran, (2017), <i>Law of Narco-Analysis Right Against Self-Incrimination</i> , Lawmann's, New Delhi.

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Course Code	FORENSIC BIOLOGY	L	T	P	C
23FS2011		3	0	0	3

Course Objectives:

Enable the student to:

1. Gain knowledge on the concepts related to biological fluids.
2. Explore the methods to analyze biological evidences.
3. Report the biological evidence present at the crime scene.

Course Outcomes:

The student will be able to:

1. Review the basics of forensic biology.
2. Predict the methodology for analysis.
3. Relate the evidences to their source of origin.
4. Distinguish between different biological evidences.
5. Differentiate between preliminary and confirmatory tests.
6. Assess the evidentiary value of biological evidences.

Module: 1	Blood	9 Hours
Composition of blood - collection and preservation - preliminary and confirmatory test for blood - ABO Blood grouping system and other blood grouping systems - Levis blood grouping from dried blood stain - Antigen - Antibody-enzymes and proteins - Blood spatter analysis. Case study. DNA analysis from blood samples.		
Module: 2	Semen & Other Body Fluids	9 Hours
Composition and structure of semen - collection and preservation - preliminary and confirmatory tests - Production and analysis of Saliva, sweat, milk and urine. Case study		
Module: 3	Hair & Fiber	9 Hours
Structure of hair- origin of hair - location of hair - Instrumental analysis of hair - Human and animal hair - Fiber-classification - natural /synthetic fibers - preliminary tests - instrumental analysis of fiber. Forensic significance of hair and fiber. Case study.		
Module: 4	Forensic Anthropology & Odontology	9 Hours
Definition- structure and morphology of bones - forensic significance of skeletal remains - Definition – odontology - Structure and arrangement of teeth- permanent and deciduous teeth - Forensic significance and age estimation - ABFO guidelines.		
Module: 5	Forensic Botany & Entomology	9 Hours
Plant based evidences, Poisonous plants, wood, pollen grains - Wildlife protection Act Entomology - Definition - Blow fly, beetles and other common arthropods.		
Total Lectures		45 Hours
Text Books		

1	Gunn, A. (2019), <i>Essential forensic biology</i> . John Wiley & Sons.
2	Li, R., Norman, S., & Schober, J. (2015), <i>Forensic biology</i> , CRC Press.
Reference Books	
1	Saferstein, R. (2015), <i>Criminalistics. An Introduction to Forensic Science</i> ", (11 th Ed), Pearson.
2	James, S.H., Nordby J.J., Bell, S. (2015), <i>Forensic Science: An Introduction to Scientific and Investigative Techniques</i> , (4 th Ed), CRC Press.
3	Eckert, W.G. (1996), <i>Introduction to Forensic Sciences</i> ", (2 nd Ed), CRC Press.
Recommended by Board of Studies	13 Feb 2024
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Course Code	CYBER FORENSICS	L	T	P	C
23FS2012		3	0	0	3
Course Objectives:					
Enable the student to:					
1. Acquire skills on the fundamental principles and methodologies of computer forensics, including various types of technologies and systems used in the field. 2. Develop proficiency in evidence collection, data recovery and seizure techniques essential for computer forensics investigations. 3. Apply in computer forensic analysis, including the discovery, identification, and reconstruction of electronic evidence to combat diverse cyber threats.					
Course Outcomes:					
The student will be able to:					
1. Demonstrate comprehensive understanding of the fundamental concepts and technologies underlying computer forensics. 2. Apply appropriate techniques for data recovery, evidence collection, duplication, preservation, and authentication in computer forensics investigations. 3. Analyze electronic evidence effectively to reconstruct past events and identify potential threats such as malware and information warfare tactics. 4. Evaluate the arsenal and tactics used in information warfare scenarios, including surveillance tools, cybercrime, identity theft and organized criminal activities. 5. Acquire practical skills in handling computer forensic cases, including searching, seizing, processing evidence, and preparing comprehensive reports. 6. Critically assess the legal and ethical considerations surrounding computer forensics investigations, including the application of the First and Fourth Amendments.					
Module: 1	Computer Forensics				9 Hours
Introduction: Computer Forensics Fundamentals - Types of Computer Forensics Technology - Types of Computer Forensics Systems - Vendor and Computer Forensics Services.					
Module: 2	Computer Forensics Evidence and Capture				9 Hours
Data Recovery - Evidence Collection and Data Seizure - Duplication and Preservation of Digital Evidence - Computer Image Verification and Authentication.					
Module: 3	Computer Forensic Analysis				9 Hours
Computer forensic analysis: Discover of Electronic Evidence-Identification of Data - Reconstructing Past Events – Fighting against Macro Threats - Information Warfare Arsenal - Tactics of the Military - Tactics of Terrorist and Rogues - Tactics of Private Companies					
Module: 4	Information Warfare				9 Hours
Information warfare: Arsenal - Surveillance Tools - Hackers and Theft of Components - Contemporary Computer Crime - Identity Theft and Identity Fraud - Organized Crime &Terrorism - Avenues Prosecution and Government Efforts - Applying the First Amendment to Computer Related Crime -The Fourth Amendment and other Legal Issues.					
Module: 5	Computer Forensic Cases				5 Hours
Computer forensic cases: Developing Forensic Capabilities - Searching and Seizing - Computer Related Evidence - Processing Evidence and Report Preparation - Future Issues					
Total Lectures					45 Hours
Text Books					

1	John R. Vacca. (2005), <i>Computer Forensics: Computer Crime Scene Investigation</i> , (2 nd Ed), Cengage Learning.
2	Marjie T Britz. (2008), <i>Computer Forensics and Cyber Crime: An Introduction</i> (2 nd Ed), Pearson Education.
3	Robert M Slade. (2004), <i>Software Forensics: Collecting Evidence from the Scene of a Digital Crime</i> , Tata McGraw Hill, Paperback.
Reference Books	
1	MariE-Helen Maras. (2014), <i>Computer Forensics: Cybercriminals, Laws, and Evidence</i> , (2 nd Ed), Jones & Bartlett Learning.
2	Had Steel. (2006), <i>Windows Forensics</i> , (1 st Ed), Wiley,
3	Majid Yar, (2013), <i>Cybercrime and Society</i> , (2 nd Ed), SAGE Publications Ltd, Hardcover.
Recommended by Board of Studies	
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Course Code		FORENSIC DERMATOGLYPHICS LABORATORY	L	T	P	C
23FS2016			0	0	3	2
Course Objectives:						
Enable the student to						
1. Apply the principle of recording fingerprints 2. Acquire knowledge on ridge tracing and ridge counting 3. Examine the methods of fingerprint detection						
Course Outcomes:						
Student will be able to						
1. Interpret the fundamental principles on which the science of fingerprinting is based. 2. Assess the method of classifying criminal record by fingerprints 3. Demonstrate the tools required for examination of fingerprints. 4. Execute the ridge tracing and ridge counting 5. Examine the significance of foot prints 6. Correlate physical methods to identify fingerprints						
List of Experiments						
1. To record plain and rolled fingerprints 2. To identify different fingerprint patterns 3. To identify core and delta and other minutiae. 4. To carry out ten-digit classification of fingerprint. 5. To carry out Henry’s extended classification (secondary, sub-secondary, major, key & final). 6. To carry out ridge counting. 7. To carry out ridge tracing. 8. To investigate physical methods of fingerprint detection. 9. To investigate chemical methods of fingerprint detection. 10. To use different light sources for enhancing developed fingerprints 11. To prepare cast of foot prints.						
Text Books						
1	Lee and Garnsleen’s. (2013), <i>Advances in Fingerprint Technology</i> , (3 rd Ed), R.S. Ramotowski (Ed.), CRC Press Boca Raton.					
2	O. Hilton. (1982), <i>Scientific Examination of Questioned Documents</i> , CRC Press, Boca Raton.					
3	A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau. (1995), <i>Scientific Evidence in Civil and Criminal Cases</i> , (4 th Ed), Foundation Press, New York.					
4	R.N. Morris. (2000), <i>Forensic Handwriting Identification: Fundamental Concepts and Principles</i> , Academic Press, London.					
Reference Books						
1	J.E. Cowger. (1983), <i>Friction Ridge Skin</i> , CRC Press, Boca Raton.					

2	D.A. Ashbaugh. (2000), <i>Quantitative- Qualitative Friction Ridge Analysis</i> , CRC Press Boca Raton.	
3	C. Champod, C. Lennard, P. Margot and M. Stoilovic. (2004), <i>Fingerprints and other Ridge Skin Impressions</i> , CRC Press, Boca Raton.	
Recommended by Board of Studies		13 Feb 2024
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Course Code	MOOT COURT FOR FORENSIC SCIENCE	L	T	P	C
23FS2017		0	0	3	2

Course Objectives:

Enable the student to

1. Enumerate the samples for evidence
2. Identify and analyze the sample
3. Enhance the communication skill by Roleplay

Course Outcomes:

Student will be able to

1. Identify the methods of collecting evidence from the crime scene
2. Analyze the evidences
3. Produce the reasoning ability
4. Improve communication skill
5. Formulate the case reports.
6. Construct analytical skill.

List of Experiments

A moot court is an activity in which students take part in simulated court proceedings, which usually involves participating in oral argument and draft documents. The student has to study the already solved case in Indian and Foreign court of law and explain how it was solved with the help of scientific aids. (It is a role play by students as forensic experts of different discipline ie. DNA, Fingerprint, Pathologist, Forensic Botanist etc) The course involves registration of the case, Proceeding to the spot with Experts, Collection of evidence to prove the crime, Place of occurrence and to connect the crime and the criminal, Collection of evidence from the Scene of crime, Victim, Accused.

(Sample cases are given, Other cases may be chosen)

1. The case of State of Orissa v. Ram Bahadur Thapa is one of the landmark precedent regarding excusing of ignorance of fact. The case relates to a murder of women by the accused in apprehension of ghost. What constitutes “good faith” and what is the degree of “due care and attention” under the law have been emphasized in this case. The notion of mistake of fact, which includes good faith have no standard value. It differs from person to person, basing on the personal intellect of a person. This case serve as vital precedent on how to adjudicate the bonafideness of a plea of general defense of Mistake of fact.
2. The Tandoor Murder Case refers to the brutal murder of Naina Sahni in New Delhi in 1995. Sushil Sharma, a leader in the Indian Youth Congress, was accused of murdering his wife, Naina Sahni, in a fit of rage. The crime gained notoriety due to the gruesome nature of the act – Sharma had murdered his wife and then attempted to dispose of her body by burning it in a tandoor (clay oven) at a restaurant. The case garnered widespread media attention and resulted in Sushil Sharma's arrest and subsequent conviction. The Tandoor Murder Case is remembered as one of the high-profile crimes in India that unfolded with dramatic elements and a sensational trial.
3. Jessica Lall, a model, was shot and killed at a Delhi restaurant in 1999. The main accused, Manu Sharma, was the son of a prominent politician. Initially, he was acquitted due to a lack of witnesses willing to testify. The verdict sparked public outrage and led to a re-examination of the case. After a retrial and re-evaluation of evidence, Manu Sharma was found guilty of murder in 2006 and sentenced to life imprisonment. The case highlighted issues of judicial integrity and the power dynamics between the influential and the justice system.
4. The Nithari Serial Killings case involves the gruesome murders of numerous individuals, mainly children and women, in Nithari, a village near Noida, Uttar Pradesh, India. The primary accused

were Moninder Singh Pandher, a businessman, and his domestic help Surinder Koli. The crimes were discovered in 2006 when human remains were found near Pandher's house. Forensic evidence, including DNA profiling, played a crucial role in linking the accused to the murders. The case exposed the negligence of law enforcement and highlighted the vulnerability of marginalized communities. Both Pandher and Koli were arrested, tried, and convicted for their roles in the heinous crimes.

5. The Murder of Neeraj Grover took place in 2008 and involved television executive Neeraj Grover. Emile Jerome Mathew, a naval officer, and Maria Susairaj, his girlfriend, were the main accused. The crime occurred in Mumbai, where Grover was allegedly killed in a fit of rage by Mathew over a romantic dispute. After the murder, Mathew and Susairaj attempted to dispose of Grover's body by chopping it into pieces and burning some parts. Both Mathew and Susairaj were arrested and faced trial.
6. The D.K. Basu Guidelines, established by the Supreme Court of India in the case of D.K. Basu v. State of West Bengal (1997), focus on preventing custodial torture and deaths. The case was prompted by the death of D.K. Basu, a human rights activist, in police custody. The guidelines aim to safeguard the rights of individuals in custody and outline procedures that law enforcement must follow,
7. The Nirbhaya gang-rape case involves a brutal sexual assault that took place in Delhi in December 2012. A young woman, referred to as "Nirbhaya" (meaning fearless), was gang-raped and brutally assaulted on a moving bus by six men, including a juvenile. The incident led to widespread public outrage, protests, and demands for justice. The Nirbhaya case had a profound impact on public discourse regarding women's safety in India, leading to legislative changes and increased awareness of sexual violence issues. It remains a landmark case that brought attention to the need for societal changes, legal reforms, and better law enforcement to address and prevent sexual assault.
8. The 2G Spectrum Case refers to a major corruption scandal in India related to the allocation of 2G (second-generation) telecom spectrum licenses. The case came to light in 2010, revealing irregularities and corruption in the allocation process during the tenure of A. Raja, the then-Telecom Minister.
9. The O.J. Simpson Murder Trial (1995) involved former American football player O.J. Simpson, who was accused of murdering his ex-wife, Nicole Brown Simpson, and her friend, Ron Goldman.
10. The Amanda Knox Trial (2007-2015) involved the murder of Meredith Kercher, a British exchange student, in Perugia, Italy. Amanda Knox, an American student and Kercher's roommate, along with Knox's boyfriend, Raffaele Sollecito, were accused of the crime.
11. The JonBenét Ramsey Case (1996) revolves around the unsolved murder of 6-year-old beauty queen JonBenét Ramsey in her Colorado home in 1996. The case remains a subject of speculation and intrigue.

(Minimum 10 cases can be studied)

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Course Code	QUESTIONED DOCUMENTS LABORATORY	L	T	P	C
23FS2018		0	0	3	2
Course Objectives:					
Enable the student to					
1. Acquire knowledge on the forgery by comparison with standards					
2. Identify forgery by understanding handwriting characteristics					
3. Analyze the counterfeited document cases					
Course Outcomes:					
Student will be able to					
1. Record individual characteristics of a handwriting					

- Analyze the natural variations in the writing - Explore the destructive and non-destructive ways of examining documents - Assess methods of identifying forgery - Analyze computer printouts - Evaluate security features in documents	
List of Experiments - To identify handwriting characters - To study natural variations in handwriting - To compare handwriting samples. - To detect simulated forgery - To detect traced forgery - To study the line quality defects in handwriting samples. - To examine the security features of currency notes, passports and plastic money. - To study alterations, obliterations and erasure in handwriting samples. - Identification of normal / disguise writing - Examination of computer printouts.	
Text Books	
1.	Erickson, E. (2014), <i>The Basic of Forensic Investigation</i> , Elsevier Inc.
2.	Ramotowski, R. (2013), <i>Lee and Gaensslen's Advances in Fingerprint Technology</i> , (3 rd Ed), CRC Press.
3	Evidence Handling & Laboratory Capabilities Guide, Virginia Department of Forensic Science, (2012).
Reference Books	
1	Bridges, B.C. (1963), <i>Practical Fingerprinting</i> , Funk & Wagnalls.
2	Alvarez, M.G.P. (2013), <i>Forensic Examination of Questioned Documents</i> , Chapter house Publishing Incorporated, Philippines.
3	Ellen, D., Day, S., Davies, C. (2018), <i>Scientific Examination of Documents – Methods and Techniques</i> , (4 th Ed), CRC Press.
4	Daluz, H.M. (2019), <i>Fingerprint Analysis – Laboratory workbook</i> , (2 nd Ed), CRC Press, 2019.
5	Bleay, S.M., Croxton, R.S., de Puit, M. (2017), <i>Fingerprint Development Techniques</i> , Wiley.
6	Lee, H.C., Gaensslen, R.E. (2001), <i>Advances in Fingerprint Technology</i> , (2 nd Ed), CRC Press, 2001
7	Mirakovits, K., Londino-Smolar, G. (2016), <i>The Basic of Investigating Forensic Science – A Laboratory Manual</i> , CRC Press.
Recommended by Board of Studies	
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Course Code	FORENSIC BALLISTICS LABORATORY	L	T	P	C
23FS2019		0	0	3	2
Course Objectives:					
Enable the student to					
1. Acquire adequate knowledge on the basic handling, collection of exhibits.					
2. Determine the nature of GSR.					
3. Discriminate various firearms and projectiles.					
Course Outcomes:					
Student will be able to					
1. Recognize all types of small arms					
2. Classify the firearms and their firing mechanisms.					
3. Administer the methods of collection of GSR.					
4. Distinguish rifling details on fired bullets					
5. Evaluate the characteristics of ammunition					
6. Plan the reconstruction of the sequence of events in shooting incidents.					

List of Experiments

1. Photography and sketching of crime scenes involving firearms.
2. To study the types of injuries caused by gun shot.
3. To disassemble and reassemble various types of small firearms, documenting their details, locking mechanism, and trigger operation.
4. Microscopic examination of cartridge cases.
5. Determination of shot size from diameter and weight of shots/pellets.
6. To prepare sulfur cast inside of barrels and study the rifling pattern, caliber, size of bore, etc.
7. Collection of GSR from Shooter's hand- dry method, wet method.
8. To determine / measure rifling details on fired bullets – determination of make/model of suspected firearms firing the bullet.
9. Restoration of erased serial numbers on firearms.
10. To perform chemical tests of powder residues (Walker's Test) around gunshot holes in fabrics.
11. Reconstruction of sequence of events in shooting incidents.
12. To study Integrated Ballistic Identification System.
13. Determination of distance/ direction of firing from deceased / injuries.

Text Books

1. Heard, B.J. (1997), *Handbook of Firearms and Ballistics*, John Wiley, England.
2. Warlow, T.A. (1996), *Firearms, The Law and Forensic Ballistics*, Taylor and Francis, London.
3. Sellier, K.G. (1994), *Wound Ballistics and the Scientific Background*, Elsevier Pub. Co., London.
4. Jauhari M. (2018), *Identification of Firearms, Ammunition, & Firearms Injuries*, BPR&D, New Delhi.
5. Ordog, G.J. (1983), *Management of Gunshot wounds*, Elsevier Pub. Co., NY.

Reference Books

1. Hatcher, Jury And Weller, (2017), *Firearms Investigation, Identification And Evidence*, Stackpole, Books, Harrisburg, PA.
2. L V. Hog. (2009), *The Cartridges Guide - A Small Arms Ammunition Identification Manual*, The Stackpole Co., Harrisburg, PA.

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Approved by Academic Council 24 Feb 2024

Course Code	FORENSIC PSYCHOLOGY LABORATORY	L	T	P	C
23FS2020		0	0	3	2

Course Objectives:

Enable the student to

1. Identify the personality traits using different psychological test
2. Administer various types of projective tests.
3. Interpret human tendencies through different Psychological tests

Course Outcomes:

Student will be able to

1. Recognize various types of psychological tests.
2. Explore the basics of psychological tests
3. Classify the types of personalities.
4. Evaluate the usage of psychological tests in forensic science
5. Predict suicidal tendencies of individuals
6. Plan test administration and interpretation

List of Experiments

1. Forming Relevant Questions with Polygraph
2. Forming Irrelevant Questions with Polygraph
3. Forming Control Questions with Polygraph
4. Perceived Loneliness Scale
5. Rosenzweig Picture Frustration (adult)

6. Mental Depression Scale 7. Dimensional Personality Inventory 8. Maudsley Personality Inventory (MPI)- H.J. Eysenck 9. Draw a Person test. 10. Eysenck Personality Inventory. 11. Locus of control. 12. Bhatia Battery. 13. The Thematic Apperception Test (TAT) 14. The Rorschach Inkblot Test (Minimum 10 experiments to be conducted)	
Reference Books	
1	Morgan, King, Weiss and Schopler. (1989), <i>Introduction to Psychology</i> , (7 th Ed), McGraw Hill, India.
2	Carson RC & Butcher JN. <i>Abnormal psychology & modern life</i> , (10 th Ed) Harper-Collins NY.
3	Patterson, Lewis E. ; & Welfel. (2000), <i>Elizabeth Reynold The Counseling process</i> , Hilgard.
4	Atkinson and Atkinson. (1975), <i>Introduction to Psychology</i> , Oxford IBH Publishing Co. Pvt. Ltd.
5	Dr. Rukmani Krishnamurthy, (2010), <i>Introduction to Forensic Science in Crime Investigation</i> .
Reference Books	
1.	Murphy, G. (2013). <i>An historical introduction to modern psychology</i> . Routledge.
2.	Stern, W., & Spoerl, H. D. T. (1938). General psychology.
3.	Galotti, K. M. (2008). Cognitive Psychology.
4.	Wise, E. A., Streiner, D. L., & Walfish, S. (2010). A review and comparison of the reliabilities of the MMPI-2, MCMI-III, and PAI presented in their respective test manuals. <i>Measurement and Evaluation in Counseling and Development</i> , 42(4), 246-254.
5.	Anastasi, A., & Urbina, S. (1997). <i>Psychological testing</i> . Prentice Hall/Pearson Education.
6.	Barlow, D. H., Durand, V. M., & Hofmann, S. G. (2018). <i>Abnormal psychology: An integrative approach</i> . Cengage learning.
7.	Psychology and Work, by Schultz D (2006), (8 th Ed).
8.	Experimental Psychology, Solso .R.L. (2008)
9.	Social Psychology, Barron and Barron
10.	Behavior Modification, Martin Garry, (2002), (7 th Ed).
Recommended by Board of Studies	
13 Feb 2024	
Approved by Academic Council	
24 Feb 2024	

Course Code	FORENSIC BIOLOGY LABORATORY	L	T	P	C
23FS2021		0	0	3	2
Course Objectives:					
Enable the student to					
1. Develop their skills to identify the hair morphology					
2. Determine blood group and identify stain in saliva and urine					
3. Prepare case reports					
Course Outcomes:					
The student will be able to					
1. Examine human hair					
2. Carry out microscopic examination of pollen grains and diatoms					
3. Identify blood groups of both fresh and dried blood samples					
4. Demonstrate concealment techniques using cryptographic PGP					
5. Handle and get the stains from Saliva and Urine					
6. Prepare case reports on entomology and wildlife forensics					
LIST OF EXPERIMENTS					
1. To examine structure of hair (cortex, medulla and cuticle).					
2. To examine human and animal hair and identify the differentiating characteristics.					

- To prepare slides of scale pattern of human hair. - To carry out microscopic examination of pollen grains. - To carry out microscopic examination of diatoms. - To cite a crime case in which diatoms have served as forensic evidence. - To prepare a case report on forensic entomology. - To prepare a case report on problems of wildlife forensics - To determine blood group from fresh blood samples. - To carry out the crystal test on a blood sample. - To identify blood samples by chemical tests. - To identify the given stain as saliva by using starch iodine test. - To identify the given stain as saliva by using radial diffusion method. - To identify the given stain as urine. - To determine sex from pelvis and skull.	
Text Books	
1	R. Saferstein, (2008), <i>Forensic Science Handbook, Vol. III</i> , Prentice Hall, New Jersey, digitized.
2	G.T. Duncan and M.I. Tracey. (1997), <i>Introduction to Forensic Sciences, (2nd Ed)</i> , W.G. Eckert (Ed.), CRC Press, Boca Raton.
Reference Books	
1	T. Bevel and R.M. Gardner. (2008), <i>Bloodstain Pattern Analysis, (3rd Ed)</i> , CRC Press, Boca Raton.
2	W.G. Eckert and S.H. James. (1989), <i>Interpretation of Bloodstain Evidence at Crime Scenes</i> , CRC Press, Boca Raton.
Recommended by Board of Studies	
13 Feb 2024	
Approved by Academic Council	
24 Feb 2024	

Course Code	CYBER FORENSICS LABORATORY	L	T	P	C
23FS2022		0	0	3	2
Course Objectives:					
Enable the student to					
1. Cultivate proficiency to discern, seize and safeguard digital evidence from crime scenes, as well as to identify concealed files.					
2. Attain competence to employ digital signatures to enhance the security of electronic mail and online transactions.					
3. Acquire practical experience to conduct the imaging of hard disks through hands-on training sessions.					
Course Outcomes:					
The student will be able to					
1. Identify encrypted files and IP address of the sender e – mails					
2. Detect, seize and preserve digital evidence from crime scenes					
3. Recognize hidden files					
4. Demonstrate concealment techniques using cryptographic PGP					
5. Identify encrypted files.					
6. Conduct imaging of hard disks					
LIST OF EXPERIMENTS					
1. To identify, seize and preserve digital evidence from crime scenes.					
2. To detect deletions, obliterations and modifications of files using encase software.					
3. To trace routes followed by e-mails and chats.					
4. To identify the IP address of the sender of e – mails.					
5. To demonstrate concealment techniques using cryptographic PGP.					
6. To identify encrypted files.					
7. To identify hidden files.					
8. To use digital signatures for securing e-mail and online transactions.					

9. To acquire data from PCs/laptop/HDDs/USBs, open drives, memory cards and SIM cards.	
10. To use symmetric and asymmetric keys for protection of digital record.	
11. To carry out imaging of hard disks.	
(Minimum 10 experiments to be conducted)	
Text Books	
1	Computer Forensics : Investigating Network Intrusions and Cyber Crime, EC-Council, ISBN-13: 978-1-4354-8352-1, ISBN-10: 1-4354-8352-9
2	Computer Forensics : Investigating Wireless Networks and Devices, EC-Council, ISBN-13: 978-1-4354-8353-8, ISBN-10: 1-4354-8353-7
Reference Books	
1	<i>Handbook of Digital Forensics and Investigations</i> , Eoghan Casey ed., Elsevier Academic Press, ISBN 13: 978-0-12-374267-4
Recommended by Board of Studies	
13 Feb 2024	
Approved by Academic Council	
24 Feb 2024	

Course Code	FOUNDATION COURSE ON COMPUTER FUNDAMENTALS AND OFFICE	L	T	P	C
23FS2023		3	0	0	3
Course Objectives:					
Enable the student to: 1. Gain knowledge on the fundamentals of MS office and internet. 2. Explore the concepts of C programming 3. Be exposed to ideas related to pointers					
Course Outcomes:					
The student will be able to: 1. Explore the fundamentals of MS Office 2. Utilize the Internet 3. Develop skills in C programming. 4. Relate the basic concepts of arrays and functions in C. 5. Demonstrate the concepts of structures in C programming. 6. Apply and recommend the concept of programming in Forensic science.					
Module: 1	MS Office			9Hours	
MS word, excel, power point, Internet					
Module: 2	Fundamentals of C Programming			9 Hours	
History of C - Characteristics of C - C Program Structure - Data Types - Variables and Constants - Operators - Conditional Statements - Looping and Iteration.					
Module: 3	Arrays and Functions in C			9 Hours	
Single Dimensional Array -Multi Dimensional Array - Types of functions - Functions and Arrays - String Functions - Recursive Functions					
Module: 4	Structures			9 Hours	
Basics, Structures and functions - Arrays of structures - Pointers to structures - Self-referential structures – Type and definition - Union - Bitfields - Enum Data Types					
Module: 5	Pointers			9 Hours	
Pointers: introduction - declaration - passing function to pointers - pointers with arrays - dynamic memory allocation.					
Total Lectures				45 Hours	
Text Books					
1	E. Balagurusamy. (2012). <i>Programming in Ansi C. (6th Ed)</i> . TMG – India.				

2	Byron C Gottfried. (2006), <i>Programming with C, Schaums' outline series (2nd Ed)</i> , Tata Mc - Graw Hill.
3	Herbert Schildt. (2000), <i>The Complete Reference C, (4th Ed)</i> , Tata Mc - Graw Hill.
Reference Books	
1	Kernighan, B. W., & Ritchie, D. M. (1988). <i>The C programming language</i> (2nd ed.). Prentice Hall.
2	Gottfried, B. S. (1992). <i>Schaum's Outline of Programming in Structured Basic</i> . McGraw-Hill Professional.
3	Jean-Paul Tremblay and Paul G Sorenson. (1984), <i>An Introduction to Data structures with Applications, (2nd Ed)</i> , McGraw Hill Book Company.
Recommended by Board of Studies	
13 Feb 2024	
Approved by Academic Council	
24 Feb 2024	

Course Code	FORENSIC MEDICINE		L	T	P	C
23FS2024			3	0	0	3
Course Objectives:						
Enable the student to: 1. Acquire knowledge on the death investigations and crime scene management. 2. Apply the knowledge on evidence processing. 3. Evaluate the post-mortem interval utilizing entomological evidence.						
Course Outcomes:						
The student will be able to: 1. Review the basics of forensic medicine. 2. Predict the steps involved in crime scene management. 3. Relate the medico legal findings to injuries. 4. Distinguish between injuries based on ante mortem and post mortem injuries. 5. Differentiate between the causes of death. 6. Assess time since death based on entomological evidences.						
Module: 1	Death Investigations					9 Hours
Definition and scope of forensic medicine –Crime scene management. - collection of first-hand information from the caller. Rendering medical assistance to the victim. Protecting life. Dying declaration and dying deposition. Witness testimony. Interviewing onlookers and segregating possible witnesses. Initial interrogation and searching for evidences.						
Module: 2	Crime Scene Management in Death Cases					9 Hours
Assessing the crime scene. Request for forensic team. Importance of command post and log book. Management of crowd and media. Importance of taking notes. Items to be a part of noting. Documentation of crime scene.						
Module: 3	Injuries					9 Hours
Handling buried body cases – search for buried bodies, Exhumation. Suicide cases – evaluating the type of injuries, gauging the psychological state of victim. Mechanical Injuries: Abrasions, Bruises, Lacerations, Incised wounds, Stab wounds, Firearm injuries, Defense injuries, fabricated/ Artificial injuries Antemortem and post mortem injuries. Aging of injuries.						
Module: 4	Pathology					9 Hours
Forensic pathology. Medico-legal aspects of death. Causes of death. Determination of time since death. Sexual offences. Drowning. Types of drowning.						
Module: 5	Time Since Death					9 Hours
Immediate changes, Early changes and Late changes of death. Stages of decomposition. Forensic Entomology. Estimation of time of Death based on entomological evidences.						

Total Lectures		45 Hours
Text Books		
1	T. Bevel and R.M. Gardner. (2008), <i>Bloodstain Pattern Analysis</i> , (3 rd Ed), CRC Press, Boca Raton.	
2	W.J. Tilstone, M.L. Hastrup and C. Hald. (2012), <i>Fisher's, Techniques of Crime Scene Investigation</i> , (1 st Ed), CRC Press, Boca Raton.	
Reference Books		
1	K. Smyth. (1983), <i>The Cause of Death</i> , VanNostrand Reinhold, New York.	
2	M. Bernstein. (1997), <i>Introduction to Forensic Sciences</i> , (2 nd Ed), W.G. Eckert (Ed.), CRC Press, Boca Raton.	
3	J. Dix. (1999), <i>Handbook for Death Scene Investigations</i> , CRC Press, Boca Raton.	
4	H.B. Baldwin and C.P. May. (2000), <i>Encyclopedia in Forensic Science, Volume 1</i> , Academic Press, London.	
Recommended by Board of Studies		13 Feb 2024
Approved by Academic Council		24 Feb 2024

Course Code	ACCIDENT INVESTIGATION	L	T	P	C
23FS2025		3	0	0	3
Course Objectives:					
Enable the student to					
1. Identify basic accident scene investigation techniques					
2. Describe simple analysis techniques for motor accidents					
3. Demonstrate understanding of accident analysis and injury assessment concepts					
Course Outcomes:					
Student will be able to					
1. Identify the background of vehicle accidents					
2. Analyze motor accidents					
3. Assess the post-crash movement					
4. Infer systematic analysis of injuries in accidents					
5. Evaluate the tachograph data analysis					
6. Predict the falsification and diagnostic signals					
Module: 1	Motor Vehicle Accidents				9 Hours
Accident scene - Sources of forensic information - Eyewitness accounts - Extent of vehicle damage - Visibility Conditions - Photographs of the accident site.					
Module: 2	Analysis of Motor Accidents				9 Hours
Estimation of speed. Interpretation of road obstructions - Tire marks, skid marks, scuff marks. Maintenance of vehicles - Abandoned Vehicles - Importance of air bags. Railway accidents.					
Module: 3	Accident Analysis				9 Hours
Post-crash movement. Collision Model. Gauging driver’s reaction - Occupants’ kinematics. Automobile common component and failure analysis, damage assessment, tyres - types speed and load rating, inflation and failures, brakes - types and brake systems, door lock and speed recording devices, safety restraint system - theory and examination of seat-belt child - seat and air-bag, vehicular fires.					
Module: 4	Analysis of Injuries				9 Hours
Types of injuries resulting from accidents - Biomechanics of injuries - Hit-and-run investigations - examination of suspect vehicle, collection of evidence & control samples - Trace evidence at accident sites.					
Module: 5	Tachographs				9 Hours

Forensic significance of tachograph data - tachograph charts. Principles of chart analysis - Accuracy of speed record - Tire slip effects - Falsification and diagnostic signals - Route tracing. Reconstruction of accidents using Computer Aided Designing.

Total Lectures	45 Hours

Text Books

1	S.C. Batterman and S.D. Batterman. (2000), <i>Encyclopedia of Forensic Sciences</i> , Academic Press, London.
2	T.S. Ferry. (1988), <i>Modern Accident Investigation and Analysis</i> , Wiley, New York.

Reference Books

1	D. Lowe. (1989), <i>The Tachograph, (2nd Ed)</i> , Kogan Page, London.
2	T.L. Bohan and A.C. Damask. (1995), <i>Forensic Accident Investigation: Motor Vehicles</i> , Michie Butterworth, Charlottesville.

Recommended by Board of Studies	13 Feb 2024

Approved by Academic Council	24 Feb 2024

Course Code	DNA TYPING	L	T	P	C
23FS2026		3	0	0	3

Course Objectives:

Enable the student to

1. Gain knowledge on the basic principle of DNA analysis and typing
2. Explore parentage testing
3. Formulate report writing in DNA typing

Course Outcomes:

Student will be able to

1. Identify the basic principle of DNA analysis
2. Apply the forensic significance of DNA typing
3. Illustrate the importance of tandem repeats and polymorphism in DNA technique
4. Compare the principles of parentage testing
5. Create a detailed report on DNA typing
6. Analyze the probability determination in a population database.

Module: 1	Basic Principles	9 Hours

DNA as biological blueprint of life. Extraction method of DNA for analysis. Quantitation of DNA - yield gel quantitation and slot blot quantitation. Mitochondrial DNA - sequence analysis of mt DNA. Case study (mitochondrial DNA).

Module: 2	Forensic DNA Typing	9 Hours

Collection of specimens. Polymerase chain reaction - historical perspective, sequence polymorphisms, individualization of evidence.

Module: 3	Short Tandem Repeat (STR) in DNA Technique	9 Hours

Short tandem repeats (STR) - role of fluorescent dyes, nature of STR loci - Restriction fragment length polymorphism (RFLP) - genetic markers used in RFLP, typing procedure and interpretation of results - Touch DNA and its collection and analysis method.

Module: 4	Parentage Testing	9 Hours

Principles of heredity - Genetics of paternity. DNA testing in disputed paternity - Mendelian laws of parentage testing - Mathematical basis of parentage identification. Missing body cases - Reference populations and databases. Case study.

Module: 5		Report Writing	9 Hours
Role of DNA typing in identifying unrecognizable bodies with case study - Allele frequency determination - Hardy-Weinberg law - Probability determination in a population database.			
Total Lectures			45 Hours
Text Books			
1	Barry A. J. Fisher, Barry A. J. Fisher, David R. Fisher, David R. Fisher. (2012), <i>Techniques of crime scene investigation</i> , CRC Press.		
2	Tom Bevel, Ross M. Gardner. (2008), <i>Bloodstain Pattern Analysis with an Introduction to Crime Scene Reconstruction</i> , (3 rd Ed), CRC Press.		
Reference Books			
1	Suzanne Bell. (2019), <i>Forensic Science: An Introduction to Scientific and Investigative Techniques</i> , (5 th Ed), CRC Press.		
2	Stuart H James and Jon J Nordby. (2007), <i>An Introduction To Forensic Scientific and Investigative Techniques</i> , (3 rd Ed), CRC Press.		
Recommended by Board of Studies		13 Feb 2024	
Approved by Academic Council		24 Feb 2024	

Course Code	FUNDAMENTALS OF FORENSIC ANTHROPOLOGY AND ODONTOLOGY	L	T	P	C
23FS2027		3	0	0	3

Course Objectives:

Enable the student to

1. Learn the basic theories of forensic anthropology and odontology.
2. Apply the knowledge for the personal identification of the individuals.
3. Analyze anthropological, odontological and bite mark evidences.

Course Outcomes:

Student will be able to

1. Asses the theories of anthropology and role of anthropology in mass disaster cases.
2. Acquire knowledge about personal identification from anthropological and odontological evidences.
3. Analyze odontological evidences in mass disaster cases.
4. Correlate and compare antimortem and post mortem dental records for personal identification.
5. Identify bitemark evidence and use it for forensic analysis.
6. Develop non-invasive methods for collection necessary forensic information related to Anthropology and Odontology

Module: 1	Forensic Anthropology	9 Hours
Theories for Anthropology, Fossil formation, Taphonomy, Relative dating techniques, Chronometric dating techniques; Bio-cultural and evolutionary approaches to disease, Birth, growth and aging, infectious disease and bio-cultural evolution. Role of anthropology in mass disaster, Identification and forensic Anthropology: Time since death, ante-mortem records and positive ids.		
Module: 2	Bones of Forensic Importance	9 Hours
Individual identification from: Anatomy of skull, ribcage, scapula, radius and ulna, carpals and, metacarpals, femur, pelvic girdle, tibia and fibula, Tarsals and meta tarsals, Vertebral column. Case studies		
Module: 3	Forensic Odontology	9 Hours
Definition and Scope of Forensic Odontology, Types of dentition, Basic structure of human teeth, types of teeth & their morphology, and determination of age from teeth using various methods, dental anomalies		

and their role in Personal Identification. Role of Forensic Odontology in mass disaster victim identification.

Module: 4	Analysis of Odontological Evidence	9 Hours

Dental Charting. Comparison of Ante-mortem and postmortem dental records. DNA isolation from bones and teeth.: Gustafson method, Root transparency, cementum annulations, tooth wear, third molar formation, aspartic acid racemization, ante-mortem and postmortem dental records, dental trauma and its forensic application, individualization from odontological samples.

Module: 5	Bite Mark Analysis	9 Hours

Bite-mark analysis History of bite-mark analysis, anatomy of human bite-mark, types of bite-marks, collection of bite-mark evidences : non-invasive Forensic dental photography (alternate light imaging, fluoroscene imagining technique, UV, IR) & invasive techniques, differential diagnosis of bite marks including carnivore bite-marks, bite-mark as biological evidence, factors affecting bitemark in perishables, histological examination of human bite, comparison of bite-marks, factors affecting bite-mark diagnosis, ABFO bite-mark scoring guide, reliability of bite-mark evidences.

Total Lectures	45 Hours

Text Books

1	Gennard, D. (2012), <i>Forensic entomology: an introduction</i> . John Wiley & Sons.
2	Byrd, J. H., & Tomberlin, J. K. (Eds.). (2019), <i>Forensic entomology: the utility of arthropods in legal investigations</i> , CRC press.
3	Gunn, A. (2019), <i>Essential forensic biology</i> . John Wiley & Sons.,
4	Li, R., Norman, S., Schober. (2015), <i>J. Forensic biology</i> . CRC Press.

Reference Books

1	Roberts, J., & Márquez-Grant, N. (Eds.). (2012), <i>Forensic ecology handbook: from crime scene to court</i> , John Wiley & Sons.
2	Hall, D. W., & Byrd, J. (2012), <i>Forensic botany: a practical guide</i> . John Wiley & Sons.
3	Coyle, H. M. (2004), <i>Forensic botany: principles and applications to criminal casework</i> . CRC press.

Recommended by Board of Studies	13 Feb 2024

Approved by Academic Council	24 Feb 2024

Course Code	DIGITAL AND MULTIMEDIA FORENSICS	L	T	P	C
23FS2028		3	0	0	3

Course Objectives:

- Enable the student to
1. Recognize the relevance of digital forensic.
 2. Apply the forensic tools for effective recovery of data.
 3. Infer the advancements in multimedia forensics.

Course Outcomes:

- The student will be able to
1. Classify cybercrimes.
 2. Explore cyber attacks
 3. Predict the tools for e discovery
 4. Analyze the data recovered using mobile forensic.
 5. Demonstrate the tools used data analysis.
 6. Apply the tools and techniques used in digital forensics.

Module: 1	Fundamentals of Computer Forensics	10 Hours

Definition of computer/cyber forensics, Branches of Digital Forensics, Digital evidence, Role of computer forensic expert. Hacking, Spoofing, Phishing, Cyber Terrorism, Cyber Stalking, Social Engineering, DOS and DDOS attack, Skimming, Identity theft, Malware attack. Difference between White hat, Black hat and Gray hat hackers.	
Module: 2	Terminologies in Computer Forensics
9 Hours	
Data, Metadata, File, Malware, Virus, Worm, Trojan, Key loggers, Adware, Spyware, Backdoor, Botnet, Zombie machine, Code, Logic Bomb, Payload, Rootkit, Script kiddie, Remote access, Spam, Vulnerability, Zero day Exploit, Slack Space, Unallocated Space.	
Module: 3	Concepts of E-Discovery
9 Hours	
Basics of e-discovery, e-discovery data collection, Tools and ESI, Metadata analysis, e-discovery of email, Instant messenger, Social Media E-discovery. Steganography tools and techniques, Encryption Decryption, File extensions, Data Carving, Registry, Cloning, Difference between Imaging and Cloning, Master Boot Record and GUID Partition Table, Introduction to Deep web and Dark web.	
Module: 4	Mobile Device Forensics
8 Hours	
Understanding Mobile Device Forensics, Acquisition procedure for mobile device, CDR (Call Data Record), GPS analysis, Open source and commercial Tools for analysis, Base terminal station.	
Module: 5	Data Recovery and Analysis
9 Hours	
Bit stream image, write blocker, Data Recovery – Logical and Physical, File Signature analysis, Hashing Concepts, File Formats of Forensic Image, different tools for analysis, Password cracking techniques, Lab analysis standard procedure. The Sleuth Kit (TSK) and Autopsy, Timeline Analysis, RAM capturing using Linux commands, dd command for Imaging.	
Total Lectures	
45 Hours	
Text Books	
1	Nelson, B., Phillips, A., & Steuart, C. (2010). <i>Guide to computer forensics and investigations</i> (p. 720). Course Technology Cengage Learning.
2	Casey, E. (2011). <i>Digital evidence and computer crime: Forensic science, computers, and the internet</i> . Academic press.
3	Ligh, M. H., Case, A., Levy, J., & Walters, A. (2014). <i>The art of memory forensics: detecting malware and threats in windows, linux, and Mac memory</i> . John Wiley & Sons.
4	Marcella Jr, A., & Menendez, D. (2010). <i>Cyber forensics: a field manual for collecting, examining, and preserving evidence of computer crimes</i> . Auerbach Publications.
5	Vacca, J. R. (Ed.). (2012). <i>Computer and information security handbook</i> . Newnes.
6	Marcella Jr, A., & Menendez, D. (2010). <i>Cyber forensics: a field manual for collecting, examining, and preserving evidence of computer crimes</i> . Auerbach Publications.
Reference Books	
1	Davidoff, S., & Ham, J. (2012). <i>Network forensics: tracking hackers through cyberspace</i> (Vol. 2014). Upper Saddle River: Prentice hall.
2	Patrick Ciccarelli. (2014), <i>Networking Basics</i> , John Wiley and Sons, Inc.
3	Britz, M. (2009). <i>Computer forensics and cyber crime: An introduction, 2/e</i> . Pearson Education India.
4	Bauchner, E. (2014). <i>Computer Investigation</i> . Simon and Schuster.
Recommended by Board of Studies	
13 Feb 2024	
Approved by Academic Council	
24 Feb 2024	

Course code	FORENSIC STATISTICS	L	T	P	C
23FS2029		3	0	0	3

Course Objectives:

Enable the students to

1. Gain adequate knowledge about Forensic research statistics							
2. Apply the concepts of mathematical statistics							
3. Explore the advantages of legal statistics							
Course Outcomes:							
The student will be able to							
1. Crime scene reconstruction using statistical methods							
2. Realize the statistics in DNA matching							
3. Adapt the statistics in Forensics							
4. Analyzing digital evidence using statistical methods							
5. Report as a Forensic statistician during crime scenes							
6. Recommend statistical concepts in Forensic Science							
Module: 1	Introduction to Forensic Statistics			9 Hours			
Overview of Forensic Statistics, Role of Statistics in Forensic Science, Historical perspective and landmark cases, Ethical considerations in forensic statistics, Introduction to key statistical concepts: probability, hypothesis testing, and significance levels.							
Module: 2	Statistical Methods in Crime Scene Analysis			9 Hours			
Crime scene reconstruction using statistical methods, Bloodstain pattern analysis, Ballistics and trajectory analysis, Pattern recognition in forensic analysis, Case studies and practical applications							
Module: 3	DNA Profiling and Statistical Inference			9 Hours			
Basics of DNA profiling, Probability and statistics in DNA matching, Likelihood ratios and the interpretation of forensic DNA evidence, Challenges, and controversies in DNA evidence. Hands on exercises with DNA profiling software.							
Module: 4	Digital Forensics and Cybercrime Statistics			9 Hours			
Introduction to digital forensics, Statistical methods for analyzing digital evidence, cybercrime trends and statistics, Forensic analysis of network traffic, Case studies on cybercrime investigations							
Module: 5	Expert Testimony and Legal Considerations			9 Hours			
The role of a forensic statistician as an expert witness, Communicating statistical findings to non-experts, Legal standards for admissibility of statistical evidence, Cross-examination and challenges in the courtroom, Ethics in expert testimony							
Total Lectures				45 Hours			
Text Books							
1	Aitken, C., & Taroni, F. (2004). <i>Statistics and the evaluation of evidence for forensic scientists</i> . John Wiley & Sons.						
2	James, S. H., & Nordby, J. J. (2002). Forensic Science and the Law. In <i>Forensic Science</i> (pp. 593-608). CRC Press..						
Reference Books							
1	Butler, J. M. (2011). <i>Advanced topics in forensic DNA typing: methodology</i> . Academic press.						
2	B. L. Tembe, Kamaluddin and M. S. Krishnan. <i>Engineering Chemistry</i> (NPTEL Web-book).						
3	Marshall, A. M. (2009). <i>Digital forensics: digital evidence in criminal investigations</i> . John Wiley & Sons.						
4	Cutler, B. L. (2009). <i>Expert testimony on the psychology of eyewitness identification</i> . Oxford University Press.						
Recommended by Board of Studies			13 Feb 2024				
Approved by Academic Council			24 Feb 2024				
Course Code	INTRODUCTION TO ENVIRONMENTAL FORENSIC SCIENCE			L	T	P	C
23FS2030				3	0	0	3
Course Objectives:							
Enable the student to							

1. Acquire knowledge on the principles of environmental forensics, including the identification of pollutants and their sources. 2. Demonstrate knowledge of biodiversity and its importance in ecosystems. 3. Analyze the impact of various pollutants on air, water, soil, and wildlife.		
Course Outcomes:		
Student will be able to 1. Apply forensic techniques to identify and analyze environmental pollutants. 2. Demonstrate the ability to assess the biodiversity of a given ecosystem and understand its ecological significance. 3. Analyze and interpret environmental impact assessments to evaluate the potential effects of human activities on the environment. 4. Proficient in collecting environmental samples, utilizing appropriate techniques and equipment, and preserving them for further forensic analysis. 5. Critically evaluate environmental laws and regulations, demonstrating an understanding of their role in preventing and addressing environmental crimes. 6. Develop effective communication skills by preparing and presenting comprehensive reports on environmental forensic investigations.		
Module: 1	Basics of Environmental Forensics	9 Hours
Introduction to Environmental Forensic science, Natural Resources - Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources; Hot Spots of biodiversity; Environment Pollution - Air Pollution, Water Pollution, Soil Pollution, Marine Pollution, Noise Pollution, Thermal Pollution, Nuclear hazards; Relationship between the environment and forensic investigations, environmental sample collection and preservation.		
Module: 2	Environmental Forensics	9 Hours
Mercury- Natural and anthropogenic sources, detecting mercury in indoor environment and forensic aspects. Asbestos - sources and detection in air, water, fibers etc. Sewage, Lead - sources, compounds, analytical methods and lead forensics. Arsenic - sources, compounds, analytical methods and forensic aspects. Pesticides- Types, analytical testing and forensic techniques. Polycyclic aromatic hydrocarbons (PAHS) - sources, types and analytical techniques.		
Module: 3	Wild Life Forensic	9 Hours
Introduction to wild life forensic, Types of Wild Life evidences - blood, hair, teeth, foot print etc., Problems of wild life Forensics, Wild life offences, Commodities in the trade, Trade level, Value of trade, Prevention of wild life crime, Laws regulating wild life crimes and examination, Wildlife Act, Foreign Trade Act 1992, Customs Act 1962, CITES, Collection of evidences, Identification of evidences.		
Module: 4	Environment and Ecosystems	9 Hours
Ecosystem characteristics structure and function; environmental pollution, xenobiotic and recalcitrance, Introduction to BOD and COD, use of biosensors to determine the quality of environment, Introduction and scope of environmental management, basic concepts of sustainable development, Environmental Impact Assessment (EIA), environment safety, risk management and emergency preparedness, international summit and treaties.		
Module: 5	Environmental Legislation	9 Hours
Central and State Boards for the prevention and control of environmental pollution, powers and functions of pollution control boards, penalties and procedure, duties and responsibilities of citizens for environmental protection. The Water Act 1974. Prevention and Control of Air Pollution Act 1981, Forest Conservation Act 1981, Environment (protection) Act 1986, Hazardous waste (Management and Handling) Rules, 1989, Bio-Medical Waste (Management and Handling) Rules, 1998.		
Total Lectures		45 Hours

Text Books	
1	Saferstein, R., & Hall, P. (2001). An introduction to forensic science. <i>Criminalistics</i> . Prentice Hall, Upper Saddle River, New Jersey, 108-112.
2	Morrison, R. D., & Murphy, B. L. (2010). <i>Environmental forensics: contaminant specific guide</i> . Elsevier.
3	Pye, K., & Croft, D. J. (Eds.). (2004). Forensic geoscience: principles, techniques and applications. Geological Society of London.
Reference Books	
1	Morrison, R. D., & Murphy, B. L. (2010). <i>Environmental forensics: contaminant specific guide</i> . Elsevier.
2	Morrison, R. D. (1999). <i>Environmental forensics</i> . CRC Press.
3	Pye, K., & Croft, D. J. (Eds.). (2004). Forensic geoscience: principles, techniques and applications. Geological Society of London.
4	Huffman, J. E., & Wallace, J. R. (2012). <i>Wildlife forensics: methods and applications</i> . John Wiley & Sons.
5	Whitelaw, K. (2012). <i>ISO 14001 environmental systems handbook</i> . Routledge.
Recommended by Board of Studies	
13 Feb 2024	
Approved by Academic Council	
24 Feb 2024	

Course Code	FORENSIC DATA SCIENCE	L	T	P	C
23FS2031		3	0	0	3
Course Objectives:					
Enable the student to					
1. Develop sufficient knowledge and insight about data science forensic					
2. Acquire the knowledge of different coding languages					
3. Explore the applications of data science in forensic science					
Course Outcomes:					
Student will be able to					
1. Illustrate the fundamentals of data science					
2. Practice the process of different coding language					
3. Describe the basics of python					
4. Explain the mechanism of data manipulation					
5. Design various codes for forensic cyber tools					
6. Recognize the importance of data science applications in forensics					
Module: 1	Introduction to Data Science				9 Hours
Selecting rows/observations - Rounding Number - Selecting columns/fields - Merging data – Data – aggregation - Data munging techniques.					
Module: 2	Introduction to Python				9 Hours
What is Python? - Why Python? - Installing Python - Python IDEs - Jupyter Notebook Overview – Installing Python idle for windows, Linux and Creating “Hello World” code.					
Module: 3	Python Basics				9 Hours
Python Basic Data types - Lists - Slicing - IF statements - Loops - Dictionaries - Tuples - Functions - Array - Selection by position & Labels.					
Module: 4	Manipulating Data				9 Hours
Selecting rows/observations - Rounding Number - Selecting columns/fields - Merging data - Data aggregation - Data munging techniques.					
Module: 5	Error Metrics				9 Hours

Classification - Confusion Matrix, Precision, Recall, Specificity, F1 Score – Regression, MSE, RMSE, MAPE.	
Total Lectures	45 Hours
Text Books	
1.	Rohan Chopra, Aaron England and Mohammed Noordeen Alaudeen. (2019), <i>Data Science with python</i> , Packt publishers, 9781838552862.
2.	Phuong Vo. T. H, Martin Czygan, Ashish Kumar, Kirthi Raman. (2017), <i>Python: Data Analytics and Visualization</i> , Packt Publishing Ltd, ISBN: 9781788290098.
Reference Books	
1.	Alberto Boschetti, Luca Massaron. (2018), <i>Python Data Science Essentials, (3rd Ed)</i> , Packt, 2018, ISBN: 9781789537864
2.	Jesus Rogel-Salazar. <i>Data Science and Analytics with Python</i> , CRC Press, ISBN: 9781498742092.
3.	David Taieb. (2018), <i>Data Analysis with Python</i> , Packt, ISBN: 9781789950069
4.	Dr. Ossama Embark. (2018), <i>Data Analysis and Visualization using python</i> , Apress publications, ISBN:9781484241080
5.	Fabio Nelli. (2018), <i>Python Data Analytics</i> , Apress publication, 2015, ISBN:9781484209592.
Recommended by Board of Studies	13 Feb 2024
Approved by Academic Council	24 Feb 2024

Course Code	INTRODUCTION TO FORENSIC ENTOMOLOGY	L	T	P	C
23FS2032		3	0	0	3
Course Objectives:					
Enable the student to					
1. Comprehend the foundational principles and methodologies of forensic botany. 2. Investigate the diverse botanical evidence encountered in forensic science. 3. Explore the field of forensic entomology, including the collection and analysis of entomological evidence during legal investigations.					
Course Outcomes:					
Student will be able to					
1. Demonstrate a comprehensive understanding of the principles and practices of forensic botany. 2. Utilize knowledge of forensic entomology to collect and analyze entomological evidence. 3. Evaluate the role of microbial forensics in epidemiological investigations. 4. Develop proficiency in handling microbial forensic samples, identifying potential biological weapons, and implementing preventive measures. 5. Analyze mode of action, identification, and preventive measures associated with various microbial infections and biological toxins. 6. Apply knowledge of microbial profiles and diseases to diagnose and track microbial diseases accurately, including those mistaken for signs of criminal activity.					
Module: 1	Forensic Botany	9 Hours			
Introduction, types, location, collection evaluation and forensic significance of fungi and plants in forensic science; wood and pollen grains-Methods of identification and comparison; various types of planktons, diatoms and their forensic importance; Diatoms:- types, morphology, methods of isolation from different tissues and bones; Study and identification of pollen grains, Paper and Paper Pulp identification, Microscopic and biochemical examination of pulp material; Identification of wood, physical properties, colour, fluorescence, hardness, weight, odour, lustre, texture, anatomical features.					
Module: 2	Botanical Evidence	9 Hours			
Different botanical evidences of forensic significance; Leaves, seeds, pollens, Limnology. Study of Various types of Poisonous Plants; Plant systematics, Identification of Food stuffs & their stains; Plants used as food, animals used as food. Examination of plant foods (starch, herbs, spices &					

flavorings, fruits, vegetables). Examination of animal foods (meat & fish) – microscopic and macroscopic examination, chemical examination, muscles, skin, hairs, scales, bones & cartilage.

Module: 3	Forensic Entomology	9 Hours

Collection of entomological evidence during legal investigations; collection of: meteorological data, specimens before body removal, ground crawling arthropods on and around the body, entomological samples from the body, entomological samples during autopsy, specimens from buried remains, from enclosed structures, aquatic habitats, Laboratory rearing of forensic insects: Larval rearing, rearing containers, monitoring growth, larval dispersal in laboratory. External factors affecting insect succession on carrion.

Module: 4	Microbial Forensics	9 Hours

Defining the microbial forensics program, epidemiology, Microbial forensic tools; Dynamics of disease transmission, Outbreak Investigation; Deliberate introduction of a biological agent; Emerging Microbial Forensic Techniques. DNA of microbes in soil for crime detection. Fungi of forensic importance: Opportunistic mycoses, Chytridiomycota zygomycota, Aspergillus fumigates, Microsporidium, Pneumocystis jiroveci, Asp.flavus & Candida sp, epidemiology, Antifungal agents. Food borne – shigella, salmonella. Etc. Forensic Aspects of Biological Toxins.

Module: 5	Microbes	9 Hours

Microbial Forensic, Biological agents in warfare: Collection, transportation and preservation of microbial forensic samples, Categories of biological weapons, study of potential bacteria, fungi, viruses, and their toxins, mode of action, identification, preventive measures during handling, laboratory setup, epidemiologic investigation for public health, investigation of suspicious disease outbreak, Diagnosing and tracking microbial diseases, SARS Role of microorganisms in body putrefaction process, Microbial profiles as identification tools, Microbial infections and human behavior (Rabies, polio, Syphilis, AIDS, filariasis),

Total Lectures	45 Hours

Text Books

1	Gennard, D. (2012). <i>Forensic entomology: an introduction</i> . John Wiley & Sons.
2	Byrd, J. H., & Tomberlin, J. K. (Eds.). (2019), <i>Forensic entomology: the utility of arthropods in legal investigations</i> . CRC press.
3	Amendt, J., Goff, M. L., Campobasso, C. P. (2010), <i>Current concepts in forensic entomology</i> , London: Springer Netherlands.
4	Gunn, A. (2019), <i>Essential forensic biology</i> . John Wiley & Sons.,
5	Li, R., Norman, S., & Schober, J. (2015), <i>Forensic biology</i> . CRC Press.

Reference Books

1	Roberts, J., & Márquez-Grant, N. (Eds.). (2012), <i>Forensic ecology handbook: from crime scene to court</i> . John Wiley & Sons.
2	Hall, D. W., & Byrd, J. (2012), <i>Forensic botany: a practical guide</i> . John Wiley & Sons.
3	Coyle, H. M. (2004), <i>Forensic botany: principles and applications to criminal casework</i> . CRC press.

Recommended by Board of Studies	13 Feb 2024

Approved by Academic Council	24 Feb 2024

Course Code	INTRODUCTION TO FORENSIC ENGINEERING	L	T	P	C
23FS2033		3	0	0	3

Course Objectives:

Enable the student to:

1. Determine the cause of failure in engineered structures and machines.
2. Identify the adulterations and errors that lead to failures or accidents.

3. Deduce conclusions in case of construction failures and associated accidents		
Course Outcomes:		
Student will be able to		
1. Assess the concepts in Forensic Engineering.		
2. Identify adulterants in building materials.		
3. Examine the scene of road accidents.		
4. Conclude the cause of accident based on evidences.		
5. Analyze the physical evidences at the scene of investigation.		
6. Apply investigative tools to reconstruct the scene of accident		
Module: 1	Introduction	9 Hours
Forensic Engineering: What is forensic engineering; Fire investigation; Industrial accidents; Traffic accident reconstruction; Transportation disaster investigation; Civil engineering investigation; Investigation report. Case study.		
Module: 2	Building Materials	9 Hours
Building Materials- Types of cement and their composition, Determination of adulterants, Analysis of Bitumen and road material, Analysis of cement mortar and cement concrete and stones. Forensic examination of electrical appliances/installations. Case study		
Module: 3	Road Accidents and Bloodstain Pattern Analysis	9 Hours
Road Accidents- Examination of scene, Filaments examination, Examination of skid marks, (BPA): Introduction, Terminologies and classification, Droplet Directionality from bloodstain patterns, Determination of Point of Convergence and Point of Origin. Impact spatter and mechanisms. Importance and Legal aspects of BPA. Case study.		
Module: 4	Glass, Soil, Paints	9 Hours
Glass-Types of glass and their composition, Glass fracture analysis, refractive index measurements. Soil- Formation and types of soil, Composition and color of soil, Forensic examination of soil, Interpretation of soil evidence. Paints- Types of paint and their composition, Forensic examination of paints, Interpretation of paint evidence. Case study.		
Module: 5	Fiber Analysis and Clue Materials	9 Hours
Fiber analysis: Forensic significance, Classification, Textile Fibers, Yarns, Fabric construction, Fabric characteristics, Microscopy characteristic, Birefringence, Fluorescence Microscopy, Colors in textile, Color Assessment, Chemical properties, Miscellaneous Clue Materials- Examination of strings/ropes, Wires/cables, Seals, Counterfeit coins. Case study		
Total Lectures		45 Hours
Text Books		
1.	Ichael Grieve. (2007), <i>Forensic Examination of Fibres</i> , (2 nd Ed) - Kindle Edition - Kindle eBook.	
2.	Noon .(2000), <i>Forensic Engineering Investigation</i> .	
3.	Sharma, B.R. (1974), <i>Forensic Science in Criminal Investigation and Trials</i> , Central Law Agency, Allahabad.	
4.	Kirk (2000) <i>Vehicular Accident investigation and reconstruction</i> .	
Reference Books		
1.	J A Siegel, P.J Saukko (2000) <i>Encyclopedia of Forensic Sciences Vol. I, II and III</i> , Acad. Press	
2.	H. James, Wouldiam G. Eckert; (1999) <i>Interpretation of Blood stain evidence at crime scene stuart</i> Second edition, CRC Press.	
3.	Sharma, B.R. (1974) <i>Forensic Science in Criminal Investigation and Trials</i> , Central Law Agency, Allahabad.	

Recommended by Board of Studies	13 Feb 2024
Approved by Academic Council	24 Feb 2024

Course Code	MICROSCOPY IN FORENSIC SCIENCE	L	T	P	C
23FS2035		3	0	0	3

Course Objectives:

Enable the student to

1. Acquire knowledge on the basic principle of light microscopy
2. Interpret the role of electron microscopes
3. Discriminate the types of photomicrography

Course Outcomes:

Student will be able to

1. Assess the properties of light
2. Distinguish different microscopes
3. Identify the parts of various light microscopes
4. Infer the working of SEM
5. Evaluate the importance of TEM
6. Predict microscope applications across forensic evidence analysis

Module: 1	Introduction to Microscopy	9 Hours

Basic principles of microscopy, Simple and Compound microscope, brief introduction to types of microscopes: Comparison microscope, Phase contrast microscope, Stereoscopic microscope, Polarizing microscope, Fluorescence microscopy, IR microscopy, Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Examination of various evidence using these microscopes.

Module: 2	Light Microscopy	9 Hours

Principle of bright field and dark field microscopy – Theory, Principles and working of compound microscope – Comparison microscope – Stereo Microscope – Fluorescence Microscope – Polarizing Microscope –Phase contrast Microscope -Forensic Application.

Module: 3	Modern Light Microscopy	9 Hours

Theory, Principles and working of interference microscope – Confocal microscope – Oil immersion microscope – Ultraviolet microscope – Infra-red microscope – X-ray microscope –Super resolution microscopy– Multiphoton microscope.

MODULE: 4	Electron Microscopy	9 HOURS

Introduction-Historical view – types – Scanning Electron Microscopy – Theory and Principles – Specific feature – instrumentation – sample preparation – specimen interaction volume – signal produced by specimen and forensic applications - Transmission Electron Microscopy – Theory and Principles – instrumentation – Forensic applications – Comparison of SEM and TEM – Comparison of Light microscopy and Electron Microscopy.

MODULE: 5	Miscellaneous Microscopy	9 HOURS

Photomicrography – Introduction, Principles and procedure of photomicrography – UV Photography – Infrared photography – Microphotography – Comparison of Light microscopy and photomicrography – Principles and applications of Magnetic Resonance Microscope – Scanning Probe Microscope – Ultrasonic microscope

Total Lectures	45 Hours

Text Books

1	Egerton, R.F. (2016), <i>Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM</i> , (2 nd Ed), Springer.

2	Wheeler, B., Wilson, L.J. (2008), <i>Practical Forensic Microscopy: A Laboratory Manual</i> , Wiley-Blackwell, Lab Manual Edition.
3	Basu, S., Millette, J.R., (1986). <i>Electron Microscopy in Forensic, Occupational, and Environmental Health Sciences</i> , Plenum Press,

Reference Books

1.	Bell, S., Morris, K. (2009). <i>An Introduction to Microscopy, (1st Ed)</i> , CRC Press.
2.	Murphy, D.B. (2001), <i>Fundamentals of Light Microscopy and Electronic Imaging</i> , Wiley-Blackwell.
3.	Chiarini-Garcia, H., Melo, R. (2011), <i>Light Microscopy – Methods and Protocols</i> , Springer.
4.	Sanderson, J. (2019), <i>Understanding Light Microscopy</i> , John Wiley & Sons.

Recommended by Board of Studies	13 Feb 2024
Approved by Academic Council	24 Feb 2024

Course Code	CHEMISTRY IN EVERYDAY LIFE	L	T	P	C
23CH2016		3	0	0	3

Course Objectives:

To enable the student

1. Acquire knowledge on the chemistry connections of everyday life.
2. Generate curiosity in learning chemistry concepts in day- to- day activities.
3. Relate what the student has learned in class to real-life situations.

Course Outcomes:

Student will be able to

1. Discern the practical aspects of chemistry in day-to-day life.
2. Learn chemistry topics through daily activities.
3. Contemplate innovative and develop application-oriented products.
4. Gain knowledge in buying certified food products
5. Make the right choice in choosing the right food.
6. Recommend the right perspectives to guard the environment

Module: 1	Drugs and Diseases	9 Hours
Clinical chemistry – sickness-disease-urine, blood analysis- diagnosing a disease- NSAID drugs - antibiotics, antiseptics, antipyretics – definitions, examples (common drugs available in the market) – lethal diseases – causes for polio, diabetes, AIDS, cancer – signs and symptoms – vaccination – protein misfolding– common drugs banned in India – effects of using banned drugs – steroids-effects of steroidal injections.		
Module: 2	Perfumes, Explosives and Dyes	9 Hours
Perfumes: historical significance-composition – the olfactory system – categories- criteria for safe perfume- effects – chemistry concepts in ice cream making – chemistry of paint – chemistry of explosives – TNT, RDX, nitrocellulose, nitroglycerine (structure and properties only) – natural and synthetic dyes (fabric) – types, advantages, applications.		
Module: 3	Chemicals in Common Products	9 Hours
Advantages and disadvantages of the following: monosodium glutamate (aginomotto) umami, the fifth taste and glutamate-effects – Data on global usage of aginimotto- lycopene (in tomato)- effects — caffeine and theobromine (in chocolates) – polyphenols (in tea) –docosahexaenoic acid acid (in fish) – cry chemistry-chemistry of eye irritation in cutting onions-thiols (in onion) – polycyclic aromatic hydrocarbons (formed during cooking meat) – constituents of talcum powder and pulmonary fibrosis – ingredients of tooth paste – the molecule of darkness and its effect on sleep cycle- melatonin (in anti-ageing product) – microban (in toys) – alpha tocopherol (in body lotions) – aluminum chloride (in		

antiperspirants) – aspartame (in artificial sweetener)- chloral hydrate (in sedatives) – citric acid (in citrus fruits).		
Module: 4	Chemistry of Daily Phenomena	9 Hours
Reasoning: kitchen gas burner burns yellow when a pot of boiling water overflows – cosmetic creams feel cool when applied to skin- various types of body lotions-moisturizers, sun screen lotion- cleaning milk-formulation- effect – seashells vary in color —chemistry of disappearing inks disappear- few examples – water does not relieve the burning sensation of chilly- capsaicin – sniffing dogs detect explosives and bombs – chemistry of smell in fish-flesh of fish smells different from other meat – puff pastries expand when prepared –water repellent fabrics – cotton is highly water absorbent but dries slowly- hydrogen bonding		
Module: 5	Chemistry Knowledge for a Better Life	9 Hours
Food adulteration Identification-effects – consumption of alcohol and its ill effects – balanced diet – iodized salt – Tooth paste-fluoride– saturated and unsaturated fat - cholesterol (LDL and HDL) –how to choose the right cooking oil- fast food and ill health – organic food – crackers – ill effects of crackers – molecules of emotion (Acetylcholine, Dopamine, Epinephrine, Serotonin, Melatonin, Oxytocin). Food adulteration-case studies (any three)		
Total Lectures		45 Hours
Text Books		
1.	Karukstis K.K., and Hecke G.R.V. (2003), <i>Chemistry connections: the chemical basis of everyday phenomenon</i> , (2 nd Ed), Elsevier Science and Technology books,	
2.	Grace Ross Lewis. (2001), <i>1001 Chemicals in everyday products</i> , (3 rd Ed), John Wiley and sons.	
Reference Books		
1.	www.listverse.com/2007/10/04/top-10-incurable-diseases.	
2.	www.foodproductdesign.com	
3.	www.srsi.org/sr1/weapon.explode.htm	
4.	Paul Engel, “Pain-free Biochemistry”, Wiley – Blackwell publishers, 2009.	
Recommended by Board of Studies		13 Feb 2024
Approved by Academic Council		24 Feb 2024

ERRATA IN THE ACADEMIC HAND BOOK 2023

Entry	ERRATA ITEMS
1	Typo mistake in the name of one of the courses in the B.Sc., Optometry curriculum as below: Ref: Academic hand book 2020 , Volume 3, page 1020, B.Sc., Optometry Curriculum Course Name : Systematic Diseases-to be changed as Systemic Diseases Course code : 20OP2036 The same must be done in the syllabus page-1050
2	The typo corrections to be done in the Academic Handbook 2023 II M.Sc Forensic Science, Semester III, the professional elective – 4, should be L-0, T-0, P-3 and C- 2. (Vol-II, Page 443) B.Sc Forensic Curriculum – the total credits should be 139 (Vol-II, page 438) In semester wise curriculum for B.Sc., Forensic Science, the General English, and Creative English course codes should be 23EN2003 and 23EN2004 respectively. (Vol-II, page 436)

Course Code	Applied Physics for Biotechnology Engineering	L	T	P	C
24PH1001		2	0	2	3
Course Objectives:					
Enable the students to:					
1. Acquire adequate knowledge on Lasers and Fiber Optics					

2. Relate the principles of Ultrasonics and Acoustics 3. Comprehend the development of Magnetic and Nano-materials		
Course Outcomes:		
The students will be able to: 1. Apply Boltzmann's statistics and Einstein's quantum theory of radiation to solve laser related problems. 2. Solve problems related to propagation of light in optical fiber cables. 3. Apply the concepts of ultrasound and its applications in biotechnology industry 4. Explain the core principles of acoustics such as sound propagation and detection as they relate to biological systems. 5. Analyze the concepts of magnetism in MRI and magnetic drug delivery. 6. Evaluate the various properties of nanomaterials for usage in biotechnology.		
Module: 1	Lasers and its applications	5 Hours
Introduction - Principle and properties of laser - Population inversion - Einstein's coefficients -Types of lasers - CO ₂ laser - Helium-neon laser - Applications: Laser Assisted Cataract Surgery (LASIK). Lab experiment: Determination of wavelength of Laser and analysis of particle size.		
Module: 2	Fiber Optics	5 Hours
Introduction - Propagation of light in optical fibers - Numerical aperture and acceptance angle -Types of optical fibers - Attenuation - Applications - Fiber optic sensor - Endoscopy and endoscopic laser surgery. Lab Experiment: Determination of Attenuation in optical fiber cable.		
Module: 3	Ultrasonics in Bio-Industry	5 Hours
Introduction - Properties of ultrasonics - Production of ultrasonic waves - Magnetostriction effect - Piezoelectric effect - Piezoelectric transducers - Applications - Ultrasound imaging. Lab Experiment: Determination of frequency of ultrasonic waves.		
Module: 4	Acoustics in Biotechnology	5 Hours
Introduction - Classification of sound - Characteristics of musical sound - Intensity of sound - Reverberation - Reverberation time - Factors affecting the acoustics of a building - Applications - Bio-acoustics and plant acoustics. Lab Experiments: Measurement of reverberation time of a hall. Frequency of a tuning fork using Melde's string apparatus.		
Module: 5	Magnetism and its application in Medicine	5 Hours
Introduction - Origin of magnetic moment - Bohr magneton - Dia, para, and ferro magnetism -Hysteresis curve - Soft and hard magnetic materials - Applications - MRI scanning. Lab Experiment: Thermal conductivity and viscosity measurements of nanofluids.		
Module: 6	Nanomaterials and its applications in Biotechnology	5 Hours
Introduction to nanomaterials - Quantum Dot - Quantum wire and quantum well - Physical properties - Optical properties - Electrical and magnetic properties of nanomaterials - Applications - Nanomaterials for targeted drug delivery - Biomimetic nano-materials for tissue engineering. Lab Experiments: Synthesis of ZnO Nanoparticles. Structural Analysis of Nanoparticles using XRD.		
Total Lectures		45 Hours
Text Books		
1	Pandey B K, Chaturvedi S (2021). <i>Engineering Physics</i> . Cengage Learning India Pvt. Ltd. ISBN No: 978-8195353675	
2	Avadhanulu M N, Kshirsagar P G (2018). <i>A Textbook of Engineering Physics</i> . S. Chand and Company Ltd. ISBN No: 10-9352833996	

Reference Books	
1	Robert Resnick Jearl Walker, David Halliday (2023). <i>Principles of Physics</i> . Wiley India Pvt. Ltd. ISBN No: 978-9357460835
2	Verma H C (2022), <i>Concept of Physics</i> . Bharati Bhawan Publishers. ISBN No: 978-8177091878
3	Hugh D. Young, (2021). <i>University Physics with Modern Physics</i> . Pearson Education. ISBN No: 978-9353949297
4	Jha A K (2019). <i>A Textbook of Applied Physics</i> . Dreamtech Press. ISBN No: 978-9389520453
Recommended by the Board of Studies	
12.04.2024	
Approved by the Academic Council	
11.05.2024	

Course Code	Introduction to Quantum Computing	L	T	P	C
24PH2001		3	0	0	3

Course Objectives:

Enable the students to:

1. Learn the fundamental concepts of quantum computing
2. Acquire the knowledge on different quantum circuits and algorithms
3. Explore the quantum theory and its applications in artificial intelligence

Course Outcomes:

The students will be able to:

1. Analyze the core principles of quantum mechanics, such as super position, entanglement, and uncertainty.
2. Illustrate the core principles of quantum computing and quantum phenomena
3. Apply the concepts of quantum gates and circuits to simulate quantum circuits
4. Analyze different quantum hardware platforms for quantum measurements
5. Assess the connections between quantum theory and machine learning
6. Evaluate the potential applications and future directions of quantum computing

Module: 1	Significance of Quantum Mechanics	7 Hours

Introduction to classical and quantum concepts - Drawbacks of classical mechanics - Origin of quantum mechanics - Wave-particle duality - Operator formalism - History and evolution of computers - Key milestones in computing - Emerging technologies - Application of supercomputers for cryptography.

Module: 2	Fundamentals of Quantum Computing	7 Hours

Introduction - Quantum computation vs classical computation - Bits to qubits - Multi qubits - Quantum superposition - Quantum entanglement - Quantum supremacy - Bloch sphere representation - Bell's inequality.

Module: 3	Quantum Gates to Quantum Error correction	9 Hours

Quantum cellular automata - Quantum logical gates - Quantum circuits - Quantum algorithms and its Types - Quantum interference - Quantum error correction - Quantum complexity theory - Application of quantum algorithms for artificial intelligence tasks.

Module: 4	Quantum Hardware	9 Hours

Quantum hardware platforms - Superconducting qubits - Trapped ions and topological qubits - Quantum gates and operations in physical systems - Quantum coherence and decoherence - Quantum control and measurement - Application in interferometry, Gravitational wave detection.

Module: 5	Applications of Quantum Computing	6 Hours

Quantum Simulation - Optimization and search algorithms - Cryptography and security - Machine learning with quantum computing - Quantum networking and communication - Integration of quantum computing and artificial intelligence.

Module: 6	Industry 5.0 and Revolution in Quantum Computing	7 Hours
Quantum supremacy and milestones - Industry and research landscape in quantum computing - Ethical considerations and societal impacts - Open problems and unresolved challenges - Potential future developments and advancements in quantum computing.		
Total Lectures		45 Hours
Text Books		
1	Adam Smith (2022). <i>The Beginner's Guide to Quantum Computing & Mechanics</i> . A. Smith Media. ISBN No: 979-8215621479	
2	Eleanor G. Rieffel, Wolfgang H. Polak (2014). <i>Quantum Computing: A Gentle Introduction</i> . MIT Press. ISBN No: 978-0262526678	
Reference Books		
1	David J. Griffiths, Darrell F. Schroeter (2018). <i>Introduction to Quantum Mechanics</i> . Cambridge University Press. ISBN No: 978-1107189638	
2	Ray LaPierre (2021). <i>Introduction to Quantum Computing</i> . Springer International Publishing. ISBN No: 978-3030693176	
3	Venkateswaran Kasirajan (2021). <i>Fundamentals of Quantum Computing: Theory and Practice</i> . Springer Nature. ISBN No: 978-3030636883	
4	Thomas G. Wong (2022). <i>Introduction to Classical and Quantum Computing</i> . Rooted Grove publishers. ISBN No: 979-8985593105	
5	Noson S. Yanofsky, Mirco A. Mannucci (2008). <i>Quantum Computing for Computer Scientists</i> . Cambridge University Press. ISBN No: 978-0521879965	
Recommended by the Board of Studies		12.4.2024
Approved by the Academic Council		11.05.2024

Course Code	Introduction to Astronomy and Space Science	L	T	P	C
24PH2002		3	0	0	3

Course Objectives:

Enable the students to:

1. Learn ancient astronomy, solar system models, types of stars and their evolution
2. Acquire the knowledge on the evolution of galaxies, and life in the universe
3. Explore the tools and techniques available to study the cosmos

Course Outcomes:

The students will be able to:

1. Analyze the structure, and sizes of various solar system components
2. Explain the physical processes that drive stellar evolution from birth to its end
3. Analyze the shape and size of the Milky Way galaxy and other types of galaxies
4. Evaluate the big bang theory, and theories related to death of the universe
5. Demonstrate the modern-day telescope technology
6. Evaluate the role of modern day space technologies to solve human problems

Module: 1	The Solar System	7 Hours
Introduction - The celestial sphere - The Celestial coordinate system - Precession and time - The laws of planetary motion - The universal law of gravitation - Various models of the solar system - Planets and their properties - Natural satellites - Asteroids - Comets - Meteoroids, meteors, and meteorites - The kuiper belt and the oort cloud.		
Module: 2	The Sun and the Stars	7 Hours
Introduction - The sun and its properties - The solar wind - The sunspot cycle - Solar prominences, and solar flares - Stellar luminosity - Stellar distances - Trigonometric parallax - The apparent and absolute		

magnitude scale - The hertzprung - Russel diagram - The life and deaths of stars - Variable stars - White dwarfs - Supernova explosions - Neutron stars and black holes.

Module: 3	The Milky Way Galaxy	7 Hours

Introduction - Open star clusters - Globular star clusters - The interstellar medium - Size, shape and structure of the milky way - Supermassive black holes - Elliptical galaxies - Spiral galaxies - Irregular galaxies - The hubble classification - The cosmic distance scale - Standard candle method - Starburst galaxies - Active galaxies - Groups, clusters, and superclusters of galaxies.

Module: 4	The Origin and Evolution of the Universe	8 Hours

Introduction - The birth of the universe - The standard big bang model - The expansion of the universe - The steady state model - Quasi-Steady state model - The big bounce model - The cosmic microwave background - Inflation - Particle physics - Four fundamental forces - Classification of elementary particles - Quarks - The standard model of particle physics - Dark matter - Dark energy - Multiverse - The fate of the universe - The Search for intelligent life in the universe - The Drake equation - The hunt for exoplanets.

Module: 5	Observing the Universe	8 Hours

Introduction - The human eye - Optical telescopes - Powers of a telescope - Refracting and reflecting telescopes - Active and adaptive optics - Significant optical telescopes - The hubble space telescope - Other windows to observe the heavens - Radio telescopes - Observing in other wavebands - The james webb space telescope - Gravitational wave astronomy.

Module: 6	Space Technology	8 Hours

Introduction - Historical overview - Earth observation - Communications - Navigation - Space astronomy - Moon missions - Interplanetary missions - Key technologies - Material science in space - Microgravity - Fluid physics - Thermo-physics - Space medicine and biology - New technologies and robotics - Space robotics - On-orbit servicing - India in space - Chandrayan 1, 2, and 3 - Aditya L1 mission.

Total Lectures	45 Hours

Text Books

1	Rohan Gharate (2022). <i>Book of Astronomy and Astrophysics</i> . Notion Press. ISBN No. 978-8886679687
2	Wilfried Ley, Klaus Wittmann and Willi Hallmann (2009). <i>Handbook of Space Technology</i> . John Wiley & Sons. ISBN No: 978-0470697399

Reference Books

1	Stan Owocki (2021). <i>Fundamentals of Astrophysics</i> . Cambridge University Press. ISBN No. 978-1108844390
2	Mohit Kumar Sharma and Suresh Chandra (2019). <i>A Textbook of Astronomy and Astrophysics</i> . Dreamtech Press. ISBN No.978-9389520903

Recommended by the Board of Studies	12.04.2024

Approved by the Academic Council	11.05.2024

Course Code	Nano-Materials for Biomedical Applications	L	T	P	C
24PH3001		4	0	0	4

Course Objectives:

Enable the students to:

1. Learn about the concepts and properties of Nanobiomaterials
2. Acquire knowledge on gold and ceramic nanomaterials for cancer therapy
3. Explore properties of nanocomposites, silica nanomaterials for bone repair and drug delivery

Course Outcomes:

The students will be able to:

1. Explain the properties of nanobiomaterials 2. Assess the therapeutic principles of gold nanoparticles for cancer therapy 3. Apply the concepts related to ceramic nanobiomaterials for Tissue engineering 4. Analyze the characteristics of nanocomposite polymer biomaterials for bone and cartilage repair 5. Illustrate the role of silica nanomaterials for imaging and drug delivery 6. Appraise the importance of nanobiomaterials for bio-medical applications		
Module: 1	Nano-Bio Materials	12 Hours
Introduction - Types of Nanobiomaterials - Physicochemical properties: Effects of size - Shape and surface area - Effect of surface charge - Composition and crystalline structure - Effect of aggregation and concentration - Metallic - Ceramic and semiconductor based nanobiomaterial - Organic/Carbon based nanobiomaterials - Organic inorganic hybrid nanobiomaterials - Silica-based Nanobiomaterials - Nanocomposites - Directed/self-assembled nanobiomaterials - Characteristics and advantages of nanomaterials.		
Module: 2	Gold Nanoparticles for Cancer Therapy	12 Hours
Introduction - Gold nanoparticle synthesis - One step approach - Seed mediation approach - Shape - Controlled synthesis - Synthesis of negatively and positively charged gold nanoparticles - Cellular uptake of gold nanoparticles - Nanoparticle assisted cancer treatment - Photodynamic therapy - Nanoparticle based hyperthermia therapy - Diagnosis and detection techniques - Surface plasmon resonance scattering - Gold nanoparticle based SERS and SERS tag for cellular detection.		
Module: 3	Ceramic Nano materials for Tissue Engineering	12 Hours
Introduction - Ceramic nanomaterials - Calcium phosphate minerals - Aluminum oxides - Titanium oxides - Zirconium oxides - Particle size and morphology analysis - Surface characterization- Cytocompatibility - Biocompatibility and toxicity - Controlled preparation of ceramic nanoparticles - Monolithic ceramic nanoparticles- Delivery of therapeutic agents - Ceramic nanocoatings - Nanocomposites for tissue engineering scaffolds - Bone regeneration.		
Module: 4	Polymer Nanocomposite for Bone and Cartilage	12 Hours
Introduction - Polymer nanocomposite - Structure and properties - Preparation methods - Electrospinning - Solvent casting - Sol-Gel - Biomineralization - Bone - Hard nanocomposite - Cartilage - Soft nanocomposite - The Bone cartilage interface - Properties required for tissue grafts to work - Polymeric and composite nanobiomaterials for bone and cartilage repair - Biomaterial scaffolds and polymer nanocomposites for osteochondral repair.		
Module: 5	Silica Nano materials for Imaging and Drug Delivery	12 Hours
Introduction- Amorphous silica nanoparticle synthesis - Relative chemical and thermal stability- Synthetic Control over size and size distribution - Characterization of silica nanoparticles - Size and charge - Silica nanoparticle preparation for biological evaluation - Heat and autoclaving - Toxicity via cellular internalization - Toxicity via particle - Cell interaction - Toxicity via bio distribution and clearance mechanisms - Applications of silica nanoparticles in drug delivery and imaging.		
Total Lectures		60 Hours
Reference Books		
1.	Rakesh Kumar Bachheti, Archana Bachheti, Azamal Husen (2024). <i>Metal and Metal-Oxide Based Nanomaterials</i> . Springer Nature Singapore. ISBN No. 978-981-99-7672-0	
2.	Rostyslav S. Stoika (2022). <i>Biomedical Nanomaterials - From design and synthesis to imaging, application, and environmental impact</i> . Springer. ISBN No. 978-3-030-76234-6	
3.	Dong Kee Yi, Georgia C. Papaefthymiou (2014). <i>Nanobiomaterials - Development and Applications</i> . CRC Press. Taylor & Francis Group. ISBN No. 13: 978-1-4398-7642-8	
4.	Feng Chen, Weibo Cai (2011). <i>Hybrid Nanomaterials - Design, Synthesis, and Biomedical Applications</i> . CRC Press. Taylor & Francis Group. 2017 ISBN No. 13: 978-1-4987-2092-2	

5.	Balaji Sitharaman (2011). <i>Nano-Biomaterials Handbook</i> . CRC Press. Taylor & Francis Group. ISBN No. 13: 978-1-4200-9467-1
Recommended by the Board of Studies	12.04.2024
Approved by the Academic Council	11.05.2024

**DIVISION OF
PHYSICAL SCIENCES**

LIST OF NEW COURSES

Sl. No.	Course Code	Course Title	Credits			
			L	T	P	C
1	22CH2001	Biochemistry	3	0	0	3
2	22FS2001	Laboratory Management and Safety	3	0	0	3
3	22FS2002	Instrumental Methods in Biology	3	0	0	3
4	22CH3001	Phytochemistry and Herbal Products	3	0	0	3
5	23CH1001	Environmental Studies	3	0	0	3
6	23CH1002	Essentials of Chemistry for Aerospace Engineers	3	0	0	3
7	23CH1003	Applied Chemistry for Food Processing Technology	3	0	0	3
8	23CH1004	Applied Chemistry Laboratory for Food Processing Technology	0	0	2	1.5
9	23PH1001	Applied Physics for Aerospace Engineering	3	0	0	3
10	23PH2001	Nanomaterials and Energy Devices	3	0	0	3
11	23CH2001	Inorganic Chemistry for Forensic Science	3	0	0	3
12	23CH2002	Physical Chemistry for Forensic Science	3	0	0	3
13	23CH2003	Organic Chemistry for Forensic Science	3	0	0	3
14	23CH2004	Forensic Chemistry	3	0	0	3
15	23CH2005	Forensic Toxicology	3	0	0	3
16	23CH2006	Inorganic Chemistry Laboratory	0	0	3	2
17	23CH2007	Physical Chemistry Laboratory	0	0	3	2
18	23CH2008	Organic Chemistry Laboratory	0	0	3	2
19	23CH2009	Analytical Chemistry Laboratory	0	0	3	2
20	23CH2010	Forensic Toxicology Laboratory	0	0	3	2
21	23CH2011	Analytical Chemistry for Forensic Science	3	0	0	3
22	23CH2012	Instrumental methods of Analysis	3	0	0	3
23	23CH2013	Biochemistry	3	0	0	3
24	23CH2014	Nano chemistry for Forensic Science	3	0	0	3
25	23CH2015	Modern Instrumental methods in Forensic Science	3	0	0	3
26	23CH2016	Chemistry in Everyday Life	3	0	0	3
27	23FS2001	Fundamentals of Forensic Science	3	0	0	3
28	23FS2002	Indian Constitution, Fundamental Laws and Procedure	3	0	0	3
29	23FS2003	Forensic Physics	3	0	0	3
30	23FS2004	Crime and Society	3	0	0	3
31	23FS2005	Crime Scene Investigation	3	0	0	3
32	23FS2006	Finger Print Analysis	3	0	0	3
33	23FS2007	Basic Biology for Forensic Science	3	0	0	3
34	23FS2008	Questioned Documents	3	0	0	3
35	23FS2009	Forensic Ballistics	3	0	0	3
36	23FS2010	Forensic Psychology	3	0	0	3
37	23FS2011	Forensic Biology	3	0	0	3
38	23FS2012	Cyber Forensics	3	0	0	3
39	23FS2013	Crime Scene Investigation Laboratory - I	0	0	3	2
40	23FS2014	Crime Scene Investigation Laboratory - II	0	0	3	2
41	23FS2015	Forensic Physics Laboratory	0	0	3	2
42	23FS2016	Forensic Dermatoglyphics Laboratory	0	0	3	2
43	23FS2017	Moot court for Forensic Science	0	0	3	2
44	23FS2018	Questioned Documents Laboratory	0	0	3	2
45	23FS2019	Forensic Ballistics Laboratory	0	0	3	2

46	23FS2020	Forensic Psychology Laboratory	0	0	3	2
47	23FS2021	Forensic Biology Laboratory	0	0	3	2
48	23FS2022	Cyber Forensics Laboratory	0	0	3	2
49	23FS2023	Foundation Course on Computer Fundamentals and Office	3	0	0	3
50	23FS2024	Forensic Medicine	3	0	0	3
51	23FS2025	Accident Investigation	3	0	0	3
52	23FS2026	DNA Typing	3	0	0	3
53	23FS2027	Fundamentals of Forensic Anthropology and Odontology	3	0	0	3
54	23FS2028	Digital and Multimedia forensics	3	0	0	3
55	23FS2029	Forensic Statistics	3	0	0	3
56	23FS2030	Introduction to Environmental Forensic Science	3	0	0	3
57	23FS2031	Forensic Data Science	3	0	0	3
58	23FS2032	Introduction to Forensic entomology	3	0	0	3
59	23FS2033	Introduction to Forensic engineering	3	0	0	3
60	23FS2034	Recent Trends in Forensic Sciences	3	0	0	3
61	23FS2035	Microscopy in Forensic Science	3	0	0	3
62	23CH3001	Chemical Kinetics and Surface Chemistry	4	0	0	4
63	23CH3002	Chemical Bonding and Main Group Chemistry	4	0	0	4
64	23CH3003	Reaction Mechanism and Stereochemistry	4	0	0	4
65	23CH3004	Quantum Chemistry and Group Theory	4	0	0	4
66	23CH3005	Coordination Chemistry	4	0	0	4
67	23CH3006	Organic Transformations and Reagents	4	0	0	4
68	23CH3007	Chemical Thermodynamics and Electrochemistry	4	0	0	4
69	23CH3008	Organometallics	4	0	0	4
70	23CH3009	Pericyclic Reactions and Natural Products	4	0	0	4
71	23CH3010	Qualitative and Quantitative Inorganic Analysis Lab	0	0	6	4
72	23CH3011	Modern Instrumental Analysis Lab	0	0	3	2
73	23CH3012	Qualitative and Quantitative Organic Analysis Lab	0	0	6	4
74	23CH3013	Preparative Inorganic Chemistry Lab	0	0	3	2
75	23CH3014	Physical Chemistry Lab	0	0	6	4
76	23CH3015	Synthetic Organic Chemistry Lab	0	0	3	2
77	23CH3016	Analytical Chemistry	3	0	0	3
78	23CH3017	Molecular Spectroscopy	3	0	0	3
79	23CH3018	Nuclear Chemistry and Solid State Chemistry	3	0	0	3
80	23CH3019	Supramolecular and Green Chemistry	3	0	0	3
81	23CH3020	Water Chemistry	3	0	0	3
82	23CH3021	Chemistry for Energy Conversion and Storage	3	0	0	3
83	23CH3022	Applied Electrochemistry	3	0	0	3
84	20CH3023	Research Methodology and IPR	3	0	0	3
85	23CH3024	Polymer Science in Industry	3	0	0	3
86	23CH3025	Medicinal Chemistry	3	0	0	3
87	23CH3026	Forensic Chemistry for Chemists	3	0	0	3
88	23CH3027	Internet of Chemical Things	3	0	0	3
89	23CH3028	Waste to Energy	3	0	0	3
90	23CH3029	Computational Chemistry and Cheminformatics	3	0	0	3
91	23CH3030	Forensic Chemistry	3	0	0	3
92	23CH3031	Forensic Toxicology	3	0	0	3
93	23CH3032	Instrumental Methods of Analysis - I	3	0	0	3
94	23CH3033	Nanomaterials Synthesis and Characterization	3	0	0	3
95	23CH3034	Forensic Chemistry Lab	0	0	3	2

96	23CH3035	Advanced Forensic Chemistry	3	0	0	3
97	23CH3036	Glass Forensic Science	3	0	0	3
98	23CH3037	Chromatography	3	0	0	3
99	23CH3038	Bioorganometallic Chemistry	3	0	0	3
100	23CH3039	Chemistry of Carbenes	3	0	0	3
101	23FS3001	Forensic Science and Criminal Justice System	3	0	0	3
102	23FS3002	Crime Scene Investigation	3	0	0	3
103	23FS3003	Forensic Biology	3	0	0	3
104	23FS3004	Advanced Questioned Documents	3	0	0	3
105	23FS3005	Forensic Psychology	3	0	0	3
106	23FS3006	Forensic Physics and Advanced Ballistics	3	0	0	3
107	23FS3007	Finger Prints and other Impressions	3	0	0	3
108	23FS3008	Cyber Crime	3	0	0	3
109	23FS3009	Medical Jurisprudence	3	0	0	3
110	23FS3010	Crime Scene Management Lab	0	0	3	2
111	23FS3011	Forensic Biology Lab	0	0	3	2
112	23FS3012	Forensic Psychology Lab	0	0	3	2
113	23FS3013	Forensic Physics and Ballistics Lab	0	0	3	2
114	23FS3014	Questioned Documents and Finger Print Analysis Lab	0	0	3	2
115	23FS3015	Cybercrime Laboratory	0	0	3	2
116	23FS3016	Forensic DNA Typing	3	0	0	3
117	23FS3017	Forensic anthropology, odontology and bitemark analysis	3	0	0	3
118	23FS3018	Forensic Aspects of Poison	3	0	0	3
119	23FS3019	Modern Instrumentation Lab	0	0	3	2
120	23FS3020	Forensic Botany, Entomology and Microbial Forensics	3	0	0	3
121	23FS3021	Wildlife and Environmental Forensics	3	0	0	3
122	23FS3022	Narcotic and Pharmaceutical Drug Analysis	3	0	0	3
123	23FS3023	Forensic Serology	3	0	0	3
124	23FS3024	Analytical Techniques in Forensic Science	3	0	0	3
125	23FS3025	Nanotechnology applications in Forensic Science	3	0	0	3

Course Code	BIOCHEMISTRY	L	T	P	C
22CH2001		3	0	0	3
Course Objectives:					
To enable students to:					
1. Recognize the importance of biochemistry					
2. Apply the role of biomolecules in forensic science					
3. Infer the importance of electrophoresis					
Course Outcomes:					
The student will be able to:					
1. Classify the various types of biomolecules					
2. Summarize the role of amino acids in forensic science					
3. Predict the composition of proteins					
4. Analyze the enzyme action					
5. Demonstrate the role of nucleic acids in forensic science					
6. Describe the principles of electrophoresis					
Module: 1	Nucleic Acids				9 Hours
Basic elements of life - Biomolecules and cells- Hierarchy of molecular organization of cells Biomolecules supra molecular structures and cell organelles- Structural organization of cells Replication. Nucleotides – Pyrimidines and purines – Nucleic acids –types of nucleic acids- Hydrolysis of nucleic acids.					

Module: 2	Amino acids	9 Hours
mRNA- Transcription- Amino acids — Protein and Non protein amino acids- Physicochemical properties – Absorption spectra – Chemical reactions– Analysis of amino acid mixtures – Complete hydrolysis of polypeptide chains and determination of amino acid composition –N-terminal and C-terminal residues of peptides.		
Module: 3	Proteins	9 Hours
Translation-tRNA — Genetic coding of amino acid sequences in proteins- Mutation – Structure of peptides– Composition of proteins- Denaturation – Estimation of proteins Functional diversity of proteins – Antibodies and immune response –specificity– Sequence isomerism in polypeptide chains– Optical and chemical properties of peptides.		
Module: 4	Enzymes	9 Hours
Enzymes – Definition, types and classification - Biological activities – Kinetics – Inhibition - Types of inhibition – Micheles-Mentor’s equation – Enzyme polymorphism – Purification of proteins and enzymes – Enzyme assay techniques: UV-Vis, Luminescence, Radio isotope and immunochemical methods – Automated enzyme analysis – Immobilized enzymes.		
Module: 5	Techniques	9 Hours
Cell and tissue culture Cell fractionation- pH and buffers - Biochemical techniques - determination of amino acid sequence – Sequence analysis of peptide fragments – PCR technique -DNA sequencing - Electrophoretic Techniques – Principles – Classification of electrophoresis - Zone Electrophoresis- Gel Electrophoresis – Capillary electrophoresis -Isoelectric Focusing – Isotachophoresis — Forensic Application of electrophoresis.		
Total Lectures		45 Hours
Text Books		
1.	Lodish, H., Berk, A., Kaiser, C. A., Kaiser, C., Krieger, M., Scott, M. P. and Matsudaira, P. “Molecular cell biology”, 9 th edition, Macmillan, 2019.	
2.	Nelson, D. L. and Cox, M. M., “Lehninger Principles of Biochemistry”, 3rd edition., Macmillan Worth, 2000.	
Reference Books		
1.	Berg M, Stryer and L, Tymczko, “Biochemistry”,9 th edition, WH Freeman, 2019.	
2.	Voet, D. and Voet, J.G., “Biochemistry”, 2nd edition, John Wiley, 1995.	
3.	Turner, P.C, McLennan, A. G., Bates, A. D. and White, M. R. H., “Molecular Biology”, 2nd edition. BioScientific/Viva Books, 2001.	
4.	Rao, P. Gundu, “Biochemistry”, Vallabh Prakashan, 1995.	
Recommended by Board of Studies		8 th May 2023
Approved by Academic Council		03 June 2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	2		3	1	1		2	1	2
CO2	2	1	2		2	2		2	2	
CO3	3		2	2	1	2	1	1		2
CO4	3	2	1	2			1	1	2	
CO5	2		2	1		1	2	2	2	
CO6		2	2	1		2	2	1	2	2

‘3’-High ‘2’- Medium ‘1’ – low ‘-’ no correlation

Course Code	LABORATORY MANAGEMENT AND SAFETY	L	T	P	C
22FS2001		3	0	0	3
Course Objectives:					
To enable students to:					
1. Describe the standards used in laboratories					

2. Practice the laboratory management and quality management 3. Apply the steps to be taken for laboratory safety		
Course Outcomes:		
The student will be able to: 1. Summarize various chemical standards 2. Demonstrate various biological standards 3. Apply the quality management systems 4. Recognize the importance of Laboratory Management 5. Utilize the laboratory Information Management system 6. Analyze the steps in maintaining the Laboratory safety		
Module: 1	Standards for analysis	9 Hours
Basic standards – Need of standards in analytical sciences – Basic chemical standards – Analytical standards – Reference materials – High purity substances – Certified reference materials – Working or secondary standards – Matrix effect in standards – Biological standards – Biochemical standards – Microbial cell lines and standards		
Module: 2	Quality Management	9 Hours
Introduction – Quality - Quality system – Quality plan – Inspection and testing – Test records – Control of inspection - Handling, storage, packaging, preservation and delivery of the material – Control of quality records – Internal quality audits – Quality assurance – Training Laboratory Accreditation – ISO 9000 - ISO 14000 and 17000 series of standards – Accreditation Boards – NABL guidelines for accreditation in India Proficiency testing system – Internal quality control – Inter and intra laboratory testing programmes – Designing and running the proficiency testing programmes – Confidentiality - Advantages of accreditation		
Module: 3	Laboratory Management	9 Hours
Administration of Laboratories – Types of laboratories – Connection between field work and laboratory – Educational requirements of laboratory personnel – Routine laboratory work – Research and development – Internal organization of a laboratory Architectural requirements – Laboratory design – Floor area - Furniture design – Auxiliary services – Receipt of reports and remnants – Record management – Requirement of equipment, glassware, chemicals and other material – Purchase procedure – Disposal of wastes – Security of the premises		
Module: 4	Laboratory Information Management system	9 Hours
Classification of LIMS - Functions – Sub-division by functional area – Definition of LIMS – Strategic design of LIMS – System development life cycle – Review of the laboratory – Project proposal – Definition of system requirements – Specifications – Commercial or Bespoke LIMS – Evaluation – Purchase and installation – Demonstration – Validation – User training and implementation		
Module: 5	Laboratory Safety	9 Hours
Planning – Written safety plan – Safety policies – Safety resources – Operations - Hazards of chemicals, solvents, poisons and explosives – Storage facilities – Biological hazards - Pressure vessels and then handling – Electrical safety – Fume cup boards-Exhausts system – Protective equipment - Emergency care and medical facilities		
Total Lectures		45 Hours
Text Books		
1.	Woodget, B. W. and Cooper, D., “Sample and Standards”, ACOL Series, Wiley, 1987	
2.	Dux, J. P., “Hand Book of Quality Assurance for Analytical Chemistry Laboratory”, Van Nostrand, 1986	
3.	Duncan, W. L and International, L.W, "Total Quality: Key Terms and Concepts" AMACOM publishers, 1995	
4.	Shah, D. H., “QA Manual”, Business Horizons, 2000	

Reference Books	
1.	Kumar, K., “Quality Management”, ABD Pub., 2000
2.	Ross, J., “Total Quality Management”, Vanity Book, Intl., 1995
3.	Seiler, J. P., “Good Laboratory practice”, Springer, 2000
4.	Diwan, P., “Quality in Totality, Manager’s Guide to TQM and ISO 9000”, Deepti&Deepti Pub., 2000
Recommended by Board of Studies	8 th May 2023
Approved by Academic Council	03 June 2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3		2			2		1	2	
CO2	2	1		2	1		1	1	1	
CO3	3	2	1			2		1	2	
CO4	3	1		2	2	1	1	2	1	1
CO5	2	2	2		1	2	2	2	1	3
CO6	2	3	1		2		2	1	2	3

'3'-High, '2'- Medium, '1'-Low, '-'No correlation

Course Code	INSTRUMENTAL METHODS IN BIOLOGY	L	T	P	C
22FS2002		3	0	0	3
Course Objectives:					
To enable students to:					
1. Comprehend the basic principles of biological analysis					
2. Validate the importance of centrifugation techniques					
3. Apply the methods in enzyme kinetics					
Course Outcomes:					
The student will be able to:					
1. Demonstrate the basic techniques used in microbiology					
2. Summarize the principles of centrifugation techniques					
3. Review the techniques used in biochemistry					
4. Recall the principles of immunoassays					
5. Express the importance of cloning procedures					
6. Analyse the methods involved in specific nucleic acid sequences					
Module: 1	General principles of Biological Analysis				9 Hours
Physiological solution, Cell and Tissue Culture, Cell fractionation, Biological variation etc.					
Module: 2	Centrifugation Techniques				9 Hours
Basic principles of sedimentation, Types of centrifuges, Density gradient centrifugation, Prerogative centrifugation, Analysis of sub-cellular fractions, ultracentrifuge, refrigerated centrifuges.					
Module: 3	Biochemical techniques				9 Hours
Enzyme kinetics, purification and protein estimation, enzyme assay techniques, visible UV spectrophotometric methods, Luminescence method, Radioisotope methods, Immuno-chemical method, automated enzyme analysis, immobilized enzymes.					
Module: 4	Immunoassay Techniques				9 Hours
General principles, production of antibodies, precipitation reaction, Gel immunodiffusion, Immune-electrophoresis, complement fixation. Radio immunoassay (RIA), enzyme immunoassay, metalloimmunoassay, chemiluminiscent/fluorescence immunoassay.					
Module: 5	Molecular Biology				9 Hours

Outline of genetic manipulation enzyme, Enzymes and in genetic manipulation, cloning procedures, Isolation of specific nucleic acid sequences-complimentary DNA, Gene libraries, colony hybridization, Nick translation, oligonucleotide probes, and expression of genes.	
Total Lectures	45 Hours
Text Books	
1.	Gordon, M.H., "Instrumental Analysis in the Biological Sciences", Springer, 1987.
2.	Rao, D.M., Swamy, A.V.N., Reddy, D.D., "Instrumental Methods of Analysis", CBS Publication, 2012.
Reference Books	
1.	Bajpai, P.K., "Biological Instrumentation & Methodology", S. Chand & Company, 2010.
2.	Naidoo, S., "Centrifugation Techniques", Arcler Education Incorporated, 2017
3.	Rickwood, D., "Centrifugation, a practical approach", Information Retrieval, 1978.
4.	Khan, M.Y., Farha, K., "Principles of Enzyme Technology", PHI Learning Pvt Ltd, 1 st Edition, 2015.
Recommended by Board of Studies	8 th May 2023
Approved by Academic Council	03 June 2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3								
CO2						3				
CO3							3	3	2	1
CO4		3								
CO5		3								
CO6		3								

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

Course Code	PHYTOCHEMISTRY AND HERBAL PRODUCTS	L	T	P	C
23CH3001		3	0	0	3
Course Objectives:					
To enable students to:					
1. Demonstrate various techniques used in phytochemistry					
2. Distinguish the methods of isolations and identifications of herbal drugs					
3. Recognize the importance of the herbal drug formulations					
Course Outcomes:					
The student will be able to:					
1. Isolate the phytochemicals from the natural resources					
2. Analyze the bioactive ingredients					
3. Separate the active compounds from the phytoresidues					
4. Identify the herbal drugs					
5. Test the phytoextracts for medicinal applications					
6. Formulate the herbals as herbal medicine					
Module: 1	Fundamentals of Phytochemistry				9 Hours
Introduction to Phytochemistry, Biosynthesis of Phytochemicals, and Mechanisms of Plant Defense Against Pathogens: Phytoalexins Induction. Biological Roles of Phytochemicals, Phytochemicals as Immunomodulators, Immunosuppressant, Phytochemicals as Nutraceuticals and Pharmafoods, Plant Metabolomics					
Module: 2	Methods and Tools				9 Hours
Methods and Tools in Phytochemical Extraction, Lyophilization, Soxhlet apparatus, Fractional distillation, Isolation and Detection Techniques, Techniques in Phyto chemotaxonomy, Chromatographical Techniques in Phytochemical Research- Flash chromatography, UV/Visible Spectroscopy and HPLC in Phytochemical Analysis: An Introduction TLC, HPLC and HPTLC - Tools in Phytochemical Analysis.					

Module: 3	Analytical Techniques	9 Hours
Analytical Techniques in Elemental Profiling, Phytochemical Test Methods, Animal Models in Phytopharmacology, Toxicological Testing of Plant Products, Role of Biostatistics in Phytochemical Research: Emphasis on Essential oil studies,		
Module: 4	Herbal Drugs	9 Hours
Quality control of herbal drugs as per WHO Guidelines. Classification, Adulteration of crude drugs and their detection by evaluation methods. Introduction, morphological, microscopical, physical, chemical, biological and spectral analysis of herbaldrugs. Products from the herbal drugs.		
Module: 5	Herbal Drugs Formulations	9 Hours
Preparation and standardization of herbal formulations- Preparation and uses of Tinctures, Herbal syrups, Herbal creams, Herbal shampoos WHO guidelines for the assessment of herbal medicines. Estimation of heavy metals in herbal preparations.		
Total Lectures		45 Hours
Reference Books		
1.	Harkishan Singh, Kapoor V.K., “Organic Pharmaceutical Chemistry”, Vallabh Prakashan, Delhi, 2012, ISBN: 8185731209.	
2.	Harbone J.B., “Phytochemical Methods”, IInd Edition, Chapman and Hall, London 2004, ISBN-13:978-94-010-8956-2.	
3.	William Pelletier, S., “Alkaloids Chemical and biological perspectives” 2006, Elsevier Science Ltd., Oxford, UK, ISBN: 008043665X.	
4.	Gurdeep R Chatwal and Agarwal O.P., “Chemistry of Natural Products”, Vol I & II., 2010, Himalaya Publishing House, Newdelhi, ISBN: 81 85842 98 1.	
5.	Sujatha V. Bhat, Nagasampige B. A., Sivakumar, M. “Chemistry of Natural Products” 2nd reprint, Springer, 2006.	
6.	Egbuna, C., Jonathan C. I., Standley C. U., Shashank Kumar, “Phytochemistry: Fundamentals, Modern Techniques, and Applications” 3-Volume Set: Volume 1: CRC Press- Taylor and Francis Group 2022.	
Recommended by Board of Studies		8 th May 2023
Approved by Academic Council		03 June 2023

I YEAR B.Tech/B.Sc (2023-24 ONWARDS)

Course Code	ENVIRONMENTAL STUDIES	L	T	P	C
23CH1001		3	0	0	3
Course Objectives					
Enable the student to:					
1. Acquire adequate knowledge on environment related aspects.					
2. Assess the impact of environmental issues on the ecosystem.					
3. Solve real time challenges in the environment caused due to anthropogenic, social, and natural factors.					
Course Outcomes					
Student will be able to:					
1. Identify environmental hazards and its impact on the biosphere.					
2. Apply practical skills for solving pollution related problems.					
3. Design strategies to combat environmental issues adopting green technologies.					
4. Adopt appropriate methods to preserve the environment for sustainable development.					
5. Assess environmental and social issues by integrating facts, concepts, and trending technologies.					
6. Recommend innovative solutions to the policy makers of the Nation to save Planet Earth.					

Module: 1	ENVIRONMENT AND NATURAL RESOURCES	09 Hours
Basic science of environment and its types - Renewable and Non-Renewable Resources – Natural resources and associated problems – Water in Science: over-utilization of surface and ground water, floods, drought, dams-benefits and problems - Forest in Science: over-exploitation, deforestation, mining and their effects on forests and tribal people - Energy Science: renewable and non-renewable energy sources, and use of alternate energy sources– Land structure science: land degradation, soil erosion and desertification – conservation of natural resources – Activity: Field study or documentation of environmental assets.		
Module: 2	ECOSYSTEMS AND BIODIVERSITY	09 Hours
Concept of an ecosystem – Structure and function of an ecosystem – Ecological succession – Food chains, food webs -Introduction to Biodiversity – Definition: Types – Bio geographical classification of India – Value of biodiversity– Biodiversity at global, National and local levels -Hot-spots of biodiversity – Threats to biodiversity – Case studies - Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity – Activity: Documentation of available ecosystems/Biodiversity within Campus.		
Module: 3	ENVIRONMENTAL POLLUTION	09 Hours
Definition, Causes, effects and control measures (two) – Air pollution (Cyclone separator, Electrostatic Separator) – Water pollution – Soil pollution – Noise pollution – Thermal pollution – Nuclear hazards – Role of an individual in prevention of pollution - Pollution case studies – Green Chemistry– principles and its uses in industries. Activity: Visit-nearby Sewage treatment Water Plant or case studies.		
Module: 4	SOCIAL ISSUES AND ENVIRONMENTAL LEGISLATION	09 Hours
Solid waste management: Causes, effects and control measures of urban and industrial wastes – E – wastes - Sustainable development – Urban problems related to energy – Water conservation methods - global warming, acid rain, ozone layer depletion, case studies – Environment Protection Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act –Public awareness – Activity: Any Online courses / Ecofriendly technology projects.		
Module: 5	HUMAN POPULATION AND DISASTER MANAGEMENT	09 Hours
Population growth, Population explosion— Family Welfare Program – Environment and human health. Human rights – HIV/AIDS – Women and Child Welfare – Role of Information Technology in environment and human health – Disaster management: Floods, earthquake, cyclone and landslides – Case Studies – Activity: Observation in NDRF, FIRE Service / One Online course certificate / Ecofriendly technology projects.		
Total Lectures		45 Hours
Reference Books		
1.	Trivedi. R.K. “Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards” Vol. I and II, Enviro Media.	
2.	Cunningham, Cooper. C.P. and Gorhani, T.H. “Environmental Encyclopedia” Jaico Publ., House, Mumbai, 2001.	
3.	Abnubha Kaushik, C.P.Kaushik, “Perspectives in Environmental Studies” New Age International Publishers, 3 rd Edition, 2009.	
4.	B..K.Sharma, “Environmental Chemistry” Comprehensive covering the UGC Syllabus, 11 th Edition, Goel Publishing House, Meerut, 2007.	
5.	Deeksha Dave, S. S. Katewa, “Text Book of Environmental Studies”, 2 nd Edition. Cengage Learning India Pvt. Ltd., New Delhi, 2012.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course code	ESSENTIALS OF CHEMISTRY FOR AREOSPACE ENGINEERS	L	T	P	C
23CH1002		3	0	0	3
Course Objectives					
Enable the students to: 1. Acquire the knowledge about fundamentals of atomic structures. 2. Discuss fuels, propellants, energy resources and storage devices. 3. Explore different spectrochemical methods.					
Course Outcomes					
The student will be able to: 1. Examine atomic structures and correlate its properties. 2. Identify the potential applications of protective coating. 3. Summarize the unique properties of fuels and propellants. 4. Illustrate the working principles of explosives. 5. Evaluate the various energy storage systems and conversion devices. 6. Report the techniques involved in spectroscopy.					
Module: 1	ATOMIC STRUCTURE				8 Hours
Introduction, dual nature of electron, Heisenbergs uncertainty principle, quantum mechanical model of an atom, wave mechanical model of hydrogen atom, concept of atomic orbital's, electron spin, Pauli Exclusion Principle					
Module: 2	PROTECTIVE COATINGS				7 Hours
Introduction, metallic coating, electroplating and its methods, electroless plating, organic coating, paints, analysis of oils, formulation of paints, failure of paint films, enamels, Varnishes, lacquers, emulsion paints, high temperature paints, special paints.					
Module: 3	FUELS AND COMBUSTION				7 Hours
Fuels-classification, Characteristics of good fuel, calorific value, bomb calorimeter, - Proximate analysis of coal and its significance- -Knocking-octane number, cetane number, antiknocking characteristics of petrol, cracking, synthetic petrol, refining of gasoline, diesel, kerosene, biomass - Biogas-production, Flue Gas Analysis Orsat Method.					
Module: 4	EXPLOSIVES AND PROPELLANTS				7 Hours
Introduction to explosives, classification of explosives, primary explosives, low explosives, high explosives, precautions during storing of explosives, blasting fuses, rocket propellants, classification of propellants.					
Module: 5	ENERGY SOURCES AND STORAGE DEVICES				8 Hours
Redox reactions electrode potential - Nernst Equation - Electrochemical series and significance - Electrochemical cell, reference electrode - Batteries dry cell -Lead acid battery - Fuel cell – Solar battery- Electrochemical sensors -Relationship between electrical energy and heat energy Gibbs Helmholtz equation, Photovoltoics.					
Module: 6	SPECTROSCOPY				8 Hours
Introduction, electromagnetic radiation, types of energy present in molecules, general features of absorption spectrometer, infrared spectra, Frank Condon principle, UV and visible spectra, , Atomic absorption spectroscopy.					
Content beyond syllabus					
Prepare a high temperature paint with Nano-additives and determine its heat transfer rate or any other topic from the syllabus.					
Total Lectures					45 Hours
Text Books					
1.	Engineering Chemistry by Jain and Jain, 16 th Edition, Dhanpat Rai Publishing Company, New				

	Delhi, 2017.
2.	University Chemistry by B. M. Mahan, R. J. Meyers, 4 th Edition, Pearson, 2009.
Reference Books	
1.	Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane, 3 rd Edition, McGraw Hill, 1980.
2.	Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan.
3.	Physical Chemistry, by P. W. Atkins, Julio de Paula, 8 th Edition, Oxford University press, 2007.
4.	A Text Book of Engg. Chemistry, Shashi Chawla, Dhanpat Rai & Co. (P) Ltd. January 2017.
5.	Essentials of Physical Chemistry, by Arun Bahl, B S Bahl & G D Tuli, S.Chand Publishing, December 2010.
6.	Applied Chemistry, Dr. Sunita Rattan, 3 rd Edition, S.K. Kataria & Sons, 2011.
7.	Engineering Chemistry, by Dr. Ranjit S. Dhillon, Dr. Chinnappan Baskar, Dr. Shikha Baskar, Wiley, June 2012.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course code	APPLIED CHEMISTRY FOR FOOD PROCESSING TECHNOLOGY	L	T	P	C
23CH1003		3	0	0	3
Course Objectives					
Enable the students to: 1. Recall the fundamentals of electronic effects. 2. Acquire knowledge on organic reaction mechanisms. 3. Adapt the principles of spectroscopic methods.					
Course Outcomes					
The student will be able to: 1. Distinguish between biopolymers and polymers. 2. Identify the effects of functional groups on the stability of molecules. 3. Develop the organic reaction mechanism. 4. Test different types of corrosion. 5. Predict the order and rate of a chemical reaction. 6. Validate the principles of spectroscopy in food technology.					
Module: 1	FUNDAMENTALS OF BIOPOLYMERS				8 Hours
Definition of biopolymers and types of biopolymers- Technical properties (elasticity, yield stress, ductility, toughness, strength, fatigue, hardness and wear resistance) of biomaterials- Description of certain biopolymers like starch, cellulose, chitosan, gelatin, alginate, keratin, fatty acids, lipids, aliphatic polyesters (PLA, PHB)-Polymers used as biomaterials (Silicon rubber, Dacron, poly(methyl methacrylate, polyurethane and cellulose) and their application.					
Module: 2	INTRODUCTION TO ELECTRONIC EFFECTS				7 Hours
Nature of bonds, Hybridisation in organic molecules, Homolysis and heterolysis of bonds, Electron displacement in organic compounds – Inductive, Electronic and Mesomeric effects- Influence of Inductive effect on acidic and basic properties of organic compounds. Hyperconjugation and steric effects.					
Module: 3	ORGANIC REACTIONS				7 Hours
Nucleophilic substitution of alkyl halides: S _N 1 and S _N 2 mechanisms- Markownikoff's rule, free radical addition and peroxide effect. Elimination reactions- E1 and E2 mechanism- Mechanisms of dehydrohalogenation of alkyl halides, Aromatic Electrophilic substitution –Aromatic nucleophilic substitution					
Module: 4	ELECTROCHEMISTRY				7 Hours
Redox reactions, electrode potential, Nernst Equation, Electrochemical series and significance, Electrochemical cell – EMF of an electrochemical cell -Corrosion – Consequences of corrosion - Dry					

Corrosion – types – mechanism – Wet corrosion – Mechanism – Galvanic corrosion – Pitting corrosion - Galvanic series - Factors influencing corrosion - Nature of metal –Nature of the environment - Corrosion control methods –Proper designing – using metals – metal alloys – cathodic protection – modifying the environment – Use of inhibitors – Application of protective coatings - Organic coatings.		
Module: 5	CHEMICAL KINETICS	8 Hours
Chemical kinetics – Basic concepts – rate law – rate equation – Kinetics of zero, first, second and third order reactions – Kinetics – composite reactions (complex reaction) – Opposing (reversible) reactions – Consecutive reactions – Chain reactions – Stationary chain reaction –Collision theory of bimolecular and unimolecular reactions – Arrhenius theory of reaction rates – Theory of absolute reaction rates.		
Module: 6	SPECTROSCOPY	8 Hours
Introduction, types of energy present in molecules, general features of absorption spectrometer, infrared spectra, Frank Condon principle, UV and visible spectra, microwave spectroscopy, Nuclear magnetic spectroscopy, Raman spectroscopy, flame photometer, atomic absorption spectroscopy, mass spectroscopy.		
Total Lectures		45 Hours
Text Books		
1.	Engineering Chemistry by Jain and Jain, 16 th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017.	
2.	University Chemistry by B. M. Mahan, R. J. Meyers, 4 th Edition, Pearson, 2009.	
Reference Books		
1.	Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane, 3 rd Edition, McGraw Hill, 1980.	
2.	Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan.	
3.	Physical Chemistry, by P. W. Atkins, Julio de Paula, 8 th Edition, Oxford University press, 2007.	
4.	A Text Book of Engg. Chemistry, Shashi Chawla, Dhanpat Rai & Co. (P) Ltd. January 2017.	
5.	Essentials of Physical Chemistry, by Arun Bahl, B S Bahl & G D Tuli, S. Chand Publishing, December 2010.	
6.	Applied Chemistry, Dr. Sunita Rattan, 3 rd Edition, S.K. Kataria & Sons, 2011.	
7.	Engineering Chemistry, by Dr. Ranjit S. Dhillon, Dr. Chinnappan Baskar, Dr. Shikha Baskar, Wiley, June 2012.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	APPLIED CHEMISTRY LABORATORY FOR FOOD PROCESSING TECHNOLOGY	L	T	P	C
23CH1004		0	0	2	1.5
Course Objectives					
Enable the student to:					
1. Perform quantitative estimation of biomolecules. 2. Describe experiments based on electrochemical techniques. 3. Synthesize and characterize nanomaterials.					
Course Outcomes					
The students will be able to:					
1. Demonstrate the spectroscopic techniques of analysis. 2. Identify methods for the estimation of biomolecules. 3. Establish methods to prepare nanomaterials. 4. Analyze samples using electrochemical techniques. 5. Separate compounds using chromatographic techniques. 6. Execute conductance-based experiments					

LIST OF EXPERIMENTS (Any 08)

1. Qualitative tests for carbohydrates
2. Quantitative method for amino acid
3. Quantitative method for protein estimation
4. Quantitative method for cholesterol estimation
5. Preparing batteries from fruits and vegetables
6. Determination of iron by potentiometry
7. Estimation of iron by spectrophotometry
8. Analysis of Water
9. Extraction of lipids and analysis by paper chromatography and TLC.
10. Determination of free fatty acid content in fats and oils
11. Qualitative and quantitative estimation of adulterant in common food items
12. Estimation of non-nutritive sweeteners
13. Estimation of effects of antioxidants usage in foods.
14. Estimation of thickeners and their effects in foods.

Reference Books

1.	A Collection of Interesting General Chemistry Experiments, Revised Edition, by Elias, A. J. Universities Press, 2007.
2	Senior Practical Physical Chemistry by Khosla, B. D.; Garg, V. C. & Gulati, A. R. Chand & Co.: New Delhi, 2011.
3	Experiments in Physical Chemistry by Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. 8 th Edition, McGraw Hill: New York, 2003.
4	Engineering Chemistry by Jain and Jain, 16 th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017.
5	Experimental Physical Chemistry by Halpern, A. M. & McBane, G. C. 3 rd Edition, W.H. Freeman & Co., New York, 2003.

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25 Aug 2023

Course Code	APPLIED PHYSICS FOR AEROSPACE ENGINEERING	L	T	P	C
23PH1001		3	0	0	3
Course Objectives					
Enable the student to: 1. Acquire knowledge on lasers and fiber optic systems in the aerospace industry. 2. Asses the significance of acoustics and ultrasonics for the testing of aerospace components. 3. Apply the magnetic materials in solar system exploration.					
Course Outcomes					
The student will be able to: 1. Comprehend the basic working principle of lasers and optical fiber technology. 2. Investigate the structural integrity of materials using acoustical phenomena. 3. Apply the non-destructive testing methods using ultrasound waves. 4. Analyze the importance of novel magnetic materials in aerospace systems.					

5. Examine the various solar system models, earth's immediate cosmic neighborhood, and other constituents of the solar system. 6. Propose a suitable technique and material for Aerospace Industry.		
Module: 1	LASER PHOTONICS IN AEROSPACE INDUSTRY	8 Hours
Introduction – Components of Laser – Principle and Properties of Laser – Einstein's Coefficients – Types of Lasers – Aerospace Industry Applications: Laser Cleaning, Marking and Cutting – Laser Enabled Additive Manufacturing for Space Exploration.		
Module: 2	FIBER OPTICS TECHNOLOGY FOR AEROSPACE INDUSTRY	8 Hours
Introduction – Propagation of Light in Optical Fibers – Numerical Aperture and Acceptance Angle – Types of Optical Fibers – Power Losses in Optical Fibers – Aerospace Industry Applications: Avionics Communication Systems – Navigation and Sensing – LIDAR.		
Module: 3	ACOUSTICAL ANALYSIS IN AEROSPACE INDUSTRY	8 Hours
Introduction – Classification of Sound – Characteristics of Musical Sound – Reverberation Time – Sabine's Formula – Room Acoustics – Aerospace Industry Applications: Aeroacoustics – Acoustic Qualification Testing – Direct Field Acoustic Testing.		
Module: 4	ULTRASONIC TESTING FOR AEROSPACE INDUSTRY	7 Hours
Introduction – Properties of Ultrasonics – Production of Ultrasonic Waves – Detection of Ultrasonic Waves – Aerospace Industry Applications: Ultrasonic Testing of Aerospace Composites – Phased Array Ultrasonic Testing – Laser Ultrasonic Inspection System.		
Module: 5	MAGNETIC PHENOMENA IN AEROSPACE INDUSTRY	7 Hours
Introduction – Origin of Magnetic Moment – Types of Magnetic Materials – Langevin's Theory of Magnetism – Hysteresis Curve – Weiss Theory of Ferromagnetism – Aerospace Industry Applications: Aerospace Sensors and Actuators – Cryogenic Magnets for Space.		
Module: 6	SOLAR SYSTEM PHYSICS	7 Hours
Introduction – Kepler's Laws – The Universal Law of Gravitation – Various Models of the Solar System – Planets – Natural Satellites – Asteroids, Comets, and Other Constituents – Aerospace Industry Applications: Space Stations – Interplanetary Space Travel.		
Total Lectures		45 Hours
Text Books		

1.	D.K. Bhattacharya and Poonam Tandon, Engineering Physics, New Delhi: Oxford University Press, ISBN – 978-0199487127, 2017.
2.	Rohan Gharate, Book of Astronomy and Astrophysics, Chennai: Notion Press, ISBN – 978-8886679687, 2022.
Reference Books	
1.	Shatendra Sharma and Jyotsna Sharma, Engineering Physics, New Delhi: Pearson India Education Services Pvt. Ltd., ISBN – 978-9386873316, 2018.
2.	Dattu R. Joshi, Engineering Physics, New Delhi: Tata McGraw Hill Education Pvt. Ltd., ISBN – 978-0070704770, 2017.
3.	Stan Owocki, Fundamentals of Astrophysics, London: Cambridge University Press, ISBN – 978-1108844390, 2021.
4.	Jearl Walker, David Halliday and Robert Resnick, Principles of Physics, New Delhi: Wiley India Pvt. Ltd., ISBN – 978-1119454014, 2020.
5.	Hugh D. Young and Roger A. Freedman, Sears and Zemansky's University Physics with Modern Physics, New Delhi: Pearson Education, ISBN – 978-0194577199, 2017.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	NANOMATERIALS AND ENERGY DEVICES	L	T	P	C
23PH2001		3	0	0	3
Course Objectives					
Enable the student to: 1. Acquire fundamental knowledge on the principles of nanomaterials and energy devices. 2. Apply nanomaterials for device fabrication 3. Design energy storage devices.					
Course Outcomes					
The student will be able to: 1. Classify the quantum states upon size reduction to nanoscale. 2. Distinguish the physical properties of nanomaterials. 3. Analyze the structural, optical properties of nanomaterials 4. Demonstrate the working and applications of energy storage devices. 5. Design and develop novel nanomaterials for constructing energy storage devices. 6. Propose a suitable nanomaterial for sustainable enery storage devices.					
Module: 1	INTRODUCTION TO NANOTECHNOLOGY				7 Hours
Size reduction of Bulk to 1D, 2D, 3D materials, quantum well, quantum wire and quantum dots, Surface to volume ratio, density of states, Quantum mechanical postulates, Electron wave length					
Module: 2	PHYSICAL AND OPTICAL PROPERTIES OF NANO MATERIALS				7 Hours

Surface energy, Gibbs equation, self purification, mechanical properties of nano materials, Optical properties, Blue shift, size and shape dependent colour, Optical band gap splitting		
Module: 3	ELECTRICAL AND MAGNETIC PROPERTIES	7 Hours
Electrical properties of nanomaterials, Step potential, column blockade effect, electrical properties of gold nanoparticles, Chiral dependent electrical properties of carbon nanotubes, nano magnetic materials, B-H Curve, Super paramagnetism		
Module: 4	NANODEVICES	8 Hours
Quantum dot solar cells, Single electron transistor, molecular and supramolecular switches,Spintronics, MEMS and NEMS		
Module: 5	ELECTRO CHEMICAL DEVICE TECHNOLOGY	8 Hours
Electro Deposition-Potentiostat ,Galvanostat, Electro plating, electroless deposition, classification of energy storage devices, primary and secondary batteries-Li ion battery technology		
Module: 6	ADVANCED ENERGY DEVICES	8 Hours
Flexible batteries, novel substrates, Thin film batteries, Nano materials for anodes and cathodes, Super capacitors, characterisation technique and analysis of battery outputs. Micro batteries for IoT devices and medical Implants		
Total Lectures		45 Hours
Text Books		
1.	Charles P.Poole, Jr.,Frank J.Owens, “Introduction to Nanotechnology”, Wiley Publications, ISBN – 978-81-265-1099-3, 2016.	
2.	Physics of Nanomaterials-Biswajit Mukjerjee And Niladri Shekhar, Intelliz Press, 2016.	
Reference Books		
1.	Introduction to Solid State Physics, C.Kittel, a chapter about Nanotechnology, Wiley, 2004.	
2.	Handbook of Thin Film Technology, Edited by Hartmut Frey and Hamid R.Khan, Springer, 2015.	
3.	Silicon VLSI Technologies, J.D.Plummer, M.D.Deal and P.B. Griffin, Prentice Hall, 2000.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

B.Sc. (FORENSIC SCIENCE) FROM 2023-24 ONWARDS

Course Code	FUNDAMENTALS OF FORENSIC SCIENCE	L	T	P	C
23FS2001		3	0	0	3
Course Objectives					
Enable the student to: 1. Describe principles and fundamental of forensic science. 2. Associate the significance of forensic science with human society. 3. Assess the crime scene management in India.					

Course Outcomes		
Student will be able to:		
1. Appraise the importance of forensic sciences. 2. Identify the techniques involved in forensic sciences. 3. Organize various laboratories to serve forensic science. 4. Recommend the importance of police organization. 5. Speculate the crime scene. 6. Summarize the procedure for crime reporting and trials.		
Module: 1	INTRODUCTION TO FORENSIC SCIENCE	9 Hours
History, scope, functions and need of forensic science – definitions and concepts in forensic science. basic principles -branches of forensic science. Frye case and Daubert standard - Forensic science in international perspectives – Forensic scientists – duties, code of conduct and qualifications. Introduction to Corroborative and substantial evidence.		
Module: 2	ORGANIZATIONAL SET UP OF FORENSIC SCIENCE LABORATORIES IN INDIA	9 Hours
Fingerprint Bureaus, National Crime Records Bureau, Police & Detective Training Schools, Bureau of Police Research & Development, Directorate of Forensic Science (CFSL, RFSL, SFSL) and Mobile Crime Laboratories. Police Academies -Services of crime laboratories. Basic services and optional services - Drug enforcement administrator. Defense research and development organization.		
Module: 3	POLICE ORGANIZATION	9 Hours
Organizational set up of Police at central and state level, Functions of Police, Relationship of Police and Forensic Scientist, History of different para-military forces (BSF, CISF, CRPF, ITBP, Assam Rifles, SSB, NSG etc.) – Activity : visit to court, police stations.		
Module: 4	LEGAL ASPECTS OF CRIME	9 Hours
Crime – Introduction, definition, types-(Types of crime and its causes – property crimes, public order crimes, violent crimes, cyber crimes, juvenile delinquency), causes and consequences - Broad concepts of criminal Justice system, Procedures involved in the detection of crime, Filing of criminal charges, Indian police system – The Police Act, Human rights and criminal justice system in India. Set up of INTERPOL.		
Module: 5	CRIME SCENE MANAGEMENT	9 Hours
Introduction, Different types of crime scene-Primary and secondary, outdoor and indoor etc. Significance, Role of Investigator, Evaluation of crime scene, protection of crime scene, Photography of Crime scene, Tools and techniques, Significance of Photography and Videography, Introduction of Sketching, Purpose of Sketching, Making of Sketches, Types of Sketches, Methods of Sketching, Procedure of Sketching, Searching Methods, Chain of Custody types, Significance and their evaluation		
Total Lectures		45 Hours
Reference Books		
1.	S.H James and J.J Nordby, “Forensic Science: An introduction to scientific and Investigative Techniques”, 2 nd Edition, CRC Press, Boca Raton, 2005.	
2.	W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2 nd Edition, W.G. Eckert (ED), CRC Press, Boca Raton, 1997.	
3.	B. A. J. Fisher, D. R. Fisher, “Techniques of Crime Scene Investigation”, CRC Press, 8 th Edition, 2012.	
Text Books		

1. B.B. Nanda and R.K Tiwari, “Forensic Science in India: A vision for the Twenty First Century”, select publishers, New Delhi, 2001.	
2. V. N. Sehgal, Surinder Nath and M. K. Bhasin, “Studies in Forensic Science No. 3: Society, Crime and Prosecution”, Kamla-Raj Enterprises, New Delhi, 2005.	
Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	INORGANIC CHEMISTRY FOR FORENSIC SCIENCE	L	T	P	C
23CH2001		3	0	0	3
Course Objectives					
Enable the student to:					
1. Acquire knowledge on periodic properties and nuclear chemistry.					
2. Discuss the chemistry of transition metals.					
3. Assess the applications of various metals in Forensic Science.					
Course Outcomes					
Student will be able to:					
1. Analyze the periodic properties.					
2. Recognize the applications of radioisotopes.					
3. Relate the nature of bonding in coordination complexes.					
4. Predict the factors affecting the stability of metal complexes.					
5. Summarize the importance of metals in biology.					
6. Realize the role of metals in Forensic science.					
Module: 1	PERIODIC PROPERTIES	9 Hours			
Periodic Properties: Modern periodic table – General characteristics of periods and groups –Periodicity in properties: Atomic radii, ionic radii, ionization enthalpy, electron affinity (electron gain enthalpy) and electronegativity (Pauling scale) Diagonal relationships – General characteristics of s, p, d and f block elements: introduction, properties, and their position in periodic table.					
Module: 2	NUCLEAR CHEMISTRY AND RADIOACTIVITY	9 Hours			
Nucleus – composition – Binding energy – Stability – Isotopes, Isobars, and isotones – Radiation – characteristics of α , β and γ radiation – Nuclear reactions – Applications of radioisotopes – Radioactive tracers					
Module: 3	COORDINATION CHEMISTRY	9 Hours			
Ligands – Examples – Complex formation – Werner’s theory – Sidgwick theory – Valence bond theory – Tetrahedral and octahedral complexes – Crystal field theory – CFSE –Factors affecting magnitude of $10Dq$ – Spectrochemical series – MO theory - stability – Factors affecting stability – Chelate and macrocyclic effect - Detection of complex formation					
Module: 4	BIOINORGANIC CHEMISTRY	9 Hours			
Metal ions in biological systems – Biochemistry of iron – Hemoglobin and Myoglobin, Mechanism of O_2 , CO_2 transportation, Elementary idea of structure and mechanism of action of sodium potassium pump, Biochemistry of zinc and cobalt – Enzyme action – Examples					
Module: 5	METAL COMPLEXES IN FORENSIC SCIENCE	9 Hours			
Heavy metal poisoning – Arsenic, Antimony, Barium, Copper, Iron, Lead, mercury, Thallium, Zinc – methyl mercury – detection & effects - Schiff bases and their applications in forensic sciences.					

Total Lectures		45 Hours
Reference Books		
1.	Lee J. D, “Concise Inorganic Chemistry”, Wiley India (P.) Ltd, New Delhi, India, 5th Edition, Reprint 2009.	
2.	Shriver and Atkins, “Inorganic Chemistry”, Oxford University Press, New Delhi, India, 4th Edition, 2009.	
3.	Huheey J. E, Keiter E. A & Keiter R. L, “Inorganic Chemistry – Principles of structure and reactivity”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th Edition, 2009.	
4.	Madan W. H, Tuli G. D, Madan R. D., “Selected Topics in Inorganic Chemistry”, S. Chand & Company Ltd, Reprint 2009.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	CRIME SCENE INVESTIGATION LABORATORY - I	L	T	P	C
23FS2013		0	0	3	2
Course Objective:					
Enable the student to:					
1. State Locard's exchange principle and its application on crime scenes. 2. Analyze case studies of forensic relevance. 3. Role play crime cases demonstrating the impact of Daubert standards.					
Course Outcomes					
Student will be able to:					
1. Identify Locard's exchange principle and draw lessons from case studies relevant to forensic science. 2. Summarize crime cases where apprehensions arose due to Daubert standards. 3. Organize knowledge of the case procedure from the initial police report to the court's ruling. 4. Analyze scientific reports and produce forwarding letters for murder, rape, hit-and-run incidents, and arson cases. 5. Compose knowledge of the workings and procedures of polygraphy (lie detection). 6. Compare proper techniques for packaging physical evidence.					
List of Experiments					
1. To study Locards exchange principle and its application on crime scene. 2. Case Studies of Forensic relevance. 3. To cite examples of crime cases in which apprehensions arose because of Daubert standards. 4. To study the Case procedure from the initial police report through the court's ruling. 5. Forwarding letter writing (in case of Murder/Rape/Assault/HBT/Asphyxial death) 6. Scientific Report Writing (in case of Murder/Rape/Hit & Run/Arson). 7. To write scientific report (in case of death due to drowning, HBT, etc) 8. To learn the workings and procedure of polygraphy. 9. To review two case studies involving corporate frauds. 10. Packaging of physical evidences. 11. Visit to Forensic Science Laboratory. (Minimum 10 experiments to be conducted)					
Reference Books					
1.	Fisher, B. A. J. Techniques of Crime Scene Investigation. CRC Press, 2013.				
2.	Saferstein, R. Forensic Science: From the Crime Scene to the Crime Lab. Pearson Education, 2015.				

3.	Cole, S. A. Suspect Identities: A History of Fingerprinting and Criminal Identification. Harvard University Press, 2009.
4.	Fisher, B. A. J. Techniques of Crime Scene Investigation. CRC Press, 2016.
5.	Saferstein, R. Forensic Science: From the Crime Scene to the Crime Lab. Pearson Education, 2015.
6.	Raskin, D. C., & Honts, C. R. (Eds.). The Handbook of Polygraph Testing. Academic Press, 2018.
7.	Wells, J. T. Corporate Fraud Handbook: Prevention and Detection, Wiley, 2011.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	INORGANIC CHEMISTRY LABORATORY	L	T	P	C
23CH2006		0	0	3	2

Course Objectives

Enable the student to:

1. Acquire the principle of volumetric titration and estimate the given unknown solution.
2. Compare the principles of chemical analysis.
3. Relate precise and accurate analysis.

Course Outcomes

Student will be able to:

1. Identify standard solutions of known concentration.
2. Associate different species in the unknown solution.
3. Administer qualitative tests of inorganic salt.
4. Analyze inorganic metal complexes.
5. Evaluate the given acid by instrumentation methods.
6. Adapt analytical skill.

List of Experiments

1. Preparing 0.01N H₂SO₄ standard solution and finding out the strength of NaHCO₃, in washing Soda
2. To determine the strength of oxalic acid solution by permanganometry.
3. To estimate dissolved oxygen in water sample.
4. Qualitative Analysis of Inorganic salt I.
5. Qualitative Analysis of Inorganic salt mixture-II
6. Qualitative Analysis of Inorganic salt-III
7. Qualitative Analysis of Inorganic salt mixture-IV
8. To prepare metal complex -I
9. To Prepare metal complex- II
10. Estimation of Fe³⁺ by spectrophotometer
11. To determine the strength of acid by pH meter
12. To determine the strength of acid by conductometry
(Minimum 10 experiments to be conducted)

Reference Books

1. Svehla G., "Vogel's Textbook of Qualitative Chemical Analysis", 6th Edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression, 2008.
2. J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas "Vogel's Quantitative Chemical Analysis", 6th Edition, 7th Impression, Dorling Kindersley limited, New Delhi, India, 2008.

Recommended by Board of Studies

Approved by Academic Council

25 Aug 2023

Course Code	INDIAN CONSTITUTION, FUNDAMENTAL LAWS AND PROCEDURE	L	T	P	C
23FS2002		3	0	0	3

Course Objectives		
Enable the student to: 1. Acquire the elements of criminal procedure code to serve judicial system. 2. Relate acts and provisions of the constitution of India to forensic science. 3. Assess the acts governing socio-economic crimes.		
Course Outcomes		
Student will be able to: 1. Discuss various types of crime laws. 2. Illustrate sections related to Indian Penal Code. 3. Summarize sections related to Indian Evidence Act. 4. Focus on the articles of Indian constitution. 5. Recognize social crimes and their causes. 6. Recommend amendments in the governing law.		
Module: 1	LAW TO COMBAT CRIME	9 Hours
Classification – civil, criminal cases. Essential elements of criminal law. Constitution and hierarchy of courts- Civil and sessions court. Criminal Procedure Code. Cognizable and non-cognizable offences-(release of warrant in cognizable and non-cognizable cases) Bailable and non bailable offences. Sentences which the court of Chief Judicial Magistrate may pass. Summary trials – Section 260(2). Judgements in abridged forms – Section 355.		
Module: 2	SECTION LAWS	9 Hours
Indian Penal Code pertaining to offences against persons – Sections 121A, 299, 300, 302, 304A, 304B, 307, 309, 319, 320, 324, 326, 351, 354, 359, 362. Sections 375 & 377 and their amendments. Indian Penal Code pertaining to offences against property Sections – 378, 383, 390, 391, 405, 415, 420, 441, 463, 489A, 497, 499, 503, 511.		
Module: 3	EVIDENCE & WITNESS LAWS	9 Hours
Indian Evidence Act – Evidence and rules of relevancy in brief. Expert witness. Defence and Prosecutor in court of law. Cross examination and re-examination of witnesses. Sections 32, 45, 46, 47, 57, 58, 60, 73, 135, 136, 137, 138, 141. Section 293 in the code of criminal procedure.		
Module: 4	CONSTITUTION OF INDIA	9 Hours
Preamble, Articles related to Fundamental Rights, Directive Principles of State Policy. – Articles 14, 15, 20, 21, 22, 51A. Introduction to five writs and their meaning-(Habeas Corpus, Mandamus, Certiorari, Quo Warranto and Prohibition)		
Module: 5	ACTS PERTAINING TO SOCIO-ECONOMIC AND ENVIRONMENTAL CRIMES	9 Hours
Narcotic, Drugs and Psychotropic Substances Act. Essential Commodity Act. Drugs and Cosmetics Act. Explosive Substances Act. Arms Act. Dowry Prohibition Act. Prevention of Food Adulteration Act. Prevention of Corruption Act. Wildlife Protection Act. I.T. Act. Environment Protection Act. Untouchability Offences Act. POCSO Act.		
Total Lectures		45 Hours
Reference Books		
1.	D.A Bronstein, Law for the Expert witness, CRC press, Boca Raton, 1999.	
2.	A.S. Pillia, Criminal Law, 6 th Edition, N.M. Tripathi Pvt Ltd, Mumbai, 1983.	
3.	Vipa P. Sarthi, Law of Evidence, 6 th Edition, Eastern Book Co. Lucknow, 2006.	

4.	R.C Nigam, Law of crimes in India, Volume I, Asia Publishing House, New Delhi, 1965.
Text Books	
1.	(Chief Justice) M.Minor, Law of Evidence, 6 th Edition, Universal Law of Publishing Co.Pvt. Ltd. New Delhi, 2002.
2.	Vipa P. Sarthi, Law of Evidence, 6 th Edition, Eastern Book Co. Lucknow, 2006.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	PHYSICAL CHEMISTRY FOR FORENSIC SCIENCE	L	T	P	C
23CH2002		3	0	0	3
Course Objectives					
To enable the student: 1. Discuss the physical properties of liquid. 2. Summarize the importance of renewable energy. 3. Apply the principles of spectroscopy to forensic science.					
Course Outcomes					
Student will be able to: 1. Acquire knowledge on water technology. 2. Examine various properties of liquid. 3. Correlate knowledge on electrochemistry to forensic science. 4. Differentiate types of corrosion. 5. Summarize the applications of bio batteries. 6. Apply the principles of photochemistry in forensic science domain.					
Module: 1	WATER TECHNOLOGY	9 hours			
Sources of water – Impurities in water - Hardness, Units and calculation of hardness – Determination of hardness by EDTA method -Disadvantages of water – Scales – Sludges – Internal conditioning – Calgon& carbonate conditioning In Caustic embrittlement – causes (DO, CO2, acids) & removal methods – Alkalinity – Calculation of alkalinity – Determination of dissolved oxygen – water borne diseases.					
Module: 2	LIQUID STATE	9 Hours			
Free volume of liquid and density measurement, physical properties of liquid, Vapor pressure, surface tension surfactants, viscosity, molar refraction, optical activity structure of liquid, determination of surface tension by stalagmeter method (drop number method), viscosity by Ostwald's viscometer method and refractive index by Abbe's refractometer method. Effect of temperature on surface tension viscosity and refractive index Applications of surface tension, viscosity and refractive index. Numerical problems.					
Module: 3	ELECTROCHEMISTRY	9 Hours			
Redox reactions, electrode potential, Nernst Equation, Electrochemical series and significance, Electrochemical cell – EMF of an electrochemical cell – Corrosion- Factors influencing corrosion - Nature of metal –Nature of the environment - Corrosion control methods –Proper designing – using metals – metal alloys – cathodic protection – modifying the environment – Use of inhibitors – Application of protective coatings - Organic coatings.					
Module: 4	RENEWABLE ENERGY	9 Hours			

Batteries – types - Dry battery – Lead acid battery – Hydrogen – Oxygen Fuel Cells– Bio-mass – Bio-gas - Bio-battery – working principles – Enzymatic bio-battery - Microbial bio-battery – Applications – Generating renewable energy from food waste using bio-battery.		
Module: 5	PHOTOCHEMISTRY	9 Hours
Laws of photochemistry, Grothus Draper law, Stark – Einstein’s Law, Bear Lambert’s law- photochemical equivalence and quantum explanation for low and high quantum yield. H2 – Cl2 reaction – photosensitization, Fluorescence, phosphorescence and chemiluminescence.		
Total Lectures		45 Hours
Reference Books		
1.	Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Company, 8 th Edition 2021.	
2.	A Text Book of Physical chemistry, A.S.Negi & S.C Anand, New age publishers; 2 nd Edition, 2007.	
3.	Basic Physical chemistry – Moore. V.J, Pearson College Div, 1982.	
4.	Introduction to solids, L.V. Azaroff, Tata Mc. Grawhill, 1960	
5.	P.R. Singh & S.K. Dixit Molecular Spectroscopy S.Chand and Company, 1985.	
6.	H.J.Arunikar, Essentials of Nuclear Chemistry 4 th Edition, New age International, NewDelhi, 1995.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	FORENSIC PHYSICS	L	T	P	C
23FS2003		3	0	0	3
Course Objectives					
Enable the student to: 1. Recognize the importance of speaker identification in Forensic Science. 2. Describe the causes of vehicular accidents, and its legal implications. 3. Evaluate the parts of a camera, different types of photography.					
Course Outcomes					
Student will be able to: 1. Quote the physics of sound production. 2. Group phonetics and voice analysis in Forensic Science. 3. Develop various methods of photographing a crime scene. 4. Analyze the legal provisions about forensic photography. 5. Assess the causes of vehicular accidents. 6. Infer various tool marks.					
Module: 1	FORENSIC SPEAKER IDENTIFICATION				9 Hours
Human Vocal cord anatomy, Voice Production, Speaker identification and authentication, Tools used for speaker identification (Open source and paid software) Forensic phonetics, Voice analysis, Forensic Significance. Case studies					
Module: 2	AUTOMOBILE ACCIDENTS- CAUSES AND INVESTIGATION				9 Hours
Vehicular accidents-Introduction, Information sources: eye witnesses, Tire marks, Skid marks, yaw marks, etc. Pedestrian impacts and vehicle speed, vehicle condition, vehicle damage, curved scuffmarks, Time and distance, reaction time, Vehicular Accident Photography, Collection and packaging of evidences.					

Module: 3	AUTOMOBILE ACCIDENTS- LEGAL ASPECTS	9 Hours
Relevant Provisions of Motor Vehicle Act, 1988 (Offenses and Penalties); Relevant Provisions of Indian Penal Code, 1860, (Sections 337 (causing hurt), 304 A (causing death due to negligence) and 279 (rash and negligent driving) and other relevant sections.		
Module: 4	FORENSIC PHOTOGRAPHY	9 Hours
Introduction, 35 mm film Camera, Digital SLR camera, Digital photo imaging, ISO number, Exposure Index, Photo imaging evidence: angle, scale, depth of field, light, ambient light, colour, temperature, flash/ strobe; Surveillance photography and Aerial photography and accessories used for the same; Various methods for developing photographs; High-speed photography; Image magnification, U. V. and I. R. illumination, legal aspects of visual evidence. Acceptance of photography evidence in court.		
Module: 5	INTRODUCTION TO TOOL MARKS	9 Hours
Definition, types of tool marks: compression marks, striated marks, combination of compression and striated marks, repeated marks: class characteristics and individual characteristics, tracing and lifting of marks, Photographic examination of tool marks; Restoration of Erased / Obliterated Marks: methods of making-cast, punch, engrave; methods of obliteration, methods of restoration- etching (etchings for different metals), magnetic, electrolytic etc., recording of restored marks. Forensic Significance.		
Total Lectures		45 Hours
Text Books		
1.	Encyclopedia of Forensic Science, Volume 1-3: Jay A Siegel, Pekka J Saukko, Geoffery Knupfer, Academic Press. 2 nd Edition, 22 February, 2013.	
2.	Criminalistics: An Introduction to Forensic Science: Richard Saferstein, Pearson Education International, 12 th Edition, 2017.	
3.	Redsicker, D. R., The Practical methodology of Forensic Photography, CRC Press, London, 2 nd Edition, 2000.	
Reference Books		
1.	Stuart H. James and Jon J. Nord, Forensic Science: An Introduction to Scientific and Investigative Techniques, CRC Press, 4 th Edition, 2014.	
2.	Edward M Robinson, Crime Scene Photography, Academic Press, 3 rd Edition, 2016.	
3.	Tom Ang, Digital Photography, reprint, 2013.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	CRIME SCENE INVESTIGATION LABORATORY - II	L	T	P	C
23FS2014		0	0	3	2
Course Objectives					
Enable the student to:					
1. Describe the methods for searching and collecting evidence from mock crime scenes. 2. Develop skills in forensic photography of various crime scenes. 3. Construct a mock crime scene.					
Course Outcomes					
Student will be able to:					
1. Memorize the guidelines for handling, preservation of different evidences. 2. Observe the simulated crime scenes. 3. Practice forensic photography, systematic evidence searching, documentation, collection and preservation techniques for various types of crime scene evidence.					

4. Distinguish different types of crime scenes. 5. Evaluate lip prints and ear prints. 6. Devise gait pattern analysis	
List of Experiments 1. To conduct mock 'Crime Scene Investigation'. 2. Forensic Photography of various types of crime scene. 3. Searching of evidences from mock crime scene. 4. Sketching of a Crime Scene using Triangulation method. 5. Sketching of a Crime Scene using Baseline method. 6. Collection and Preservation of evidences from mock crime scene (Murder, Hit and Run crime scene, Hanging, etc) 7. To study Forensic Evidence Analysis in relevant FSL division. 8. Reconstruction of various types of crime scene. 9. Collection of liprints and Identification of minutiae in lip prints. 10. Comparison of Ear prints. 11. Analysis of Gait pattern of an individual. 12. Visit to police station. (Minimum 10 experiments to be conducted)	
Reference Books	
1.	"Crime Scene Photography" by Edward M. Robinson
2.	"Crime Scene Investigation: A Guide for Law Enforcement" by National Institute of Justice
3.	"Practical Crime Scene Processing and Investigation" by Ross M. Gardner
4.	"Introduction to Forensic Sciences" by William G. Eckert
5.	"Crime Scene Investigation: A Guide for Law Enforcement" by National Institute of Justice
6.	"Practical Crime Scene Processing and Investigation" by Ross M. Gardner
7.	"Practical Crime Scene Analysis and Reconstruction" by Ross M. Gardner
8.	"Forensic Odontology: Principles and Practice" by Thomas J. David
9.	"Ear Identification" by Aldo Nadi and Michele Nadi
10.	"Forensic Gait Analysis" by Haydn Kelly
Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	PHYSICAL CHEMISTRY LABORATORY	L	T	P	C
23CH2007		0	0	3	2
Course Objectives					
To enable the student:					
1. Recognize the functional group of the organic compound through qualitative analysis. 2. Comprehensive understanding of the principles underlying spectroscopic analysis. 3. Gaining the knowledge to handle various corrosive chemicals.					
Course Outcomes					
Student will be able to:					
1. Acknowledge the significance of pH in pharmaceuticals. 2. Enumerate the flow capacity of various liquid. 3. Utilize the appropriate instruments for analyzing organic compounds. 4. Deduce diverse approaches to detect metallic poisons. 5. Summarize the acquired knowledge to effectively analyze genuine samples. 6. Propose diverse spectral analysis methods for drug samples.					
List of Experiments					

1. Determination of alkali content in antacid tablet using HCl. 2. Determination of viscosity 3. Determination of melting point, Determination of boiling point 4. Analysis of Corrosive chemicals: Hydrochloric acid, sulphuric acid, and nitric acid and alkalis. 5. Forensic analysis of oils and fats 6. Analysis of Phenolphthalein in trap cases 7. Detection of metallic poisons using Reinsch Test 8. Presumptive Drug Testing by Color/spot test, Microcrystalline testing 9. Quantitative drug analysis by UV-vis spectrophotometry 10. Chemical analysis of liquors. 11. Characterization and analysis of adulteration of Petroleum products. 12. Analysis of forensically important cosmetics (Minimum 10 experiments to be conducted)	
Reference Books	
1.	A.I. Vogel – “Text book of practical organic chemistry”, 5 th Edition ELBS, London, 1989
2.	B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4 th Revised Edition, 1992.
3.	Daniel R. Palleros, “Experimental Organic Chemistry” John Wiley & Sons, Inc., New York, 2000.
4.	B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, “Text book of Practical Organic Chemistry”, LBS, Singapore, 1994.
5.	Gnanapragasam N.S., Ramamurthy G, “Organic Chemistry Lab Manual”, revised Edition, S. Viswanathan printers and publishers Pvt. Ltd., Chennai, Reprinted 2011.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	FORENSIC PHYSICS LABORATORY	L	T	P	C
23FS2015		0	0	3	2
Course Objectives					
Enable the student to:					
1. Gain a comprehensive understanding of the analysis conducted on soil, paint, and glass samples. 2. Scrutinizing the tool marks. 3. Acknowledge the significance of conducting microscopic examinations on various samples.					
Course Outcomes					
Student will be able to:					
1. Examine the density gradient method. 2. Differentiate paint samples by physical matching and thin layer chromatography methods. 3. Illustrate spectroscopic analysis of the samples. 4. Examination and authentication of audio and video recordings. 5. Assess the necessary skills on storage media and its authentication. 6. Acknowledge the methodology to collect digital evidences.					
List of Experiments					
1. To compare soil samples by density gradient method. 2. To compare paint samples by physical matching method using stereo microscope. 3. To compare paint samples by thin layer chromatography method. 4. To compare glass samples by refractive index method. 5. To identify and compare tool marks. 6. To compare cloth samples by physical matching and fibre analysis. 7. Physical and microscopic examination of automobile paints and its spectroscopic analysis. 8. Tool marks examination using comparison / stereo microscope.					

9. Auditory and spectrographic analysis of audio evidence for speaker identification. 10. Examination and authentication of audio video recording. 11. Examination and comparison of skid marks and tyre marks. 12. Collection of digital evidences using different softwares. (Minimum 10 experiments to be conducted)	
Reference Books	
1.	W. Robinson, Undergraduate Instrumental Analysis, 5th Edition, Marcel Dekker, Inc., New York, 1995.
2.	D.R. Redsicker, The practical Methodology of Forensic Photography, 2 nd Edition, CRC Press, Boca Raton, 2000.
3.	Kathy Mirakovits and Gina Londino, The Basics of Investigating Forensic Science, CRC Press, 2015.
4.	Franck H and Franck D, Forensic Engineering Fundamentals, CRC Press, Boca Raton, Florida, USA, 2013.
5.	Li CT, Computational Forensics, Digital Crime, and Investigation, Yurchak Printing Inc, Hershey, USA, 2011.
Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	Recent Trends in Forensic Science	L	T	P	C
23FS2034		3	0	0	3
Course Objectives					
Enable the student to: 1. Relate the importance of forensic science in Crime and Society. 2. Trace the various branches of forensic science and their significance in Criminal Cases. 3. Develop concepts and application of forensic science in various Crime cases.					
Course Outcomes					
Student will be able to 1. Memorize the basic concepts of forensic science. 2. Assess the procedures involved in Crime scene management. 3. Evaluate the importance of analysis of Fingerprints and Questioned documents. 4. Classify the various types of toxins and their analysis as per the nature of crime. 5. Summarize the importance of Forensic Serology. 6. Illustrate the Industrial Forensic and Cybercrimes.					
Module: 1	FORENSIC SCIENCE AND CRIME SCENE MANAGEMENT			9 Hours	
Forensic science – Definition –History and scope- Branches of Forensic Science – Central and state forensic science laboratories in India - Directorate of Forensic Science and Mobile Crime Laboratories., Crime – Definition, types, causes and consequences - Broad concepts of criminal Justice system, - Investigating the Crime Scene - Role of Investigator - the Collection of Evidence - Evaluation of crime scene, protection of crime scene, Photography and Videography of Crime scene, Chain of Custody types - Report writing and presentation in court of law. Case studies					
Module: 2	FINGER PRINTING AND QUESTIONED DOCUMENTS			9 Hours	
Introduction- Formation of ridges. Fingerprint patterns, fingerprint characters classification of Fingerprints, Identifying various fingerprint patterns, Different methods of latent fingerprint development, Automatic fingerprint identification system, Definition of questioned documents. Types of questioned documents- Examination of Questioned Documents, Basic tools needed for forensic documents, Examination of signatures, Comparison of handwriting.- Standards for comparison of handwriting, Comparison of Photocopied documents - Examination of counterfeit Indian currency notes, passports, visas and stamp papers, case studies					

Module: 3	FORENSIC TOXICOLOGY	9 Hours
Introduction, Role of the toxicologist, significance of toxicological findings, Alcoholic Beverages, Definition of alcohol and illicit liquor, Alcoholic and non-alcoholic beverages and their composition, Absorption-distribution and elimination- Estimation of ethyl alcohol in blood and urine –Types of drugs - Narcotics, stimulants, depressants and hallucinogens- General characteristics- Drug addicts and crimes, - Classification of poisons-Plant Poison, Animal Poison, Metallic Poison, Physico-chemical characteristics, Carbon monoxide poisoning. Techniques used in toxicology. Dose-response relationship, Medico legal Autopsy.		
Module: 4	FORENSIC BIOLOGY AND SEROLOGY	9 Hours
Forensic Biotechnology, Common body fluids - Composition and functions of blood -Collection and preservation of blood Distinction between human and non-human blood. Antigens and antibodies, DNA fingerprinting/DNA Profiling, composition, functions and forensic significance of saliva, sweat, milk, semen and urine - tests for their identifications, Analytical techniques usEdition		
Module:5	INDUSTRIAL FORENSIC AND CYBERCRIMES	9 Hours
Industrial Products: Physical and chemical examination of adulterated and non-adulterated oils and fats, Analysis of chemical fertilizers, consumer items such as gold, silver, tobacco, tea, sugar, salts - Types of cement and their composition, Analysis of cement mortar and cement concrete and stones, Building Collapse, Paint and Varnishes: Nature, composition and forensic examination, vehicle accidents Forensic examination of electrical appliances Cybercrimes - Definition - computer crimes - Types of computer crimes – Digital Evidence Collection, Preservation and investigation (E-Mail Tracking, IP Tracking, E-Mail Recovery, Recovering deleted evidences)		
Total Lectures		45 Hours
Reference Books		
1.	M. Houck, Jay Siegel, “Fundamentals of Forensic Science”, Academic Press, 3 rd Edition, 2015.	
2.	K. Mirakovits, G. Londino-Smolar,“The Basics of Investigating Forensic Science” CRC Press, 2015.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

M.Sc. (CHEMISTRY) & M.Sc. (FORENSIC SCIENCE) FROM 2023-24 ONWARDS

Course Code	CHEMICAL KINETICS AND SURFACE CHEMISTRY	L	T	P	C
23CH3001		4	0	0	4
Course Objectives					
To enable the student:					
1. Acquire knowledge on the rate and order of reactions. 2. Differentiate slow and fast reaction kinetics and macromolecules. 3. Evaluate homogenous and heterogeneous catalysis.					
Course Outcomes					
Student will be able to:					
1. Distinguish the types and kinetics of fast reactions. 2. Ascertain the kinetics of flow techniques. 3. Realize the theory of acid – base catalysis. 4. Correlate the theory of surface chemistry phenomena. 5. Recognize the importance of photosensitization of chemiluminescence.					

6. Apply the principles of photochemistry.		
Module: 1	CHEMICAL KINETICS	12 Hours
Rates of chemical reaction – kinetics of first, second and third order reactions – complex methods of determining rate laws, order and molecularity concepts –Theories of reaction rates –Arrhenius theory, hard-sphere collision theory of gas phase reactions – Potential energy surfaces – Activated complex theory for ideal gas reactions (formation in terms of partition functions) – Relation between activated complex theory and hard sphere collision theory – Thermodynamic formulation-activated complex theory (Enthalpies and entropies of activation) – Kinetic isotopic effect.		
Module: 2	KINETICS OF REACTION IN SOLUTION AND FAST REACTIONS	16 Hours
Comparison between gas phase and solution reactions – Cage effect – The influence of the solvent on the reactions between ions and reaction between ions and neutral molecules – Influence of ionic strength on rates of reactions in solution – Significance of volume and entropy of activation – Secondary salt effect - Kinetic treatment of complex ion. Study by stop-flow techniques, relaxation methods – Flash photolysis, magnetic resonance methods - Kinetic theory of gases and its Postulates – Maxwell distribution of Molecular velocities - Expressions for most probable velocity, average velocity, root mean square velocity – Collision diameter, Collision frequency, Mean free path. Transport properties of gases – Thermal conductivity, Viscosity, Diffusion - principle of equipartition of energy.		
Module: 3	CATALYSIS	16 Hours
Specific and general acid-base catalysis – Bronsted catalysis law – Acidity functions. Enzyme catalysis (single substrate reactions only) – Michaelis-Menton kinetics – Influence of pH and temperature on enzyme catalysis. Surface Phenomenon and Heterogeneous catalysts - Adsorption and free energy relation at interfaces – Gibbs adsorption isotherm – Physisorption and chemisorptions – Adsorption isotherms (Langmuir and BET) – Measurement of surface area – Kinetics of heterogeneous catalysis (Langmuir Hinshelwood mechanism and Eley-Rideal mechanism) – Semiconductor catalysis.		
Module: 4	SURFACE CHEMISTRY	8 Hours
Adsorption –Physical adsorption, chemisorption, - Applications – Factors influencing – Langmuir adsorption isotherm – types of adsorption isotherm – Gibbs adsorption isotherm –BET equation – Determination of surface area -Insoluble surface film on liquids.		
Module: 5	PHOTOCHEMISTRY	8 Hours
Absorption and emission of radiation – Theories – Spontaneous and induced emission –Laser – Franck Condon principle - Type 1 & 2 – Physical properties of electronic excited state – Emission – Resonance emission – Selection rule – Fluorescence – Phosphorescence – Delayed fluorescence: E-Type and P-type – Excimer and Exciplex complex formation – Photosensitization and Chemiluminescence – Experimental techniques – Actinometry – Chemical actinometry – Flash photolysis.		
Total Lectures		60 Hours
Reference Books		
1.	Peter Atkins & Julio De Paula, Physical Chemistry 10th Edition, Oxford University Press, 2014.	
2.	Castellan, G. W. Physical Chemistry, 4th Edition, Narosa, 2004.	
3.	McQuarrie, D. A. & Simon, J. D., Molecular Thermodynamics, Viva Books Pvt. Ltd.: New Delhi, 2004.	
4.	Engel, T. & Reid, P. Physical Chemistry 3rd Edition, Prentice-Hall, 2012.	
5.	Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY, 2011.	
7.	Zundhal, S.S. Chemistry concepts and applications Cengage India, 2011.	

Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	CHEMICAL BONDING AND MAIN GROUP CHEMISTRY	L	T	P	C
23CH3002		4	0	0	4

Course Objectives

Enable the student to:

1. Acquire the principles of various chemical bonding.
2. Relate the chemistry of s-block elements.
3. Identify the main group elements and bonding.

Course Outcomes

Student will be able to:

1. Memorize the nature of chemical bonds and their properties.
2. Summarize the chemistry properties of s-block elements.
3. Assess the structural and chemical properties of s-block elements.
4. Distinguish the structure, bonding and properties of nitrogen, phosphorous and sulfur.
5. Identify the structure, bonding and properties of interhalogen and compounds of xenon.
6. Construct fresher inorganic chains, rings, and cages.

Module: 1	COVALENT AND NON-COVALENT BONDING	12 Hours
Theory of acid-base chemistry, covalent bond, hybridization and resonance, Bent's rule, VSEPR theory, Valence bond theory, MO-theory, LCAO approximation, covalent radii, bond parameters, bond length, bond order, bond energy, bond polarity, Berry pseudorotation, van der Waals radius, orbital pictures of bonding (sp ³ , sp ² , sp), hydrogen bond and their applications		
Module: 2	IONIC BONDING	12 Hours
Ionic radii, lattice energy, Born Haber cycle, Born-Landé equation, Fajans rule, Different types of electrostatic interactions, Stoichiometric and non- stoichiometric defects, crystal defects, Schottky defects, F-center and Frenkel defect, properties of ionic compounds, metallic bond, Structures of type ABX ₃ , Perovskite., Factors affecting the radii of ions, Radius Ratio		
Module: 3	STRUCTURAL AND CHEMICAL PROPERTIES OF S-BLOCK ELEMENTS	12 Hours
Chemical properties of s-block metals, reaction with water, air, nitrogen, uses and their compounds, oxides, oxoacids, hydroxides, peroxides, superoxides, organometallic compounds of Li, Mg and Be, synthesis, and bonding, Non-aqueous coordination chemistry, Complex ions in aqueous solution, complexes with crown ethers and cryptands, biological importance,		
Module: 4	STRUCTURAL AND CHEMICAL PROPERTIES OF OTHER NON-TRANSITION ELEMENTS	12 Hours
Synthesis, structure, bonding and properties of Nitrogen, Phosphorous, Sulfur, Pseudohalogen, Interhalogen compounds and polyhalogen ions, Oxides of nitrogen, Oxoacids of nitrogen, Oxoacids of phosphorus, Compounds of xenon,		
Module: 5	INORGANIC CHAINS, RINGS AND CAGES	12 Hours
Phosphazenes and its polymer, S-N compounds, Polymeric sulphur nitride (Polythiazyl) Nomenclature of Boranes and Carboranes, Wade's rule, Stylx number borazine, industrial importance of the main group compounds		
Total Lectures		60 Hours

Reference Books	
1.	B.R., Puri, L.R. Sharma and Madan S. Pathania, "Principles of Physical Chemistry", Shoban Lal Nagin Chand & Co., Jalandhar, 2000.
2.	S. Glasstone and D.Lewis, "Elements of Physical Chemistry", 2 nd Edition, 1982.
3.	M.J. Piling and P.W. Seakins, "Reaction Kinetics", Oxford University Press, 2 nd Edition, 1996.
4.	G.W. Castellan, "Physical Chemistry", Narosa publishing house, Chennai, 1989.
5.	P.W. Atkins, "Physical Chemistry", 8 th Edition, Oxford University Press, 2006.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	REACTION MECHANISMS AND STEREOCHEMISTRY	L	T	P	C
23CH3003		4	0	0	4

Course Objectives

Enable the student to:

1. Acquire knowledge about stereochemistry and asymmetric synthesis.
2. Gain a comprehensive understanding of the electronic effects on reaction pathway.
3. Identify the various types of organic reaction mechanism.

Course Outcomes

Student will be able to:

1. Elucidate the role of electronic effects in predicting the reaction pathway.
2. Propose the possible mechanism for organic transformation.
3. Predict the product formed in the reaction by applying the mechanism.
4. Explicate the product selectivity in the organic reactions.
5. Assign configuration for chiral molecule and predict stable conformer.
6. Create newer stereoselective molecules by applying the organic reactions.

Module: 1	AROMATICITY	12 Hours
Electronic effects and its importance - Inductive effect, Resonance effect, Hyperconjugation, Steric effect. Quantitative treatments of the Effect of structure and reactivity – Derivation of Hammett equation– Derivation of Linear Free Energy Relationship – Problems on Substitution constant, reaction constant and pKa calculation. Significance of sigma and rho – Isotopic labeling and types of kinetic isotopic effects and mechanism. Aromaticity – Benzenoid and Non-Benzenoid compounds Huckel's rule for smaller rings – 8, 10, 12, 14 and 16– Annulenes, heterocycles, fulvene, fulvalene, homoaromaticity.		
Module: 2	SUBSTITUTION MECHANISM - NUCLEOPHILIC	11 Hours
Aliphatic and Aromatic nucleophilic substitution mechanism– S_N^2 , S_N^1 , S_N^Ar , Effect of substrate, attacking nucleophile, leaving group and reaction medium. Mixed S_N^1 and S_N^2 , S_N^i , single electron transfer mechanism, Anchimeric assistance by lone pair, alkene, aryl groups – addition to allylic carbons S_N^2 . S_N^Ar Addition elimination - Effect of substrate, leaving group and attacking nucleophile. Elimination Addition- Generation of benzyne, regioselectivity, Diazonium salt – reactions.		
Module: 3	ELECTROPHILIC SUBSTITUTION AND ELIMINATION MECHANISM	13 Hours
Aromatic electrophilic substitution – Arenium ion mechanism – alkylation, acylation, nitration, sulfonation, halogenation, Reimer-Tiemann and Vilsmeier Haack reaction, o-, p-, m- selectivity. Orientation in mono and di-substituted benzene rings –Electrophile addition to C-C-multiple bonds, Markovnikov rule. Epoxidation- Addition to 1,3-diene-Elimination – Mechanisms of β -elimination – (E_2 , E_1 , E_1CB) –Effect of substrate, attacking base, leaving group and medium, Saytzeff rule, Bredt's rule – Hoffman Elimination, 1,1-elimination and carbene generation, syn-elimination, Chugaev and Cope elimination Nitrene Intermediates.		

Module: 4	PRINCIPLES OF STEREOCHEMISTRY	12 Hours
Stereoisomerism – Definitions- enantiomer, diastereomer, geometrical isomer, epimer, anomer, chirality, optical rotation, specific rotation-problem. Enantiomeric excess – problem-Topicity-Enantiotopic, diastereotopic and homotopic-Inter conversion between Fischer, Newmann, Saw Horse and Wedge-dash projections-absolute Configuration. Cahn-Ingold-Prelog rule- R&S, E&Z– Axial chirality-atropisomerism planar chirality and helicity. R&S configuration for biaryls, allenes, spiro compounds, cyclophanes-stereogenicity, stereoselectivity, and asymmetric induction.		
Module: 5	ASYMMETRIC SYNTHESIS	12 Hours
Conformation of ethane, butane, cyclohexane, decalin. Gauche effect, Eg. 1,3-diaxial interaction, stable conformer of mono, and disubstituted cyclohexanes. Chiral auxiliaries, Methods of asymmetric induction-Substrate, reagent and catalyst-controlled reactions-determination of enantiomeric and diastereomeric excess-enantio-discrimination. Asymmetric synthesis-Cram’s rule, Prelog’s rule, Evan’s chiral auxiliary in aldol reaction, Sharpless asymmetric epoxidation, Asymmetric dihydroxylation-ADH –Optical Resolution and Kinetic resolution – Enzymatic and kinetic methods.		
Total Lectures		60 Hours
Reference Books		
1.	Finar. I.L, “Organic Chemistry, Volume 1”, Doorling Kindersley (Indian), 6 th Edition, 5 th impression, 2008.	
2.	Jerry March, “Advanced Organic Chemistry”, Wiley Eastern Limited, New Delhi, 4 th Edition, 2008.	
3.	Morrison and Boyd, “Organic Chemistry”, United States of America, 3 rd Edition, 1992.	
4.	Kalsi. P.S. “Stereochemistry Conformation and Mechanism”, New Age International Publishers, New Delhi, 6 th Edition, 2005.	
5.	Carey, F. A, and Sundberg, R. J, “Advanced Organic Chemistry Part – A”, Plenum Press, 2007.	
6.	Jonathan Clayden, Nick Greeves, Stuart Warren. “Organic Chemistry”, 2 nd Edition, Oxford University Press, 2012.	
7.	Ernest. L. Eliel, “Stereochemistry of carbon compounds”, Tata-McGraw Hill, New Delhi, 22 nd Reprint 2009.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	QUANTUM CHEMISTRY AND GROUP THEORY	L	T	P	C
23CH3004		4	0	0	4
Course Objectives					
Enable the student to:					
1. Acquire knowledge in quantum chemistry. 2. Recognize the kinetics of rate equations. 3. Apply the principles of group theory.					
Course Outcomes					
Student will be able to:					
1. Demonstrate the importance and application of quantization in molecular energy levels. 2. Relate shape, energy of atomic orbitals & molecular orbitals and bond formation between atoms. 3. Correlate the LCAO, MO and VB treatments of hydrogen molecule. 4. Interpret the quantum chemistry in bonding. 5. Appreciate the symmetry in molecules and in nature. 6. Identify and group the objects or molecules of same category based on the symmetry elements.					

Module: 1	INTRODUCTION TO QUANTUM MECHANICS	12 Hours
Introduction - The failures of classical mechanism — black body radiation – The photo electric effect, Problems – The Compton effect – The diffraction of electrons – wave particles duality- de Broglie Equation- Problems – Hydrogen spectrum- Uncertainty principle, Problems – Postulates of quantum mechanics, Problems.		
Module: 2	QUANTUM CHEMISTRY OF ATOMS, MOLECULES	12 Hours
Scrodinger equation- derivation, Free particle, particle in one dimensional box, three dimensional box Harmonic oscillator - problems - The Schrodinger equation for hydrogen atom - Variation and perturbation theory – Problems - Application of perturbation / variation theorems to ground state of helium atom.- Problems		
Module: 3	QUANTUM CHEMISTRY OF BONDING	12 Hours
Pauli's exclusion principle – Aufbau principle – Slater detrimental wave functions – Term symbols and spectroscopic states – Born Oppenheimer approximation –Linear Combination of atomic orbitals (LCAO), MO and VB treatments of hydrogen molecule – Hybridization – Huckel- theory of linear conjugated systems ethylene, butadiene – Cyclic systems -cyclobutene – Wood- ward Hoffman rules		
Module: 4	INTRODUCTION TO GROUP THEORY	12 Hours
Molecular symmetry – symmetry elements and symmetry operations-successive operations, inverse operations - Cartesian coordinate system - relations among symmetry elements - Properties of a group – Abelian, non abelian and Isomorphic groups - Multiplication tables – classes, subgroups - Molecular point groups - Representations of a group-Reducible and irreducible, representations		
Module: 5	APPLICATIONS OF GROUP THEORY	12 Hours
Standard reduction formula relating reducible and irreducible representations -Symmetries of normal modes of vibration in non-linear molecules (H ₂ O, NH ₃) - Selection rules for vibrational spectra - Symmetries of M.O and symmetry selection rule for electronic transition in ethylene and formaldehyde - Hybridization schemes for atoms in methane, ethylene and butadiene.		
Total Lectures		60 Hours
Reference Books		
1.	Cotton F.A. “Chemical application of group theory”, Wiley India Pvt. Ltd., New Delhi, India, 3 rd Edition, 2009.	
2.	Carter R.L., Molecular Symmetry and Group Theory, John Wiley & Sons, NY, 2005.	
3.	R. K. Prasad. I.N. Levine, Quantum Chemistry, 4 th Edition, New Age International Publishers, 2010	
4.	Chandra, A.K. “Quantum Chemistry” Tata McGraw –Hill Pvt. Ltd., New Delhi, 4 th Edition, 2002.	
5.	Hanna, M.W., “Quantum Mechanics in Chemistry”, Addition Wisley, London, 3 rd Edition, 1981.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	COORDINATION CHEMISTRY	L	T	P	C
23CH3005		4	0	0	4
Course Objectives					
Enable the student to:					
1. Memorize the fundamentals of coordination chemistry.					
2. Acquire knowledge on the structure and properties of coordination complexes.					
3. Discuss the application of coordination chemistry.					

Course Outcomes		
Student will be able to:		
1. Explicate the theory of coordination chemistry. 2. Connect the structure and stability of coordination complexes. 3. Summarize the bonding and magnetic properties of coordination complexes. 4. Ascertain the electronic spectra of coordination complexes. 5. Relate the reaction mechanism of coordination compounds. 6. Apply the principles of coordination chemistry in creating newer molecules.		
Module: 1	STRUCTURE AND STABILITY OF COORDINATION COMPLEXES	12 Hours
Structure of transition metal coordination complexes, ligand, coordination, geometry, coordination number, isomerism and optical isomerism, HSAB concept, thermodynamic stability, successive and overall stability constants, Factors affecting stability of complex compounds, Irving-William series, chelate and macrocyclic effect		
Module: 2	BONDING AND MAGNETIC PROPERTIES	12 Hours
Bonding and properties of transition metal coordination complexes,- VBT, CFT and their limitations; d-orbital splitting in octahedral, JT-distorted octahedral, square planar, square pyramidal, trigonal-bipyramidal, and tetrahedral complexes; CFSE for d ¹ to d ¹⁰ systems, pairing energy, low-spin and high-spin complexes, Spectrochemical Series, Molecular orbital (MO) theory of selected octahedral and tetrahedral complexes, magnetic properties, magnetic susceptibility and the spin-only formula, Ferromagnetism, antiferromagnetism and ferrimagnetism,		
Module: 3	ELECTRONIC SPECTRA OF COORDINATION COMPOUNDS	12 Hours
Electronic spectra of octahedral and tetrahedral complexes- UV-Vis, charge transfer, colors, intensities and origin of transitions, interpretation, term symbols and splitting of terms in free atoms, selection rules for electronic transitions, Orgel and Tanabe-Sugano diagram, calculation of Dq, B, C, Nephelauxetic ratio.		
Module: 4	REACTION MECHANISM OF COORDINATION COMPOUNDS	12 Hours
Reaction mechanisms substitution reactions in octahedral and square planar complexes, trans effect and its influence, water exchange, anation and base hydrolysis, stereochemistry, inner and outer sphere electron transfer mechanism, Electron transfer reactions, Marcus theory.		
Module: 5	BIO-INORGANIC CHEMISTRY	12 Hours
Bioinorganic Chemistry: Transition metals in biology - their occurrence and function, active-site structure and function of metalloproteins and metalloenzymes with various transition metal ions and ligand systems, O ₂ binding properties of heme (haemoglobin and myoglobin) and non-heme proteins hemocyanin & hemerythrin), their coordination geometry and electronic structure, co-operativity effect, Hill coefficient and Bohr Effect; Electron transfer proteins - active site structure and functions of ferredoxin, rubridoxin and cytochromes, and their comparisons. Vitamin B12 and cytochrome P450 and their mechanisms of action.		
Total Lectures		60 Hours
Reference Books		
1.	Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4 th Edition, 2009.	
2.	Purcell K. F & Kotz J. C., "Inorganic Chemistry" Cengage Learning, New Delhi, India, Reprint, 2010.	
3.	Greenwood N. N. & Earnshaw A, "Chemistry of the Elements", Reed Elsevier India Private Ltd, Gurgaon, India, 2 nd Edition, 2010.	
4.	Gopalan R, Ramalingam V, Concise Coordination Chemistry, Vikas Publishing House Pvt. Ltd, 2001.	

5.	Cotton F. A & Wilkinson G, "Advanced Inorganic Chemistry", 6 th Edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.
6.	Shriver and Atkins, "Inorganic Chemistry", Oxford University Press, New Delhi, India, 4 th Edition, 2009.
7.	Catherine Housecroft and Alan G. Sharpe, Inorganic Chemistry, 4 th Edition, Pearson, Harlow, England, 2012.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	ORGANIC TRANSFORMATIONS AND REAGENTS	L	T	P	C
23CH3006		4	0	0	4
Course Objectives					
Enable the student to:					
1. Acquire skills in organic naming reactions.					
2. Realize the potential of various reagents used in organic transformations.					
3. Comprehend the molecular rearrangement and apply retrosynthesis to target molecule.					
Course Outcomes					
Student will be able to:					
1. Elucidate the importance of metal-assisted coupling reactions in synthesis.					
2. Summarize the reagents used for oxidation and reduction reactions.					
3. Apply modern synthetic reagents in organic synthesis.					
4. Demonstrate and analyze the use of multi-component coupling in synthesis.					
5. Predict and identify the product formed in molecular rearrangements					
6. Utilize the retrosynthetic approach to create complex target molecules.					
Module: 1	METAL-ASSISTED COUPLING REACTIONS	12 Hours			
Coupling reactions-definition, Organometallic reactions-oxidative addition, insertion - reductive elimination, Heck reaction, catalytic cycle, Suzuki Coupling, Stereospecificity- aryl and vinyl boron compound synthesis- Stille Coupling, Negishi coupling- Buchwald amination, Sonogashira coupling, Glacier coupling- pi-allyl complex-Tsuji Trost reaction –Regio- and stereoselectivity, Ullmann reaction, catalytic cycles.					
Module: 2	OXIDATION AND REDUCTION REAGENTS	12 Hours			
DMSO based oxidation- Swern, Corey Kim, Moffatt-Pfitzner- Metal oxide oxidants- PCC, PDC, Jones reagent, MnO ₂ , KMnO ₄ , TPAP- Hypervalent iodine- IBX, Dess-Martin periodinane, Oppeneur oxidation. Reduction – Metal hydrides- NaBH ₄ , LAH, DIBAL-H, NaCNBH ₃ , LiBH ₄ , BH ₃ , Selectride, Li/liq.NH ₃ reduction of the aromatic ring, alkyne, cyclohexenone, Bouvel-Blanc reduction, Raney/Ni, Pd/C, H ₂ -MPV reduction.					
Module: 3	MULTICOMPONENT REACTIONS AND REAGENTS	12 Hours			
Modern Synthetic Reagents: NBS- DDQ- DCC, R ₂ CuLi, Gilman Reagent, Wittig salt, Wittig-Horner reaction, trimethylsulfonium and sulfoxonium ylide- Corey-Chaykovsky reaction, Tebbe reagent, <i>m</i> -CPBA, CH ₂ I ₂ and Zn/Cu-Simmons Smith–diazomethane-SeO ₂ , multicomponent reactions, Strecker's amino acid synthesis, Ugi reaction, Passerini reaction, Biginelli reaction, mechanism.					
Module: 4	NAMING REACTIONS	12 Hours			
1,2-shift to electrophilic carbon – Wagner –Meerwin, Pinacol-Pinacolone, Benzil-Benzilic acid rearrangement- Favorski- Dieneone phenol- Wolf rearrangement-Demjanov – 1,2-shift to electrophilic Oxygen – Baeyer Villiger Oxidation, Dakin reaction- hydroboration oxidation -1,2-shift to electrophilic					

nitrogen –Curtius - Schmidt – Hoffmann – Lossen rearrangements, Beckmann rearrangement – Sommelet Hauser-Benzidine rearrangement-Neber rearrangement.		
Module: 5	RETROSYNTHESIS AND PROTECTING GROUPS	12 Hours
Synthons and reagents – Strategy I: The order of events – one group disconnection – Linear and Convergent Synthesis-Strategy II: Chemoselectivity – Two group Disconnection – Strategy III; Reversal of polarity, 1,3-dithiane and cyclization – Strategy IV: protecting groups – Strategy V: Stereoselectivity – Strategy VI: Carbonyl condensation - Strategy VII: Aliphatic nitro compounds – Strategy VIII: Ring synthesis. Umpolung of reactivity.		
Total Lectures		60 Hours
Reference Books		
1.	Jerry March, “Advanced Organic Chemistry”, Wiley Eastern Limited, New Delhi, 4 th Edition, 2008.	
2.	Carruthers, W.; Coldham, I. Modern Methods of Organic Synthesis, 4 th Edition Cambridge University Press, 2004.	
3.	Organic Chemistry (5thEdn.) Robert. T. Morrison & N. Boyd. Hill Edition 2016.	
4.	Stuart Warren, “Organic Synthesis – The disconnection approach” – A John Wiley and Sons, Ltd., 2 nd Edition, 2010.	
5.	Smith M. B., Organic Synthesis, 3 rd Edition, Wave Functions Inc. 2010.	
6.	Jonathan Clayden, Nick Greeves, Stuart Warren. “Organic Chemistry” 2 nd Edition, Oxford University Press, 2012.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	CHEMICAL THERMODYNAMICS AND ELECTROCHEMISTRY	L	T	P	C
23CH3007		4	0	0	4
Course Objectives					
To enable the student:					
1. Acquire the basics of chemical thermodynamics. 2. Develop knowledge in the interpretation of various physical quantities in thermodynamics. 3. Infer the importance of electrochemistry.					
Course Outcomes					
Student will be able to					
1. Quote the principles of chemical thermodynamics. 2. Evaluate the physical parameters in chemical thermodynamics. 3. Apply the laws of thermodynamics in day today matters. 4. Analyze the basic principles of thermodynamics and electrochemistry. 5. Utilize the knowledge of electrochemistry in everyday life. 6. Evaluate the efficiency of fuel cells.					
Module: 1	CHEMICAL THERMODYNAMICS – I	12 Hours			

Thermodynamics - State variables – Thermodynamic equilibrium - reversible process – Irreversible process – Heat and work – First law of thermodynamics - Mathematical formulation of first law of thermodynamics – Enthalpy – Relationship between ΔH and ΔE – Enthalpy of reaction – Types – The effect of temperature on ΔH – Kirchhoff's equation – Hess law – Limitation of first law of thermodynamics - Second law of thermodynamics – Spontaneous process and spontaneity – Non spontaneous process – Third law of thermodynamics – Entropy – Entropy change in phase transformations – Entropy changes of an ideal gas in different processes – Entropy at absolute zero – Determination of absolute entropies of solids, liquids and gases – Trouton's rule.		
Module: 2	CHEMICAL THERMODYNAMICS – II	12 Hours
Gibbs free energy – Gibbs free energy and spontaneity – Prediction of feasibility of a chemical reaction – Effect of temperature on spontaneity – Helmholtz energy – Maxwell's relations – Gibbs Helmholtz equation – Applications - Thermodynamics of open systems – Partial molar properties – Chemical potential – Gibbs – Duhem equation – Variation of chemical potential with temperature and pressure – Clapeyron equation – Clapeyron – Clausius equation – Applications – Activity – Activity coefficient – Ideal solution – Real solution – Fugacity – Determination of a fugacity of a gas – Chemical equilibrium – Characteristics of chemical equilibrium – Law of mass action – Equilibrium law – Equilibrium constant expression for a reaction in general terms – Van't Hoff Isotherm – Van't Hoff isochore – Relationship between K_p , K_c and K_x .		
Module: 3	Statistical Thermodynamics	12 Hours
Concepts of probability and Maxwell Boltzmann distribution – Basic derivation – prove that $\beta = 1/KT$ – Relationship between entropy and thermodynamic probability systems with degeneracy – Definitions of partition function – applications – derivation of thermodynamic functions from partition function – entropy for monoatomic gases – Sackur – Tetrode equation – The Bose – Einstein's system – Basic derivation – Fermi – Dirac system – Basic derivation – negative Kelvin temperature. Heat capacity of solids – Debye and Einstein models – Thermodynamics functions of ideal gases, translational, vibrational and rotational contributions at different levels of approximation.		
Module: 4	METAL/ELECTROLYTE INTERFACE	14 Hours
Conductivity of solutions and their measurement - the Arrhenius ionization theory - transport numbers and mobilities of ions - measurement of transport numbers – Hittorff method and moving boundary method - ionic activities and activity coefficients and their determination by various methods - Debye-Huckel-Onsager theory - ionic atmosphere - limiting law - Electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations Outer Helmholtz plane (OHP) and Inner Helmholtz plane (IHP) - potential profile and difference across double layer region - Structure of the double layer - Helmholtz-Perrin, Gouy-Chapman, and Stern models – Electrode kinetics - Butler-Volmer equation—one step one electron transfer kinetics - exchange current density - Tafel equation and plots.		
Module: 5	ELECTROCHEMICAL ENERGY SYSTEMS	10 Hours
Batteries – types - Dry batteries – Lead acid batteries- - Li-ion batteries- applications- Solar battery – photovoltaics - transducers - actuators -Electrochemical sensors –Hydrogen – fuel cells – hydrocarbons – polymer electrolyte fuel cells - Methanol Fuel cells.		
Total Lectures		60 Hours
Reference Books		
1.	B.R., Puri, L.R. Sharma and Madan S. Pathania, "Principles of Physical Chemistry", Shoban Lal Nagin Chand & Co., Jalandhar, 2000.	
2.	S. Glasstone and D.Lewis, "Elements of Physical Chemistry", 2 nd Edition, 1982.	
3.	M.J. Piling and P.W. Seakins, "Reaction Kinetics", Oxford University Press, 2 nd Edition, 1996.	

4.	G.W. Castellan, "Physical Chemistry", Narosa publishing house, Chennai, 1989.
5.	Samuel Glasstone, "An Introduction to Electrochemistry", Maurice Press, 2007.
6.	Atkins P.W., "Physical Chemistry", Oxford University Press, 8 th Edition, 2006.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	ORGANOMETALLICS			L	T	P	C
23CH3008				4	0	0	4
Course Objectives							
Enable the student to:							
1. Attain knowledge on the bonding and structural properties of organometallic chemistry.							
2. Relate the organometallic reactions and mechanism.							
3. Recognize the applications of organometallic compounds.							
Course Outcomes							
Student will be able to:							
1. Correlate the bonding and properties of organometallic complexes.							
2. Describe the structure of various types of transition metal organometallic complexes.							
3. Utilize the reactions and apply the respective mechanism of organometallic complexes.							
4. Practice the applications of organometallic complexes in catalysis.							
5. Illustrate the organometallics of s- and p-block elements.							
6. Identify the organometallic cluster complexes that can be used for various applications.							
Module: 1	BONDING AND STRUCTURE						12 Hours
Complexes with pi-acceptor and sigma-donor ligands, synthesis, structure and bonding in metal carbonyls, nitrosyls, dioxygen complexes and dinitrogen complexes, EAN and 18 electron rules, synthesis, properties, structure and bonding in ferrocene, Arene, olefin, acetylene and allyl complexes, carbenes, carbynes, and N-heterocyclic carbenes, Agostic interaction, Fluxional molecules							
Module: 2	ORGANOMETALLIC REACTIONS						12 Hours
Reactions, Oxidative addition, Reductive elimination, Insertion, Migration, Nucleophilic and electrophilic attack on coordinated ligands, Carbonylate anions as nucleophile, Fluxionality.							
Module: 3	ORGANOMETALLICS IN CATALYSIS						12 Hours
Hydrogenation of olefins, Tolman catalytic loops, hydroformylation, acetic acid from ethanol, oxidation of alkenes to aldehydes and ketones, olefin polymerization, Cyclooligomerisation of acetylenes, olefin isomerisation using Ni catalyst, C-H activation and metathesis reactions.							
Module: 4	ORGANOMETALLICS OF S- AND P-BLOCK ELEMENTS						12 Hours
Synthesis, structure, bonding and applications of organometallics of alkali metal, beryllium, magnesium, silicon, tin, lead, selenium, tellurium, aluminium, lewis Base adducts of AlR ₃ compounds, zinc, copper and other transition metal reagents							
Module: 5	ORGANOMETALLIC CLUSTER						12 Hours
Structure and bonding of metal carbonyls, chromium, iron and cobalt carbonyl reagents, metal-metal bond, carbonyl and non-carbonyl clusters, clusters in catalysis, metal (Fe, Cr, Mo, Ni, Co, Rh) carbonyl compounds in organic synthesis							
Total Lectures						60 Hours	
Reference Books							

1.	Huheey J.E, Keiter E.A & Keiter R.L, “Inorganic Chemistry – Principles of structure and reactivity”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4 th Edition, 2009.
2.	Shriver and Atkins, “Inorganic Chemistry”, Oxford University Press, New Delhi, India, 4 th Edition, 2009.
3.	Purcell K.F & Kotz J.C., “Inorganic Chemistry”, Cengage Learning, New Delhi, India, Reprint, 2010.
4.	Cotton F.A. & Wilkinson G, “Advanced Inorganic Chemistry”, 6 th Edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.
5.	Gupta B.D. & Elias A.J., “Basic Organometallic Chemistry”, CRC Press, New Delhi, India, 2010.
6.	Greenwood N.N. & Earnshaw A, “Chemistry of the Elements”, Reed Elsevier India Private Ltd, Gurgaon, India, 2 nd Edition, Reprinted 2010.
7.	Catherine Housecroft and Alan G. Sharpe, Inorganic Chemistry, 4 th Edition, Pearson, Harlow, England, 2012
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	PERICYCLIC REACTIONS AND NATURAL PRODUCTS	L	T	P	C
23CH3009		4	0	0	4
Course Objectives					
Enable the student to:					
1. Recognize the fundamental principles of pericyclic and photochemical reactions.					
2. Acquire knowledge on the synthesis and reactions of heterocyclic compounds.					
3. Realize the importance of natural products and biomolecules in the functioning of living system.					
Course Outcomes					
Student will be able to:					
1. Relate the principles and applications of pericyclic reactions to predict the product.					
2. Reason out for the product formed in the photochemical reaction.					
3. Describe the synthesis of heterocycles molecules from suitable precursors.					
4. Summarize the properties and applications of heterocyclic compounds.					
5. Elaborate the extraction and structural elucidation of natural products.					
6. Report the structure and role of biomolecules in living system.					
Module: 1	PERICYCLIC REACTIONS	12 Hours			
Introduction-definition and types- Electrocyclic ring closing and ring opening-conrotatory and disrotatory, FMO method, correlation diagram- Woodward-Hoffmann rule –Nazarov cyclization, Cycloaddition reactions - selectivity- Diels Alder- endo, regio and stereoselectivity – ene reactions. Sigmatropic rearrangement – [3,3], Cope, oxy-cope, Claisen, Johnson-claisen, Ireland-claisen, stereochemistry of sigmatropic reaction, [2,3] sigmatropic reactions- stereochemistry, Electrocyclic reactions - chelotropic reactions					

Module: 2	PHOTOCHEMICAL REACTIONS	12 Hours
Reactivity of Electronically excited ketones Norrish Type I, Type II reactions – Photoreduction and oxidation – Paterno-Buchi reaction - Photo rearrangements – Photo Fries rearrangement, di-pi-methane and oxa-di-pi-methane rearrangement, Lumiketone rearrangement, Remote functionalization Barton and Hoffmann-Loftler-Freytag reaction, cis-trans isomerization photostationary state		
Module: 3	HETEROCYCLES	10 Hours
Nomenclature – Compounds containing two hetero atoms – Azoles – Chemistry of Pyrazole, Imidazole, Oxazole and Thiazole – Diazines – Chemistry of Pyridazine, Pyrimidines and Pyrazines		

Module: 4	NATURAL PRODUCTS	14 Hours
Natural products-extraction, Soxhlet extraction, Index of hydrogen deficiency, Empirical formula from CHN- General methods of structure elucidation of alkaloids – Structure, synthesis and stereochemistry of the following alkaloids – Quinine and Morphine - Terpenoids - Classification - Structure, Stereochemistry and synthesis of Camphor. Steroids – Introduction, Nomenclature - Constitutional study of cholesterol.		
Module: 5	BIOMOLECULES	12 Hours
Amino acids – Common and amino acids – classification – Physicochemical properties of amino acids. Proteins and peptides — Structure of peptides – Optical and chemical properties of peptides- Steps in determination of amino acid sequence – Complete hydrolysis of polypeptide chains and determination of amino acid composition – Identification of N-terminal and C-terminal residues of peptides. Proteins - Composition of proteins – Size of protein molecules – structure of proteins - Denaturation. Enzymes – Definition, types and classification - Biological activities – Kinetics – Inhibition - Types of inhibition – Nucleic acids - structure of DNA and RNA.		
Total Lectures		60 Hours
Reference Books		
1.	Jagadamba Singh and Jaya Singh, “Photochemistry and Pericyclic Reactions”, New Age International Publishers, New Delhi, 3 rd Revised Edition, Reprint, 2011.	
2.	Finar. I. L, “Organic Chemistry”, Volume 2, Doorling Kindersley (Indian), 6 th Edition, 2008.	
3.	Raj.K. Bansal, “Heterocyclic Chemistry”, New Age International Publishers, 4 th Edition, Reprint, 2009.	
4.	Finar. I.L., “Organic Chemistry”, Volume 2, Doorling Kindersley (Indian), 6 th Edition, 5 th Impression 2008.	
5.	Gurdeep R. Chatwal, “Organic Chemistry of Natural Products”, Himalaya Publishing Home, New Delhi, 5 th & Enlarged Edition, 2008.	
6	Lehninger “Principles of Biochemistry” 5 th Edition, 2008 - Nelson, D. L. and M. M. Cox. (W. H. Freeman & Co.).	
7	Carey, F. A., Sundberg. R. J, “Advanced Organic Chemistry Part – B: Reactions and Synthesis”, Plenum Press, 2008.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	QUALITATIVE AND QUANTITATIVE INORGANIC ANALYSIS LAB	L	T	P	C
23CH3010		0	0	6	4
Course Objectives					
Enable the student to:					
1. Acquire the necessary skills in qualitative inorganic analysis containing common and less common ions. 2. Synthesize the metal complexes. 3. Characterize the metal complexes using spectroscopic techniques.					
Course Outcomes					
Student will be able to:					
1. Perform semimicro analysis. 2. Classify the ions into various groups. 3. Differentiate between common and less common ions. 4. Practice complex preparation techniques. 5. Predict the mechanism of the various preparative synthetic steps. 6. Create novel inorganic complexes and characterize by spectroscopic techniques.					

List of Experiments					
1. Semimicro qualitative inorganic analysis-I					
2. Semimicro qualitative inorganic analysis -II					
3. Semimicro qualitative inorganic analysis -III					
4. Semimicro qualitative inorganic analysis -IV					
5. Semimicro qualitative inorganic analysis -V					
6. Semimicro qualitative inorganic analysis -VI					
7. Semimicro qualitative inorganic analysis -VII					
8. Semimicro qualitative inorganic analysis –VIII					
9. Semimicro qualitative inorganic analysis –IX					
10. Semimicro qualitative inorganic analysis –X					
11. Preparation of Potassium trioxalato ferrate(III) trihydrate					
12. Preparation of Hexathiourea Lead(II)nitrate					
13. Preparation of Tetraamine copper (II) sulphate					
14. Synthesis of hexaammine cobalt(III) chloride					
15. Preparation of Diaquabis (ethylenediamine) copper (II) iodide					
16. Preparation of Dichlorobis (ethylenediamine) cobalt(II) chloride					
17. Preparation of Potassium trioxalato Chromium(III)					
18. Solid phase synthesis of <i>trans</i> - bis glycinato copper (II):					
19. Preparation of bis(N, N' disalicylalethylene-diamine)-μ- aquadacobalt(II)					
20. Synthesis of pentaamminechlorocobalt(III) chloride					
21. Preparation of Mangesedioxide nano-particles					
22. Preparation of bis-chloro bis-triphenyl phosphine nickel (II)					
Reference Books					
1.	Ramanujam V. V., “Inorganic semimicro qualitative analysis”, 3 rd Edition, The national publishing company, Chennai, India, reprinted 2008.				
2.	Svehla G., “Vogel’s Textbook of Qualitative Chemical Analysis”, 6 th Edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression 2008.				
3.	Gopalan R, Ramalingam V, Concise Coordination Chemistry, Vikas Publishing House Pvt. Ltd, 2001.				
Recommended by Board of Studies					
Approved by Academic Council			25 Aug 2023		

Course Code	MODERN INSTRUMENTAL ANALYSIS LAB	L	T	P	C
23CH3011		0	0	3	2
Course Objectives					
Enable the student to:					
1. Acquire knowledge on the theory, instrumentation, and applications of separation techniques.					
2. Analyze the sample using spectroscopic techniques.					
3. Characterize the molecules by applying the UV-Vis, SEM and EDAX techniques.					
Course Outcomes					
Student will be able to:					
1. Handle various analytical techniques.					
2. Correlate the physical and chemical principles involved in instrumental analysis.					
3. Apply the principles of data acquisition and data analyses.					
4. Interpret analytical data and communicate the information about identification of different materials.					
5. Choose the instrument for specific characterization.					
6. Solve the quantitative analytical problems.					
List of Experiments					
1. IR spectral Analysis of drug Sample					

2. IR spectral Analysis of ligand and its metal complexes 3. UV-Visible spectral analysis of organic compound 4. UV-Visible spectral Analysis of organic compound 5. Absorption and emission measurement of any one dye 6. Identification of compounds using Thin Layer Chromatography 7. Analysis of Surface Morphology of metal oxide by Scanning Electron Microscopy – I 8. Elemental analysis using EDAX 9. NMR analysis of drug molecule 10. Analysis of Powder XRD Data- II 11. HPLC analysis of sample	
Reference Books	
1.	A.I. Vogel – “Text book of practical organic chemistry”, 5 th Edition ELBS, London, 1989.
2.	B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4 th Revised Edition, 1992.
3.	Daniel R. Palleros, “Experimental Organic Chemistry” John Wiley & Sons, Inc., New York, 2000
4.	B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, “Text book of Practical Organic Chemistry”, LBS, Singapore, 1994.
5.	Gnanapragasam N.S., Ramamurthy G, “Organic Chemistry Lab Manual”, revised Edition, S. Viswanathan printers and publishers Pvt. Ltd., Chennai, Reprinted 2011.
6	Mendham J., Denny R. C., Barnes J. D. and Thomas M. J. K., “Vogel’s Textbook of Quantitative Chemical Analysis”, 6 th Edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, Seventh impression 2008.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	QUALITATIVE AND QUANTITATIVE ORGANIC	L	T	P	C
23CH3012	ANALYSIS LAB	0	0	6	4
Course Objectives					
Enable the student to:					
1. Recognize the functional groups of the organic compounds by qualitative analysis. 2. Carryout various types of organic reactions to analyze the organic compound. 3. Comprehend the principle and estimate organic compound quantitatively.					
Course Outcomes					
Student will be able to:					
1. Perform systematic analysis of an organic compound. 2. Predict the mechanism of the various reactions. 3. Assess the importance of analyzing organic compound. 4. Employ various types of organic reaction in synthesis. 5. Apply the knowledge in estimating the real samples. 6. Prepare derivatives for the given organic compound.					
List of Experiments					
1. Qualitative analysis of organic mixture-I 2. Qualitative analysis of organic mixture-II 3. Qualitative analysis of organic mixture-III 4. Qualitative analysis of organic mixture-IV 5. Qualitative analysis of organic mixture-V 6. Qualitative analysis of organic mixture-VI 7. Qualitative analysis of organic mixture-VII 8. Qualitative analysis of organic mixture-VIII					

9. Estimation of Phenol 10. Estimation of Aniline 11. Estimation of Ascorbic acid 12. Estimation of Glucose (Minimum 10 experiments to be conducted)	
Reference Books	
1.	A.I. Vogel – “Text book of practical organic chemistry”, 5 th Edition ELBS, London, 1989.
2.	B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4 th Revised Edition, 1992.
3.	Daniel R. Palleros, “Experimental Organic Chemistry” John Wiley & Sons, Inc., New York.
4.	B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, “Text book of Practical Organic Chemistry”, LBS, Singapore, 1994.
5.	Gnanapragasam N.S., Ramamurthy G, “Organic Chemistry Lab Manual”, revised Edition, S. Viswanathan printers and publishers Pvt. Ltd., Chennai, Reprinted 2011.
Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	PREPARATIVE INORGANIC CHEMISTRY LAB	L	T	P	C
23CH3013		0	0	3	2
Course Objectives					
Enable the student to: 1. Acquire adequate knowledge on the basic principles of formation of Inorganic complexes. 2. Provide the students an appreciation for the preparation of inorganic complexes. 3. Explore the metal complexes using spectroscopic techniques.					
Course Outcomes					
Student will be able to: 1. Apply the practical skill to prepare inorganic metal complexes. 2. Adopt appropriate methods to prepare the inorganic complexes. 3. Purify and check the purity of the prepared compounds. 4. Predict the mechanism of various preparative synthetic steps. 5. Practice complex preparation techniques. 6. Solve the real time challenges in characterize the inorganic complexes by spectroscopic techniques.					
List of Experiments					
1. Preparation of Potassium trioxalato ferrate(III) trihydrate 2. Preparation of Hexathiourea Lead(II)nitrate 3. Preparation of Tetraamine copper (II) sulphate 4. Synthesis of hexaammine cobalt(III) chloride 5. Preparation of Tris ethylene diamine Nickel (II) Chloride 6. Synthesis of Cis-dichloro bis (ethylenediamine) Cobalt (III) Chloride. 7. Synthesis of Schiff base copper (II) complex. 8. Preparation of Diaquabis (ethylenediamine) copper (II) iodide 9. Preparation of Dichlorobis (ethylenediamine) cobalt(II) chloride 10. Preparation of Potassium trioxalato Chromium(III) 11. Solid phase synthesis of <i>trans</i> - bis glycinato copper (II): 12. Preparation of bis(N, N' disalicylalethylene-diamine)-μ- aquadichloro cobalt(II) 13. Synthesis of pentaamminechlorocobalt(III) chloride 14. Preparation of Mangesedioxide nano-particles 15. Preparation of bis-chloro bis-triphenyl phosphine nickel (II) (Minimum 10 experiments to be conducted)					
Reference Books					

1.	Ramanujam V. V., "Inorganic semimicro qualitative analysis", 3 rd Edition, The national publishing company, Chennai, India, reprinted 2008.
2.	Svehla G., "Vogel's Textbook of Qualitative Chemical Analysis", 6 th Edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression 2008.
3.	Gopalan R, Ramalingam V, Concise Coordination Chemistry, Vikas Publishing House Pvt. Ltd, 2001.
4.	Allcock, H, R., "Inorganic Syntheses", Volume 25, John Wiley & Sons, New York, USA, 1989.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	PHYSICAL CHEMISTRY LAB	L	T	P	C
23CH3014		0	0	6	4
Course Objectives					
Enable the student to: 1. Perform the chemical reactions monitored by the electroanalytical techniques. 2. Develop skills and knowledge in the application area of electrochemical based experiments. 3. Apply the techniques used for kinetics studies.					
Course Outcomes					
Student will be able to: 1. Relate the physical chemistry concepts in chemical kinetics. 2. Estimate samples using instrumental techniques. 3. Asses the importance of velocity of the reaction, distribution properties and adsorption studies. 4. Recognize the factors affecting the rate of the reactions. 5. Realize the importance of absorption studies. 6. Utilize the practical knowledge in solving problems and communicate the results and conclusions effectively.					
List of Experiments 1. Determination of strength of the mixture of acids 2. Determination of percentage purity of AgNO ₃ solution conductometrically 3. Precipitation reaction between BaCl ₂ & MgSO ₄ – Conductometry 4. Verification of Onsager equation 5. Verification of Ostwald's Dilution law 6. Precipitation Titration of KCl Vs AgNO ₃ (Potentiometry) 7. Determination of dissociation constant of weak acid using quinhydrone electrode 8. Determination of strength of unknown KI solution by potentiometric method 9. Determination of pH of a given buffer by potentiometry 10. Precipitation titration (AgNO ₃ Vs KCl + KI) – Potentiometry 11. Ester hydrolysis – Comparison of acid strength 12. Freundlich adsorption isotherm 13. Verification of the validity of Beer – Lambert's law and determination of the concentration of chromium present in the given K ₂ Cr ₂ O ₇ by spectrophotometry 14. Determination of the strength of ferrous ion present in the given solution by potentiometric method. (Minimum 10 experiments to be conducted)					
Reference Books					
1.	A.I. Vogel – “Text book of practical organic chemistry”, 5 th Edition ELBS, London, 1989.				
2.	Anand A., Kumari R., “Physical Chemistry Laboratory Manual: An Interdisciplinary Approach”, I K International Publishing House Pvt. Ltd, 2019.				
3.	Sinha S.K., “Physical Chemistry: A Laboratory Manual”, Alpha Science International Ltd; 1 st Edition, 2014.				
4.	Gold, “Physical Chemistry Laboratory Manual”. Primis; 2 nd Edition, 1998.				

5.	Athawale, V.D., Mathur, P., “Experimental Physical Chemistry”, New Age International Publishers, 2001.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	SYNTHETIC ORGANIC CHEMISTRY LAB	L	T	P	C
23CH3015		0	0	3	2

Course Objectives

Enable the student to:

1. Acquire the relevant technical skills in organic preparations.
2. Apply the purification techniques to get pure organic compound.
3. Develop skills to prepare various novel organic compounds.

Course Outcomes

Student will be able to:

1. Design and prepare organic compounds.
2. Purify the prepared organic compound and check the purity.
3. Setup the apparatus for various preparative techniques and synthetic conditions.
4. Predict the mechanism of various synthetic methods.
5. Recognize the importance of distillation, refluxing and recrystallization techniques.
6. Employ various types of reaction to prepare organic compounds.

List of Experiments

1. Preparation of Acetanilide from aniline
 2. Preparation of *p*-bromo and *p*-nitro acetanilide from acetanilide
 3. Preparation of 4-Nitrobenzanilide from Aniline
 4. Preparation of 2,4,6-tribromo aniline from aniline
 5. Preparation of Aspirin from methyl salicylate
 6. Preparation of Ethyl Benzoate from Benzaldehyde
 7. Preparation of picric acid from phenol
 8. Preparation of Benzilic acid from Benzoin
 9. Preparation of Sandmeyer reaction Product
 10. Preparation of *p*-nitro benzoic acid from 4-nitro toluene
 11. Preparation of *m*-nitrophenol from *m*-nitroaniline
 12. Preparation of Eosin from fluorescein
- (Minimum 10 experiments to be completed)

Reference Books

1. A.I. Vogel – “Text book of practical organic chemistry”, 5th Edition ELBS, London, 1989.
2. B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised Edition, 1992.
3. Daniel R. Palleros, “Experimental Organic Chemistry” John Wiley & Sons, Inc., New York, 2000.
4. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, “Text book of Practical Organic Chemistry”, LBS, Singapore, 1994.
5. Gnanapragasam N.S., Ramamurthy G, “Organic Chemistry Lab Manual”, revised Edition, S. Viswanathan printers and publishers Pvt. Ltd., Chennai, Reprinted 2011.

Recommended by Board of Studies

Approved by Academic Council

25 Aug 2023

Course Code	ANALYTICAL CHEMISTRY	L	T	P	C
23CH3016		3	0	0	3

Course Objectives		
Enable the student to:		
1. Develop sufficient knowledge about the physical/chemical basis of measurement. 2. Select the instruments for the successful analysis of complex mixtures. 3. Apply and analyze various instrumental techniques in solving analytical problems.		
Course Outcomes		
Student will be able to:		
1. Illustrate the range and theories of instrumental methods available in analytical chemistry. 2. Recognize the appropriate instruments for analyzing complex mixtures. 3. Identify the proper separation technique. 4. Summarize the importance of thermal methods of analysis. 5. Analyze the sample using microscopic techniques. 6. Apply the acquired instrumentation technical skills in paint, glass, paper, water, food, body fluid analysis.		
Module: 1	DATA ANALYSIS	09 Hours
Errors in chemical analysis – Mean, Median, Mode, Accuracy and Precision –Absolute and Relative Error; simple problems - Determinate errors and Indeterminate errors. Improving accuracy of analysis mean, standard deviation absolute and relative errors; Covariance and coefficient correlation; significant figures and Q-test – Problems.		
Module: 2	CHROMATOGRAPHY	09 Hours
Classification – techniques and applications in column, Ion exchange, Paper and Thin layer chromatography-problems - Gas chromatography and high performance liquid chromatography (HPLC) – principle, Instrumentation and application – problems.		
Module: 3	THERMAL METHODS OF ANALYSIS	09 Hours
Thermal Characterization techniques Principle and applications of Differential Thermal Analysis (DTA), Differentials Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) Thermometric titration - Theory – Instrumentation – Applications – Problems.		
Module: 4	MICROSCOPY ANALYSIS	09 Hours
Atomic absorption Spectroscopy - Instrumentation – Applications - X-ray Methods – Instrumentation — Diffraction pattern — Applications – Crystal Tonography - Surface Characterization Techniques – SEM – TEM – instrumentation – Applications – Problems.		
Module: 5	CHEMICAL ANALYSIS IN INDUSTRIES	09 Hours
Paint analysis – Glass Analysis – Paper and Pulp Analysis - Water analysis - Food analysis - Body Fluid analysis – Chemical Sensors - Experiments - Process - Instruments – Application.		
Total Lectures		45 Hours
Reference Books		
1.	Willard H, Merrit L, Dean J. A. & Settle F.A., “Instrumental methods of chemical analysis”, CBS Publishers and Distributers Pvt. Ltd, New Delhi, 7 th Edition, 1986.	
2.	Skoog D. A, West D. M, Holler F. J & Crouch S. R, “Fundamentals of Analytical Chemistry”, Cengage Learning India Pvt. Ltd, New Delhi, India, 8 th Edition, 2004.	
3.	Day R. A.& Underwood A. L., “Quantitative Analysis”, 6 th Edition, Printice Hall of India Pvt Ltd, New Delhi, 2006.	
4.	Srivatsava A. K. & Jain P. C, “Chemical Analysis”, S. Chand Publications, New Delhi, 3 rd Edition, 1997.	

5.	Chatwal G. R & Anand S. K, "Instrumental Methods of Chemical Analysis", Himalaya Publishing House, Mumbai, India, 5 th Edition, Reprint 2011.
6.	G. Sharma, B K Chaturvedi, Richard E. Wolfe, Basic Analytical Chemistry, DK publishers, 2011.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	MOLECULAR SPECTROSCOPY	L	T	P	C
23CH3017		3	0	0	3

Course Objectives

Enable the student to:

1. Acquire knowledge the basics of spectroscopic techniques.
2. Relate the principle and application of spectroscopic techniques.
3. Apply the spectroscopic techniques in solving problems.

Course Outcomes

Student will be able to:

1. Memorize the principles of spectroscopic techniques.
2. Summarize the unique properties of the different spectroscopy techniques.
3. Identify the technique required for a particular problem.
4. Analyze the samples using the spectroscopy techniques.
5. Predict the nature and properties of molecules using spectroscopy.
6. Utilize the spectroscopic techniques in solving the real level problems.

Module: 1	ELECTRONIC AND MICROWAVE SPECTROSCOPY	9 Hours

Introduction to electromagnetic radiation- Regions of the spectrum, characterization of electromagnetic radiation, Born-Oppenheimer approximation, Electronic spectra of Diatomic Molecules- linear combination of atomic orbitals (LCAO), Molecular term symbols, selection rules for electronic spectra, Franck-Condon principle. Electronic Spectra of polyatomic molecules. Introduction to rotational spectroscopy, Stark effect, rotational spectra diatomic molecules – the rigid diatomic molecule, selection rules for rotational spectra, Effect of isotopic substitution, the non-rigid rotator, Polyatomic molecules- Linear molecules, Techniques and instrumentation and chemical analysis by microwave spectroscopy

Module: 2	VIBRATIONAL AND RAMAN SPECTROSCOPY	9 Hours

Introduction, simple harmonic oscillator, Anharmonic oscillator, Infrared spectroscopy of di- and polyatomic molecules-carbon monoxide, fundamental vibrations of polyatomic molecules and their symmetry, Overtone, combination of bands, Fermi resonance, vibration-rotation spectroscopy, P, Q, R, branches, factors affecting vibrational frequencies, Instrumentation and Applications. Raman spectroscopy- Classical and quantum theories of Raman effect, molecular polarizability, Polarization of light and the Raman effect, Pure rotational Raman spectra- linear, symmetric top and asymmetric top molecules, Vibrational Raman spectra, Mutual exclusion principle, instrumentation and application of Raman spectroscopy.

Module: 4	NMR AND ESR SPECTROMETRY	9 Hours

NMR spectroscopy- introduction, Nuclear magnetic resonance phenomenon, The absorption process, Relaxation process- spin spin relaxation, Spin lattice relaxation, Chemical shift, factors influencing chemical shift, NMR spectra of AX, A₃X and AB systems. ESR spectroscopy – introduction, Theory of g-factor, factors affecting the magnitude of g value, hyperfine coupling, Spectra of simple organic radicals, Spectra of first row transition metals, Zero field splitting, Kramer's degeneracy

Module: 3	MOSSBAUER AND PHOTOELECTRON SPECTROSCOPY	9 Hours

Mossbauer spectroscopy- introduction, principle, Isomer shift, Quadrupole effects, Hyperfine splitting,

Applications of Mossbauer spectroscopy. Photoelectron spectroscopy (PES)-PrinciplePhotoelectron spectroscopy (PES)- instrumentation, Ultraviolet Photo electron spectroscopy (UPS)X- Ray Photo electron spectroscopy (XPS) Auger electron spectroscopy		
Module: 5	FLUORESCENCE SPECTROSCOPY	9 Hours
Flourescence spectroscopy- introduction, principle, instrumentation, Jablonski diagram, Fluorescence, Phosphorescence, Delayed fluorescence, Characteristics of Fluorescence emission, Fluorescence Lifetimes and quantum yields, Fluorescence Quenching, Resonance energy transfer (FRET), Steady state and time resolved Fluorescence		
Total Lectures		45 Hours
Reference Books		
1.	Banwell, C. N, “Fundamentals of Molecular Spectroscopy”, 4 th Edition, Tata McGraw-Hill India Ltd, 2010	
2.	Drago R. S, Physical Methods for Chemists, 2 nd Revised Edition, Saunders (W.B.) Co Ltd.	
3.	SatyaNarayana D. N, “Vibrational Spectroscopy Theory and Applications”, New Age International Publishers, New Delhi, 2004.	
4.	Lakowicz J. R, “Principles of fluorescence spectroscopy”, Springer Science+Business Media, New York, USA, 3 rd Editon, 2006.	
5.	SatyaNarayana D.N., “Magnetic Resonance Spectroscopy ESR, NMR, NQR“, I. K. International, New Delhi, 2009.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	NUCLEAR CHEMISTRY AND SOLID STATE CHEMISTRY	L	T	P	C
23CH3018		3	0	0	3
Course Objectives					
Enable the student to:					
1. Acquire adequate knowledge on the applications of radioisotopes.					
2. Outline the importance of solid state chemistry.					
3. Solve real time challenges through the nanomaterials for various applications.					
Course Outcomes					
Student will be able to:					
1. Describe the basic concepts of nuclear chemistry.					
2. Summarize the applications of radioisotopes.					
3. Relate the band theory of solids.					
4. Classify the various types of solid-state reactions.					
5. Categorize the nanomaterials.					
6. Propose newer coordination polymers and nuclear chemistry					
Module: 1	NUCLEAR CHEMISTRY –I				9 Hours
Atom – History - Nuclear Stability – Factors affecting Nuclear Stability - Nuclear Fission – Nuclear Fusion – fission products and fission yields; Nuclear models – Shell model – Liquid drop model - Types of radioactive decay –Alpha decay – Theory of alpha decay - The tunnel effect - Beta decay – Types of beta decay - Electron capture - Nuclear deexcitation – Artificial radioactivity. Types of nuclear reactions - Elastic and inelastic scattering –Cross section - Q value – Transuraniens - Photonuclear reaction - Radioactive capture - Thermonuclear reactions					
Module: 2	NUCLEAR CHEMISTRY –II				9 Hours

Breeder reactor – Counting techniques: G.M., Ionization and Proportional counter - use of radio isotope in analytical chemistry, isotopic distribution analysis,, dating methods, applications of radio isotopes in agriculture industry and medicine. – Esterification – Friedal Craft’s reaction - Solubility of sparingly soluble substance – Isotope dilution analysis – Carbon dating – Thyroiditis - Assessing the volume of blood in a patient - Brain tumor location - bone fracture healing- Optimum use of fertilizers - Control of predatory insects (SIT).		
Module: 3	SOLID STATE CHEMISTRY - I	9 Hours
Solids – types – crystal structure – defects - Conductivity in ionic solids - Band theory of solids -metals and their properties; semiconductors - extrinsic and intrinsic, - Hall effect; thermoelectric effects (Thomson, Peltier and Seebeck); insulators – dielectric, ferroelectric, pyroelectric and piezoelectric properties, multiferroics – Superconductivity - Magnetic properties: Dia, para, ferro, ferri, and antiferro magnetic types; soft and hard magnetic materials; select magnetic materials - spinels, garnets and perovskites.		
Module: 4	SOLID STATE CHEMISTRY - II	9 Hours
Preparative methods: Solid state reactions, Chemical Precursor methods, co-precipitation, sol-gel metathesis, self-propagating high temperature synthesis, ion exchange reactions, intercalation/deintercalation reactions; hydrothermal and template synthesis, high pressure synthesis. Types of crystal growth method – slow evaporation, slow cooling, gas diffusion method - Powder x-ray diffraction, indexing the powder XRD patterns, Systematic absences, Structure factor		
Module: 5	NANOMATERIALS AND COORDINATION POLYMERS	9 Hours
Nanomaterials – Classification based on dimension - Types –methods of synthesis of inorganic nanomaterials -Top down – High energy Ball milling – microfabrication – Bottom up –CVD – Sol-Gel Method – Synthesis of Metal nanoparticles - Self assembled monolayers - Characterization of nanomaterials – Introduction to XRD, SEM and TEM – Applications – Coordination polymers – classification - examples-Applications.		
Total Lectures		45 Hours
Reference Books		
1.	Arnikaar H. J, “Essentials of Nuclear Chemistry”, New Age International Publishers Ltd., New Delhi, India, 4 th Edition, 2007.	
2.	G. Freindlander, J. W. Kennedy, E.S. Macias, and J. M.Miller, Nuclear and Radiochemistry, John Wiley and Sons, New York, 1991.	
3.	West R, “Solid State Chemistry and its Applications”, Wiley India Pvt. Ltd, New Delhi, India, 2007.	
4.	L. E. Smart and E. A. Moore, Solid State Chemistry - An Introduction, 4 th Edition, CRC Press, 2012.	
5.	H. V. Keer, Principles of the Solid State, 2 nd Edition, New Age International, 2017.	
6.	M. Weller, T. Overton, J. Rourke and F. Armstrong, Inorganic Chemistry, 6 th Edition, Oxford University Press, 2014. (South Asia Edition 2015) .	
7.	Shriver and Atkins, “ Inorganic Chemistry”, Oxford University Press, New Delhi, India, 4 th Edition, 2009.	
8.	Cotton F. A & Wilkinson G, “Advanced Inorganic Chemistry”, 6 th Edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.	
9.	C. P. Poole, F. J. Owens, “Introduction to Nanotechnology”, Wiley-Interscience, 2008.	
10	A.K. Das, D. Mahua, “An Introduction to Nanomaterials and Nanoscience”, CBS Publishers and Distributors, Pvt. Ltd, 2017.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	SUPRAMOLECULAR CHEMISTRY AND GREEN CHEMISTRY	L	T	P	C
23CH3019		3	0	0	3

Course Objectives		
Enable the student to:		
1. Acquire knowledge on new functional systems by combining various chemical elements through non-covalent interactions. 2. Adapt the principles of formation of various types of supramolecular architecture. 3. Explore cost-competitive chemical products by reducing pollution at its source.		
Course Outcomes		
Student will be able to:		
1. Comprehend the fundamental principles governing non-covalent interactions. 2. Develop the skills to design and synthesize supramolecular structures and host-guest systems with specific functionalities. 3. Synthesize and assemble molecular structures of different shapes and dimensions. 4. Construct supramolecular architecture based on solid state & mechanical interlocking concepts. 5. Identify the application of supramolecular chemistry in appropriate fields. 6. Design, practice and recommend greener methodologies in chemical reactions		
Module: 1	BASICS OF SUPRAMOLECULAR CHEMISTRY	9 Hours
Basic concept and principles- History - Terminology – Selectivity – Sensitivity - Lock and key principle - induced fit model – complementarity – Co-operativity - chelate effect – Pre-organization – Non-covalent interactions – Kinetic and thermodynamic selectivity – Binding Constant - Guests in solution – Macrocyclic vs. acyclic hosts – Synthesis of macrocycles (High dilution and Template methods)		
Module: 2	SUPRAMOLECULAR REACTIVITY - BIOMIMETIC SYSTEMS AND ARTIFICIAL RECEPTORS	9 Hours
Introduction - Podands - Cation binding Hosts – Crown ethers - Cryptands – Spherands – Heterocrowns – Biological receptors - ion channels – Anion binding Hosts – Challenges and concepts - Charged receptors – Neutral receptors – Lewis acid receptors – Neutral molecule binding – Calixarenes, cyclodextrins, cucurbituril and dendrimers		
Module: 3	SELF ASSEMBLY AND SUPRAMOLECULAR STRUCTURES	9 Hours
Self-assembly using metal templates – Racks, ladders, and grids – Helicates – Mechanically interlocked molecules- Molecular polygons – Rotaxanes, Catenanes and knots – Borromean rings – Knotaxanes - Self-assembling capsules – Molecular containers – Metal directed capsules – Hydrogen bonded capsules - molecular devices – switches, shuttles - examples of recent developments in supramolecular chemistry		
Module: 4	SOLID STATE SUPRAMOLECULAR CHEMISTRY	9 Hours
Introduction – Zeolites - structure – composition – catalysis. Clathrates – Urea/thioureaclathrates – Trimesic acid clathrates –Hydroquinone and Dianin's compound – Clathrate hydrates - Crystal engineering - Role of hydrogen bonds –Solid state reactivity – Metal organic frameworks (MOF's) – Guest properties of MOF's.		
Module: 5	GREEN METHODOLOGIES	9 Hours
Green Chemistry – Introduction and overview, Principles of Green Chemistry, atom economy, Catalysis: Homogeneous and heterogeneous catalysts, photocatalysts - Designing biodegradable products - Green reaction conditions -Ionic liquids - Supercritical fluids - Fluorous phase reactions - Microwave and Ultrasound assisted reactions - solid-phase organic synthesis - ball milling apparatus - applications of Green chemistry		
Total Lectures		45 Hours
Reference Books		
1.	Jonathan Steed, David Turner, Carl Wallace, Core Concepts in Supramolecular and Nanochemistry, John Wiley & Sons, 2007.	

2.	V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, Second Edition, CRC Press, 2012.
3.	I. Chorkendorff, J. W. Niemantsverdriet, Concepts of Modern Catalysis and Kinetics, Second Edition, Wiley-VCH Publishers, 2007.
4.	P.T. Anastas and J.C. Warner, Green Chemistry, Theory and Practice, Oxford University Press, 2000.
5.	Supramolecular Chemistry: From Biological Inspiration to Biomedical Applications, Peter. J. Cragg, Springer Publishers, 2010.
6.	Crystal engineering using multiple hydrogen bonds, In Structure and Bonding, Ed:Andrew D. Burrows, Vol. 108, 55-96, 2004.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	WATER CHEMISTRY	L	T	P	C
23CH3020		3	0	0	3
Course Objectives					
To enable the student:					
1. Acquire knowledge on the importance of water quality. 2. Infer on the standards for water usage. 3. Evaluate different water treatment processes.					
Course Outcomes					
Student will be able to:					
1. Enumerate the roll and importance of drinking water to health. 2. Apprehend on the control of water borne diseases. 3. Realize the need of purity of water to reduce the transmission of various diseases. 4. Judge the standards of water before supplying to a community. 5. Apply the type of treatment required with respect to water quality. 6. Construct various treatment methods for getting drinking water.					
Module: 1	WATER FOR HUMAN BODY				6 Hours
The Water in You: Water and the Human Body -vital nutrient to cell- role of water -regulating body temperature -water for mineral transportation–digestion- keep mucosal membrane moist- flushing waste-water from saliva-as lubricants in joints-water therapy					
Module: 2	WATER CHEMISTRY				12 Hours
.Dissolved gasses: Factors affecting natural waters. Acid, base, salts: Hydrogen ions, modern concept of pH and buffer. Water analysis: collection and preservation of water samples .Measurement of temperature, transparency, turbidity, determination of pH, electrical conductivity, salinity, chlorinity, total solids (TDS, TSS, TVS, TVDS), dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, Calcium, Magnesium, Inorganic Nitrogen (Ammonium and Nitrate) and phosphorus. Elements, radicals, and compounds –physical and chemical properties-Chemical water analysis Hydrogen ion concentration and pH-Alkalinity- Colloids and coagulation- Organic compounds Organic matter in wastewater- Laboratory chemical analyses. Water Quality Parameters					
Module: 3	DETERMINATION OF WATER QUALITY PARAMETERS				12 Hours
Chemistry of waste water – water pollution, pollutants in water, water quality requirement , potable water standards, wastewater effluent standards principles of determination of water quality parameters like pH, alkalinity, BOD, COD, hardness, lethal doses of pollutants – sulphides, chlorides, Ca, Mg, and analysis of minerals Fe, Mn, Ca, Mg in water. Sources of water – Molecular structure and physical properties –					

Hydrogen Bonding – Water as a solvent – Quality characteristics of water: total acidity and alkalinity, hardness of water – methods of determination of hardness, total solids, disadvantages of using hard water – Comparative account on physical and chemical properties of H ₂ O and D ₂ O. total solids (TDS, TSS, TVS, TVDS),		
Module: 4	WATER QUALITY AND POLLUTION	6 Hours
Properties of pure water, fresh water Quality of surface waters- Water quality in flowing waters -Water quality in stored waters Groundwater quality- Water quality standards- Microbiological quality of drinking water - Chemical quality of drinking water.		
Module: 5	WATER TREATMENT FOR DRINKING PURPOSE	9 Hours
Drinking water or Municipal water – Standard of potable water as per Indian Standard purification of water for domestic use – Removal of suspended impurities – Removal of microorganisms – Methodology in various commercial domestic Water Purifiers (Water Doctor, Auro PureIt, Aqua guard, Kent etc		
Total Lectures		45 Hours
Reference Books		
1.	Engineering Chemistry by Jain and Jain, 16 th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017.	
2.	University Chemistry, B. M. Mahan, R. J. Meyers, 4 th Edition, Pearson, 2009.	
3.	Waste Treatment and Disposal 2 nd Edition Paul T Williams, Wiley, 2005.	
4.	Wastewater Treatment", Rao M.N., Datta A.K., 3 rd Edition, Oxford & IBH Publishing Co. New Delhi, 2008.	
5.	Viessman Jr, Hammer J. M, Perez, E.M, and Chadik, P. A, Water Supply and Pollution Control, PHI Learning, New Delhi, 2009.	
6.	Peavy, H.S., Rowe and Tchobonoglous,,G., “Environmental Engineering”, McGraw Hill, 1985.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	CHEMISTRY FOR ENERGY CONVERSION AND STORAGE	L	T	P	C
23CH3021		3	0	0	3
Course Objectives					
Enable the student to:					
1. Acquire adequate knowledge on definition and importance of energy conversion to form sustainable product. 2. Develop the process of preparation of catalyst for conversion of energy. 3. Explore the energy conversion techniques with solar cell, fuel cell, pyrolysis and gasifier.					
Course Outcomes					
Student will be able to:					
1. Evaluate the fundamental principles of photosynthetic energy conversion. 2. Adopt the appropriate process of catalyst preparation form sustainable materials. 3. Describe the methodology of solar energy system. 4. Explore the mechanism of batteries and fuel cells. 5. Design the pyrolysis model based on temperature. 6. Apply practical skills for function and application different gasifier units.					

Module: 1	PHOTO BIOCHEMISTRY	9 Hours
Chemical potential in energy conserving systems, energy conversion and energy storage in photosynthetic organisms, evolution and physical conditions of photosynthesis, efficiency of photosynthesis, genetic modification of photosynthetic organisms, photo biological hydrogen production. Energy crisis – world and Indian Scenario - Solid waste Management - Conversion devices – Incinerators, gasifiers, digestors.		
Module: 2	CATALYSIS FOR RENEWABLE FUELS	9 Hours
Catalysts – types of catalysis process – Application – homogeneous and heterogeneous catalyst – mechanism of heterogeneous catalyst process - Preparation of homogeneous and heterogeneous catalyst - heterogeneous nano based catalyst – Properties – Application in the field of Energy. Supercapacitor – recent research in catalyst derived from waste materials.		
Module: 3	SOLAR CELLS	9 Hours
Principles for conversion of solar energy to electricity, fundamental calculations and measurement of efficiency of solar cells, different solar cell techniques, photoelectric energy, dye sensitized solar cells, charge separation and transport, new solar cell materials.		
Module: 4	BATTERIES AND FUEL CELLS	9 Hours
Electrochemical processes in different batteries, supercharging of batteries, chemistry of different types of fuel cells, characterization and chemical reactions of phase interfaces in fuel cells, safety and reliability in the utilization of batteries and fuel cells.		
Module: 5	PYROLYSIS AND GASIFIER	9 Hours
Pyrolysis – pyrolysis process based on heating rate – Types – slow, fast and flash method – Properties and Application. Gasification reaction – mechanism of gasification - Types Gasifiers – Fixed bed system – Fluidized bed gasifiers – Downdraft, updraft and crossdraft gasifiers – advantage and disadvantages - Design, construction and operation.		
Total Lectures		45 Hours
Reference Books		
1.	Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.	
2.	Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.	
3.	Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.	
4.	Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.	
5.	Introduction to Biomass Energy Conversions, Sergio C. Capareda, CRC press, Taylor & Francis, 2014.	
6.	Non-Conventional Energy Resources, G.D. Rai, 8 th reprint, Khanna Publisher, 2013.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	APPLIED ELECTROCHEMISTRY	L	T	P	C
23CH3022		3	0	0	3
Course Objectives					
To enable the student:					
1. Observe the basic concepts of electrochemical techniques.					
2. Acquire the knowledge about electrochemical synthesis and electroplating procedures.					
3. Infer the quality on electrochemical power sources.					

Course Outcomes		
Student will be able to:		
1. Recollect the fundamentals of electrochemistry. 2. Relate the principles of electroanalytical techniques. 3. Recognize different electrochemical synthetic routes. 4. Apprehend the concept of electrometallurgy and electroplating procedures. 5. Classify the batteries based on their application. 6. Apply electrochemical principles on efficiency of electrical vehicles.		
Module: 1	FUNDAMENTALS OF ELECTROCHEMISTRY	9 Hours
Electrochemical Cells: Electromotive force - measurement of EMF - the potentiometer – the electrochemical potential - the cell EMF and the cell reaction - reversible cells - types of half cells - classification of cells - the standard EMF of a cell - standard electrode potentials - calculation of the EMF of a cell - Nernst equation and its limitations - calculation of solubility products - standard free energies and entropies of aqueous ions - electrode concentration cells – electrolyte- concentration cells - cells with liquid junctions - oxidation - reduction reactions.		
Module: 2	ELECTROCHEMICAL TECHNIQUES	9 Hours
Current-voltage relationships - mass transfer - diffusion limited currents - kinetic currents - adsorption currents, voltammetry, amperometry, coulometry, Polarography, impedance spectroscopy, cyclic voltammetry, rotating disc electrodes, chronoamperometry, chronopotentiometry, chronocoulometry, conductometric and potentiometric titrations (basic principles and applications only in all the above methods).		
Module: 3	ELECTROCHEMICAL CELLS	9 Hours
Electrochemical cells - components of electrochemical cells- Types of cells - divided and undivided cells - chlor-alkali cells mercury, diaphragm and membrane cells - electro-inorganic chemicals - chlorates, perchlorates - electrosynthesis of fluorine - electro-organic chemicals - electro-reduction of nitro and carbonyl groups - Kolbe synthesis - electrodimerisation - adiponitrile		
Module: 4	ELECTROMETALLURGY AND ELECTROPLATING	9 Hours
Electro winning and electro refining of Cu and Ni, production of aluminium - Hall-Heroult process - Electrolytic production of magnesium and sodium - Electroplating operations - preplating operations - electroplating of nickel and chromium - zinc electroplating - Gold plating - anodizing of Al - electroforming		
Module: 5	ELECTROCHEMICAL POWER SOURCES	9 Hours
Thermodynamic reversibility - Classification of batteries – primary batteries: Dry Leclanche cells, alkaline primary batteries - Secondary batteries: Lead acid, Nickel cadmium, Lithium batteries – High temperature batteries - sodium-sulphur system - Fuel cells – Use of batteries in electric vehicle		
Total Lectures		45 Hours
Reference Books		
1.	John O'M Bockris, Amulya K. N. Reddy, Maria E. Gamboa-Adeco, “Modern Electrochemistry”, Vol.2 Part 1, Springer Science & Business Media, 2000.	
2.	Allen J.Bard, Larry R.Faulkner, “Electrochemical Methods: Fundamentals and Applications”, Second Edition, John Wiley & Sons, 2001.	
3.	Fritz Scholz, “Electroanalytical Methods - Guide to Experiments and Applications”, 2 nd Edition, Springer-Verlag Berlin Heidelberg, 2010.	
4.	Joseph Wang, “Analytical Electrochemistry”, Third Edition, John Wiley & Sons, 2006.	
5.	Jocek Lipkowski and Phil N. Ross, “Electrocatalysis”, John Wiley & Sons, 1998.	
Recommended by Board of Studies		

Approved by Academic Council	25 Aug 2023

Course Code	RESEARCH METHODOLOGY AND IPR	L	T	P	C
23CH3023		3	0	0	3
Course Objectives					
Enable the student to: 1. Acquire knowledge in research methodology and to protect their innovations through IPR regulations. 2. Develop curiosity towards the Chemistry software's & reaction set-up for their wet-lab research. 3. Apply the different research methodologies in solving problems and obtain their IPR.					
Course Outcomes					
Student will be able to: 1. Identify a research problem using the available literature. 2. Analyze the metrics involved in research. 3. Realize the potential applications of chemical software's. 4. Formulate the chemical reaction design, set-ups and technical writings. 5. Create a research problem/proposal/manuscript with the awareness of plagiarism. 6. Recommend the procedure to obtain IPR.					
Module: 1	CHEMICAL LITERATURE	9 Hours			
Chemical/Beilstein abstracts, CAS Number, DOI, Citation Index, Impact Factors, h-index, i10 index, Q1, Q2 rating, Scifinder and Reaxys design, Keyword Text Search, Identification of Research Problems, Scopus, Web of Sciences and SCI Indexing.					
Module: 2	CHEMISTRY SOFTWARES	9 Hours			
Structure Tools, Chemical drawings and Chiral representations, Chems sketch, BioRad, Chemoffice, Chemdraw, 3D representation, DFT calculations, Energy Minimization process, Substructure identifications, Chemical Structures for manuscript (ACS, RSC, Elsevier), Formating. Chemical compounds and Suppliers identification.					
Module: 3	CHEMICAL REACTION DESIGNS	6 Hours			
Dean Stork Reaction set-up, Soxhlet extraction set-up, Barr hydrogenation Apparatus, Karl-Fisher Titrations for moisture content Concept of Rotary evaporator, Flash Chromatography, Distillations, Auto Titrator, Reaction monitoring- dry/wet reaction set-up, Handling hygroscopic compounds. Low Temperature bath (freezing mixture), Anhydrous conditions.					
Module: 4	RESEARCH ETHICS AND TECHNICAL WRITINGS	9 Hours			
Research ethics – Plagiarism, Research Misconduct, Effective literature studies approach and analysis, Effective technical writing, how to write a report, Formate of the Research Paper, Manuscript Review process - Developing a Research Proposal, Format of the research proposal, a presentation and assessment by a review committee.					
Module: 5	INTELLECTUAL PROPERTY RIGHTS	9 Hours			
Nature of Intellectual Property: Patents, Designs, Trade and Copyright - Process of Patenting and Development: Technological research, innovation - Patenting, development. International Scenario: International cooperation WIPO. Procedure for grants of patents, Patenting under PCT- Patent Rights: Scope of Patent Rights. Licensing, Transfer of technology, Commercialization. Patent information and databases. Geographical Indications.					
Total Lectures					45 Hours
Reference Books					
1.	R. Burns, "Introduction to Research Methods", Addison Wesley Longman, Third Edition, 1997.				
2.	C. R. Kothari, "Research Methodology: Methods and Techniques", New- Age International, 2008.				

3.	S.Usharani, "Analytical Chemistry", first Edition, Mcmillan, India Ltd, 2000.
4.	Vogel's Text Book of Practical Organic Chemistry by Furiniss, Harnaford, Smith, Talchall, VII Edition 2010.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	POLYMER SCIENCE IN INDUSTRY	L	T	P	C
23CH3024		3	0	0	3
Course Objectives					
Enable the student to:					
1. Develop knowledge in the classification and mechanism of polymer formation. 2. Summarize the characterization techniques used in polymer chemistry. 3. Realize the applications & importance of industrial safety and management in polymer industry.					
Course Outcomes					
Student will be able to:					
1. Acquire the basic knowledge about polymers. 2. Assess the various polymers, properties and choose the methods for characterizing the polymer. 3. Relate the thermal and mechanical properties of various polymers. 4. Develop various fabrication techniques. 5. Practice and recommend the industrial hygiene and safety. 6. Recognize and practice the industrial safety psychology.					
Module: 1	FUNDAMENTAL CONCEPTS OF POLYMERS	9 Hours			
Polymers - Classification of polymers - functionality- polymers tacticity – naturally occurring polymers – polysaccharides – cellulose and proteins – polymerization reactions – Bio polymers – introduction. Problems based on functionality and Tacticity - Principles and mechanisms of polymerization – Free radical, Ionic, Zeigler-Natta – Types of polymerization - Addition, step growth polymerization and coordination polymerization					
Module: 2	POLYMER WEIGHT DETERMINATIONS	9 Hours			
Polymer stereochemistry – amorphous, crystalline Glass transition melting temperature – viscosity- thermal behaviour of polymers – Tg, Tm and their relationship – elastic effect of polymers-Calculation of Molecular weight and number average in polymers – viscometry analysis – End Group Analysis – Light Scattering techniques					
Module: 3	POLYMER RHEOLOGY	9 Hours			
Introduction to Rheology - Importance of rheology- Injection moulding, Blow moulding, Extrusion Moulding- Rheology of Individual Polymers: polyethylene, propylene, polystyrene, poly vinyl chloride, nylons, , polycarbonates - Inorganic polymers – polyphosphazines - GRA, GRM, GRP, hypalon, Natural Rubber Vulcanization – Compounding – Composites.					
Module: 4	FIBER TECHNOLOGY	9 Hours			
Introduction to fiber Technology - Definition of fibres, Classification and nomenclature of fibres, structure principles of fibre forming polymers, Principles of finishing and dyeing of manmade fibre.- Natural & Synthetic fiber: Introduction, Cotton, Rayon, Cellulose acetate, Wool, Polyamide, Acrylic fibre, Polyethylene terephthalate, Spandex, Glass, Asbestos, - Spinning & Finishing of fiber: Introduction, Melt spinning, Dry spinning and Wet spinning					
Module: 5	INDUSTRIAL HYGIENE, SAFETY & PSYCHOLOGY	9 Hours			

Concept of Industrial safety, Accident causes & prevention, Safety committee and policies - Types of chemical hazards and control, Control techniques, importance for safety inspection, classification of chemicals - Transportation of hazardous chemicals, storage hazards and controls, safety work permit, safety of pipe lines, safe startup & shut down procedures, emergency shut down - Green Chemistry: Principles of green chemistry Psychology In Industry: Causation in behavior. Stress Management. Industrial training. Motivation. Fatigue.	
Total Lectures	45 Hours
Reference Books	
1.	V.R. Gowariker, N.V. Viswanathan, N.V.Jayadev Sreedhar, "Polymer Science", 2012.
2.	G.S. Misra, "Introductory Polymer chemistry", New Age International Pvt. Ltd., 2008.
3.	Anil Kumar and Rakesh K. Gupta, "Fundamentals of polymer engineering" 2018.
4.	R.J. Young, P.A. Lovell, "Introduction to polymers" Stanley Thomas Publishers, London, 2021.
5.	P. Bahadur, "Principles of polymer science", Alpha Science International Ltd., 2 nd Edition, 2019.
6.	Sunil S.Rao & R.K.Jain Industrial Safety, Health and Environment Management Systems, Khanna publishers, 2015.
Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	MEDICINAL CHEMISTRY	L	T	P	C
23CH3025		3	0	0	3
Course Objectives					
Enable the student to:					
1. Memorize the principles underlying to drug design and metabolism.					
2. Elucidate the enzyme structure and comprehend DNA-drug interactions.					
3. Recognize the importance of medicines and diseases.					
Course Outcomes					
Student will be able to:					
1. Comprehend the basic principles of drug metabolism and pharmacokinetics.					
2. Assess the biochemical and physiological effects of drugs through pharmacodynamics.					
3. Build knowledge on the drug design with their classification and their recent developments.					
4. Acquire the importance of various enzyme structure elucidation &DNA-drug interactions.					
5. Analyze the different medicines required for different diseases with respect to their metabolism.					
6. Create a general awareness about the medicines and diseases in the society.					
Module: 1	DRUG DISCOVERY, DESIGN, AND DEVELOPMENT				9 Hours
History of medicinal chemistry, DDD, general mechanism of drug action on lipids, carbohydrates, proteins, and nucleic acids, drug metabolism and inactivation, receptor structure and active sites, drug discovery development, design and delivery systems, gene therapy, and drug resistance.					
Module: 2	DRUG METABOLISM				9 Hours
Introduction, oxidation, reduction, hydrolysis, conjugation, Pharmacokinetics: Drug Absorption, drug distribution, drug elimination (ADME), drug disposition, pharmacokinetic parameters, uses of pharmacokinetics in drug development process, Pharmacodynamics: Enzyme stimulation, inhibition, sulphonamides, membrane-active drug, biotransformation, xenobiotics.					
Module: 3	DRUGS ACTIVITY AND CLINICAL TESTING				9 Hours
Development of new drugs, Procedures followed in drug design, Concepts of lead compound and lead modification, Concepts of pro-drugs and soft-drugs, Factors affecting bioactivity, Resonance, Inductive effect, Isosterism, Bio-isosterism, Spatial considerations. Clinical testing and synthesis of drugs - Various					

phases in preclinical testing and clinical trials –Theories of drug activity: Occupancy theory, Rate theory, Induced fit theory. Quantitative structure-activity relationship (QSAR) - testing drugs in vivo – therapeutic index and therapeutic ratio.		
Module: 4	ENZYME INTERACTIONS AND INHIBITORS	9 Hours
Mechanism, kinetic, spectroscopic, isotopic and stereochemical studies. Chemical models and mimics for enzymes, design, synthesis and evaluation of enzyme inhibitors. DNA-protein interaction and DNA-drug interaction. Concepts of drug receptors. Elementary treatment of drug-receptor interactions. Physico-chemical parameters: Lipophilicity, Partition coefficient, electronic ionization constants. LD-50, ED-5.		
Module: 5	ANTIBIOTICS AND CARDIOVASCULAR DRUGS	9 Hours
Introduction and classification, synthesis uses and side effects of antibiotics (a) penicillin-V (b) penicilline–G (c) cephalosporin - mode of action of penicillin and cephalosporin. Cardiovascular diseases, arteriolar dilators, diuretics, adrenergic receptor blockers, synthesis mode of action, uses and side effects of cardiovascular drugs,		
Total Lectures		45 Hours
Reference Books		
1.	Munendra Mohan Varshney, <u>Asif Husain</u> , A Text Book of Medicinal Chemistry, I.K. International Publishing House Pvt. Limited, 2015.	
2.	D. J. Abraham. Burgers medicinal chemistry and drug discovery, Wiley, 6 th Edition, 2003.	
3.	William O. Foye. Thomas L. Lemice and David A.Williams, Principles of Medicinal Chemistry, Wiley-VCH, 7 th Edition, 2002	
4.	AshutoshKar. Medicinal Chemistry, New Age International, 3 rd Edition, 2005.	
5.	Pandeya, S.N., and Dimmock, J.R., An Introduction to Drug Design, New Age International 2008.	
6.	Abraham, D.J., and Rotella, D.P., Burger's Medicinal Chemistry and Drug Discovery, Vol-1, Edition John Wiley & Sons 7 th Edition, 2010.	
7.	I. Wilson, Giswald and F. Doerge, Text Book of Organic Medicinal and Pharmaceutical Chemistry, J.B. Lippincott Company, Philadelphia, 1971.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	FORENSIC CHEMISTRY FOR CHEMISTS	L	T	P	C
23CH3026		3	0	0	3
Course Objectives					
Enable the student to:					
1. Acquire adequate knowledge on the definition and importance of forensic chemistry. 2. Assess the process of handling the physical evidences. 3. Solve the real time challenges of forensic analysis of blood, hair, explosion, soil, drug and documents.					
Course Outcomes					
Student will be able to:					
1. Acquire adequate knowledge on forensic chemist aspects of blood and semen. 2. Identify the types of explosives and forensic examination. 3. Learn the chemical aspects of hair, fiber and drugs. 4. Categorize the fire accident and arson. 5. Learn the chemistry of soil evidence in crime scene. 6. Recommend innovative solution to the chemistry aspects of document examination.					

Module: 1	BLOOD AND SEMEN	9 Hours
Forensic Chemistry - Introduction - branches - Preliminary screening - presumptive tests - colour and spot tests - Qualitative and quantitative forensic analysis of inorganic and organic material - Nature of Blood – components – sampling, handling and preserving blood samples – Blood clotting – Typing and techniques – evaluation of colour stains in crime scene. Nature of semen – composition of semen- sampling, handling and preserving semen – methods and techniques.		
Module: 2	EXPLOSIVE MATERIALS	9 Hours
Definition - Chemistry of explosives – types of explosives - Dust explosion, Gas/vapour explosion, BLEVE, Effect of blast wave on structures & human. Approach to scene of explosion - post-blast - explosion residue collection - Systematic analysis of explosives and explosion residues in the laboratory using chemical and instrumental techniques- Examples- Profiling and tagging of explosives Interpretation of results.		
Module: 3	HAIR, FIBRE AND DRUGS	9 Hours
Forensic significance of hair – Nature and structure of hair – medulla and cortex – sampling, handling and preserving hair evidence – methods and techniques in examining hair samples Dyes in hair. Fibre – classification sampling and preserving – examining techniques. Analysis of Narcotic Drugs and Psychotropic Substances - classification of NDPS - Forensic examination of NDPS.		
Module: 4	FIRE AND ARSON	9 Hours
Chemistry of Fire, Combustion reaction, Fire Triangle, Fire Tetrahedron - Accelerants & types of accelerants, Combustible and Flammable liquids, Flash point, Fire point, Ignition point, Auto Ignition point, vapour density, vapour pressure, Fire extinguisher. Arson -Analysis of arson residues by conventional and instrumental methods- Documenting the fire or crime scene - Scheme of analysis - Extraction of samples from debris -Clean-up -, Analysis - Interpretation of GC-MS spectra.		
Module: 5	SOIL AND DOCUMENT EXAMINATION	9 Hours
Petrography – classification – composition of soil – examination of soil sample in crime scene – characterization techniques. Chemical aspects of document examination in crime scene – preliminary examination of the document – type of ink - - physical and chemical examination of document – age of document – illegible writing and miscellaneous of document.		
Total Lectures		45 Hours
Reference Books		
1.	James, S. H., Nordby, J. J. and Bell, S “Forensic Science: An Introduction to Scientific and Investigative Techniques”, 4 th Edition, CRC Press, USA, ISBN-10: 9781439853832, ISBN-13: 978-1439853832, 2015.	
2.	Beveridge, A, “Forensic Investigation of Explosions 2 nd Edition, CRC Press, ISBN: 1420087258, 978142008725, 2011.	
3.	Yinon, J. and Zitrin, S, “Modern Methods and Applications in Analysis of Explosives”, John Wiley & Sons, ISBN: 0471965626, 9780471965626, 1996.	
4.	Clarke, “Clarke’s Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids and Postmortem Material” Edited by Moffat, A. C., Osselson, M. D., Widdop, B. and Clarke, E.G.C: 3 rd Edition, Pharmaceutical Press, ISBN: 0853694737, 9780853694731, 2004.	
5.	Almirall, J. R. and Furton, K. G, “Analysis and Interpretation of Fire Scene Evidence”, CRC Press, ISBN: 0203492722, 9780203492727, 2004.	
6.	Detenay, J. D and Icove, J. D, “Kirk’s Fire Investigation”, 7 th Edition, Pearson, 2011, ISBN10: 0135082633, ISBN-13: 978-0135082638, 2011.	
7.	Gough, T. A, “The Analysis of Drugs of Abuse” John Wiley, ISBN: 0471922676, 9780471922674, 2004.	
8.	Elkins, Kelly M, Introduction to forensic chemistry, CRC Press Taylor & Francis Group, 2019.	

9.	Tres, Laura L, Histology and cell biology and introduction to pathology, 4 th Edition, 2016.
Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	INTERNET OF CHEMICAL THINGS	L	T	P	C
23CH3027		3	0	0	3

Course Objectives

Enable the student to:

1. Provide knowledge on chemical resource management.
2. Associate the use of internet in molecular processes.
3. Develop a comprehensive understanding on the challenges in IoCT.

Course Outcomes

Student will be able to:

1. Identify the use of computer programs in chemistry.
2. Asses the importance of internet in chemistry.
3. Utilize the information technology and library resources.
4. Reliaze the IoCT concepts in molecular processes.
5. Apply the knowledge of IoCT in analytical techniques.
6. Solve the problems by implementing IoCT.

Module: 1	COMPUTERS AND CHEMISTRY	9 Hours
Introduction to Computers and Computing - Memory Devices - Secondary Storage - Computer Languages - Number Systems and Some Related Numerical Problems - Operating System- . Principles Of Programming - Algorithms and Flow-Charts - Use of Computer Programmes - Operation of PC - Data Processing - Running of Standard Programs and Packages such as MS WORD - MS EXCELEmpphasis on Calculations and Chart Formations. X-Y Plot.		
Module: 2	INTERNET AND CHEMISTRY	10 Hours
Application of Internet in Chemistry - Search Engines - Information Technology and Library Resources: The Internet and World Wide Web. Web resources - E-Consortium - UGC infonet - E-books - Internet Discussion Groups and Communities - Blogs - Search engines - Scirus - Google Scholar - ChemIndustry - Wiki-Databases - ChemSpider - Science Direct - SciFinder - Scopu s.		
Module: 3	INTERCONNECTION AND NETWORKING OF CHEMICAL MACHINES	10 Hours
Internet of Chemical Things - Interconnection and Networking of Chemical Machines - Computing Devices and all Chemical Services Delivered through the Infrastructure of the Internet - Flow Chemistry – Use of Small Low Powered Computer Systems – Inexpensive Robotic and Computer Applications.		
Module: 4	USE OF IoCT IN MOLECULAR PROCESSES	10 Hours
Use of IoCT in Solvent Choice - Rate of Product Formation - Environmental Impact and Reagent Expense – Increased Data Collection – New Reactivity Schemes – Use of IoCT in Molecular Processes – IR Spectroscopy – Mass Spectroscopy - Remote Operation - Monitoring of Long-Term (Bio)Chemical Reactions –Microbial Fermentation Monitoring - Experimental Conditions.		
Module: 5	CHALLENGES IN IoCT	6 Hours
Safety of Experimenters - Challenges in IoCT- Size – Energy Consumption – Processing Power.		
Total Lectures		45 Hours
Reference Books		

1.	C. J. Cramer, “Essentials of Computational Chemistry” 2 nd Edition, Wiley International, 2005.
2.	C. Hugh, “Using Artificial Intelligence in Chemistry and Biology: A Practical Guide”, CRC Press, 2008.
3.	S. V. Ley, D. E. Fitzpatrick, R. J. Ingham and N. Nikbin, “The Internet of Chemical Things”, Beilstein Magazine, Issue 1, (doi: 0.3762/bmag.2). and references therein, 2015.
4.	S.-H. Chiu and P. L. Urban, “Biosens. Bioelectron.,” 64, 260- 268 and references therein, 2015.
5.	J. R. Dean, A. M. Jones, D. Holmes, R. Reed, J. Weyers and A Jones, “Practical Skills in Chemistry” Pearson Education Ltd., 2002.
6.	G.R.D. Prabhu, H. A. Witeka and P. L. Urban, “Telechemistry: Following Chemical Reactions via Cloud Using the Particle Photon Wi-Fi Module”, Reaction Chemistry & Engineering, 4, 1616-1622, Royal Society of Chemistry (doi: 10.1039/C9RE00043G) and references therein, 2019.
7.	D. A. Skoog, F. J. Holler and S. R. Crouch, “Principles of Instrumental Analysis” 7 th Edition - Cengage International, Boston, 2017.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	WASTE TO ENERGY	L	T	P	C
23CH3028		3	0	0	3
Course Objectives					
Enable the student to: 1. Identify the types of waste materials. 2. Learn the conversion processes to convert waste to energy. 3. Solve the real challenges in biomass, biogas and biodiesel.					
Course Outcomes					
Student will be able to: 1. Acquire adequate knowledge on concept of waste to energy conversion and its properties. 2. Assess the impact of different parameter used in catalyst. 3. Prepare biodiesel and analyze its performance. 4. Design a community biogas plant. 5. Adopt appropriate methods to use in biomass pyrolysis. 6. Develop a small size biomass gasifier.					
Module: 1	INTRODUCTION TO ENERGY FROM WASTE	7 Hours			
Classification of waste materials –Energy crisis – world and Indian Scenario - Solid waste Management - Agro based, Forest residue, Industrial waste – Municipal solid waste – physical and chemical properties-Energy calculation – modified dulong’s formula -Conversion devices – Incinerators, gasifiers, digestors.					
Module: 2	CATALYST FROM WASTE MATERIALS	7 Hours			
Catalysts – types of catalysis process – Application – homogeneous and heterogeneous catalyst – mechanism of heterogeneous catalyst process - Preparation of homogeneous and heterogeneous catalyst - heterogeneous nano based catalyst – Properties – Application in the field of Energy. Supercapacitor – recent research in catalyst derived from waste materials.					
Module: 3	BIODIESEL PRODUCTION	8 Hours			
Bio fuel – advantages and disadvantages – worldwide scenario in bio diesel – oil extraction methods - Waste vegetable oil and animal fat extraction and characterization – fatty acid composition –biodiesel synthesis method - Transesterification – mechanism – ASTM characterization – Gas chromatography analysis method - Application.					

Module: 4	BIOGAS PRODUCTION	7 Hours
Properties of biogas - Calorific value and composition – advantage - Biogas plant technology and status – mechanism in production of biogas from biodegradable wastes - Types of biogas Plants – Fixed and Floating dome method - Applications - alcohol production from biomass as a waste source..		
Module: 5	BIOMASS PYROLYSIS	8 Hours
Pyrolysis – pyrolysis process based on heating rate – Types – slow, fast and flash method – Properties and Application - Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications. current research scenario in pyrolysis product to energy application		
Module: 6	BIOMASS GASIFIER	8 Hours
Gasification reaction – mechanism of gasification - Types Gasifiers – Fixed bed system –Fluidized bed gasifiers – Downdraft, updraft and crossdraft gasifiers – advantage and disadvantages - Design, construction and operation – Application - Bench mark performance parameter.		
Total Lectures		45 Hours
Reference Books		
1.	Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.	
2.	Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.	
3.	Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.	
4.	Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.	
5.	Introduction to Biomass Energy Conversions, Sergio C. Capareda, CRC press, Taylor & Francis, 2014.	
6.	Non-Conventional Energy Resources, G.D. Rai, 8 th reprint, Khanna Publisher, 2013.	
7.	Biogas system: Principles and Application, K.M. Mital, New Age International Private Ltd., New Delhi, 2012.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	COMPUTATIONAL CHEMISTRY AND CHEMINFORMATICS	L	T	P	C
23CH3029		3	0	0	3
Course Objectives					
Enable the student to:					
1. Develop a comprehensive understanding of drug molecular design using computational tools. 2. Elucidate the structure and properties of the molecules using informatics. 3. Enhance the theoretical knowledge of the molecular concepts for AI tool development.					
Course Outcomes					
Student will be able to:					
1. Identify the application of cheminformatics to small molecules. 2. Demonstrate the concepts of data mining. 3. Compare the various computational tools. 4. Apply the cheminformatics tools to determine the properties of molecules. 5. Determine the various parameters of a molecule using computational methods. 6. Utilize the theoretical knowledge on different molecules using different computational tools.					
Module: 1	BASICS OF COMPUTATIONAL CHEMISTRY	9 Hours			

Introduction – tools of computational chemistry – fundamental principles and applications – molecular mechanics: developing a force field – parameterizing – ab initio methods: Hartree SCF method – Hartree-Fock equations – basis sets – types of basis sets and their uses – semi empirical methods – density functional theory: Kohn-Sham approach – molecular dynamics and Monte Carlo Simulations: steps involved – predicting Molecular geometry – constructing a z-matrix.		
Module: 2	DATA MINING	9 Hours
Introduction – types of data – KDD process – data processing: data cleaning – integration – transformation – reduction – summarization – data mining techniques: classification: decision tree – artificial neural network – k-nearest neighbors – Naive Bayes – clustering – association – regression – deviation – data warehousing: multidimensional data model: operations – schemas: star – snowflake – fact constellation – applications of datamining.		
Module: 3	INTRODUCTION TO CHEMINFORMATICS	9 Hours
Development of new drugs, Procedures followed in drug design, Concepts of lead compound and lead modification, Concepts of pro-drugs and soft-drugs, Factors affecting bioactivity, Resonance, Inductive effect, Isosterism, Bio-isosterism, Spatial considerations. Clinical testing and synthesis of drugs - Various phases in preclinical testing and clinical trials –Theories of drug activity: Occupancy theory, Rate theory, Induced fit theory. Quantitative structure-activity relationship (QSAR) - testing drugs in vivo – therapeutic index and therapeutic ratio.		
Module: 4	MOLECULAR DESCRIPTORS AND QSAR	9 Hours
Structural data, Biological data - Molecular Descriptors - Descriptors Calculated from the 2D Structure, Descriptors Calculated from the 3D Representations, Data verification and manipulation. Deriving a QSAR Equation - Simple and Multiple Linear Regression, Designing a QSAR “Experiment”, 3D-QSAR, Nonlinear Models, Model validation, Principal Components Regression, Partial Least Squares, Molecular Field Analysis and Partial Least Squares.		
Module: 5	MACHINE LEARNING	9 Hours
Machine Learning: Definition of learning. Representation and prior knowledge. Neural Networks, Supervised, Unsupervised, and Semi-Supervised Learning, Deep Learning and Linear Regression. Algorithms and Model Selection: Linear Regression, Linear Regression Assessment, Logistic Regression, Naive Bayes; Evaluating and choosing the best hypothesis; Model selection.		
Total Lectures		45 Hours
Reference Books		
1.	Leach A. R. and Gillet J. V., An Introduction to Cheminformatics, New Delhi: Springer. Print, 2009.	
2.	Errol Lewars, Computational Chemistry, New Delhi: Springer, 2008.	
3.	Han J. and Kamber M., Data mining Concepts and Techniques, (2nd Edition), Hariyana: Elsevier India Pvt. Ltd., 2009.	
4.	An Introduction to Chemoinformatics by Andrew R. Leach and Valerie J. Gillet. Springer Publisher, 2010.	
5.	Applied Chemoinformatics - Achievements and Future Opportunities. Edited by Thomas Engel and Johann Gasteiger. Wiley-VCH publisher, 2011.	
6.	E. Alpaydin, 3 rd Edition, Introduction to Machine Learning., MIT Press, 2014.	
7.	P. Baldi, S. Brunak, F.Batch. The Machine Learning Approach –, MIT Press, 2014.	
8.	Leach A. R., Molecular Modelling Principles and Applications, 2 nd Edition, UK: Pearson Education, 2010.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	FORENSIC CHEMISTRY	L	T	P	C
23CH3030		3	0	0	3
Course Objectives					
Enable the student to:					
1. Memorize the methods of analyzing trace amounts of Hydrocarbons in Fire and Arson Cases.					
2. Evaluate the cases involving arson and chemistry of explosives with the help of different analytical methods.					
3. Adapt skills for examination of narcotic drugs, psychotropic substances, and alcoholic beverages.					
Course Outcomes					
Student will be able to:					
1. Associate the petroleum products and their analysis with Fire and Arson Cases.					
2. Describe the conditions for fire and scientific concept of evaluation of clue materials.					
3. Apply the properties and composition of important explosive substances for analysis.					
4. Correlate the characteristics and significance of narcotics, drugs, psychotropic substances, alcoholic beverages with crime cases.					
5. Summarize the testing methods for narcotics, drugs and psychotropic substances.					
6. Infer the importance of analyzing narcotics, drugs, and psychotropic substances.					
Module: 1	PETROLEUM AND PETROLEUM PRODUCTS				9 Hours
Petroleum products: types, by products, uses and importance - Examination of petroleum products: distillation and fractionation-Commercial uses of petroleum - Standard methods of analysis of petroleum products for adulteration -Scope, importance and forensic importance of analysis for the adulterants in petroleum products.					
Module: 2	CASES INVOLVING ARSON				9 Hours
Chemistry of fire - Conditions for fire - Fire scene patterns. Location of point of ignition - Recognition of type of fire - Searching the fire scene - Collection and preservation of arson evidence - Analysis of fire debris - Analysis of ignitable liquid residue - post-flashover burning - Scientific investigation and evaluation of clue materials - Information from smoke staining					
Module: 3	EXPLOSIVES AND ANALYSIS OF CEMENT				9 Hours
Introduction, classification, composition and characteristics - Synthesis and actions of explosives (TNT, PETN and RDX, IED) - Explosion process and affect types of explosions, post blast residue collection - Examination of explosion residues in laboratory (chemical and instrumental).					
Cement, Concrete and Mortar: chemical composition, different type of cements, methods of samplings of cements, mortar and concrete, common adulterant of cement and their detection, Chemical analysis of cement, instrumental method of analysis of by ICP, AAS and XRD					
Module: 4	FORENSIC EXAMINATION OF ADULTERANTS AND TRAP CASES				9 Hours
Dyes: Different type of dyes, role of dyes in crime investigation, food colors (edible and non-edible dyes), and dyes used in cosmetic and pharmaceutical. Chemical and instrumental methods for analysis of dyes.					
Fertilizers: Introduction to fertilizer, different type of fertilizers and classification, substandard and sub-standard adulterated fertilizers, common adulterants. Chemical and Instrumental methods of analysis of fertilizers.					
Trap cases: Introduction and forensic significance, trap chemicals: phenolphthalein and anthracene, mechanism of color reaction, factor affecting the color, detection of phenolphthalein and alkali, method of detection of degraded product on conversion of pink color to colorless solution by TLC and UV visible spectrophotometer; Case studies.					
Module: 5	RELATED LAWS				9 Hours

Relevant provisions of: Explosives Act 1984, (Definition, Powers of Central Govt. and Licensing Authority, Offences and Penalties) and Section 286 of IPC, 1860, (Negligent conduct with respect to explosive substance), Explosive Substances Act 1908, (Definition, Offences and Penalties). Relevant provision of:- Prevention of Food Adulteration Act 1954 (Definition, Power of Food Inspector, Offences and Penalties), Narcotic Drugs & Psychotropic Substances Act 1985 (Definition, Licit Opium Cultivation, Minimum and Commercial Quantity in Narcotic Drugs, Offences and Penalties), Prevention of Illicit Trafficking in NDPS Act 1985 (Detention of a Person Under the Act), Drugs Control Act 1940 (Definition, Power of Chief Commissioner Under the Act), Drugs & Cosmetics Act 1945 (Definition, Adulterated, Misbranded, Spurious Drugs and Cosmetics, Offences and Penalties); Landmark cases.	
Total Lectures	45 Hours
Reference Books	
1.	A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, Scientific Evidence in Civil and Criminal Cases, 4 th Edition. The Foundation Press, Inc., New York, 1995.
2.	B.R. Puri, L.R. Sharma and K.C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi, 2007.
3.	J R Almirall, K G Furton, Fire scene evidence, CRC Press, 2004.
4.	Fred Smith, Jay A. Siegel, Handbook of Forensic Drug Analysis, Elsevier Academic Press, 2004.
5.	F.G. Hofmann, A Handbook on Drug and Alcohol abuse, 2 nd Edition, Oxford University Press, New York, 1983.
6.	W.J. Tilstone, M.L. Hastrup, C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton, 2013.
7.	R. Saferstein, Criminalistics, 8 th Edition, Prentice Hall, New Jersey, 2004.
Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	FORENSIC TOXICOLOGY	L	T	P	C
23CH3031		3	0	0	3
Course Objectives					
Enable the student to:					
1. Locate the minute quantities of narcotics, drugs, and psychotropic substances from crime scenes. 2. Acknowledge the methods of analyzing the drug abuse in sports and contaminants in liquor. 3. Analyze and characterize poisons.					
Course Outcomes					
Student will be able to:					
1. Enumerate the chemical composition and properties of narcotics, drugs, and psychotropic substances. 2. Describe the Issue of Substance Abuse in Sports. 3. Compute the various contaminants present in alcoholic beverages. 4. Infer the analysis of toxicological aspects and poisons. 5. Choose an assessment on the extraction process of drugs from diverse matrices. 6. Speculation of drugs using various methods.					
Module: 1	NARCOTICS, DRUGS AND PSYCHOTROPIC SUBSTANCES				9 Hours
Broad classification – Narcotics, stimulants, depressants and hallucinogens. General characteristics and common example of each classification. Natural, synthetic and semi-synthetic narcotics, drugs and psychotropic substances. Drug addicts and crimes, Tolerance, addiction and withdrawal symptoms of narcotics, drugs and psychotropic substances. Presumptive and screening tests for narcotics, drugs and					

psychotropic substances in breast milk, saliva, urine, hair and antemortem blood. Analysis of narcotics, drugs and psychotropic substances in postmortem blood. Postmortem changes affecting the analysis of narcotics, drugs and psychotropic substances. Collection and preservation of drug evidence, excretion of drugs.		
Module: 2	DRUGS OF ABUSE IN SPORTS	9 Hours
Introduction of drugs of abuse in sports, prohibited classes of substances, prohibited substances in Sport (alcohol and Beta Blockers), in competition (Narcotics, Stimulants, Cannabinoids, Glucocorticosteroids). Dope tests. Introduction of WADA, doping control policies and operational guidelines, identification of sport drugs by Instrumental, techniques such as GC, GC-MS, and HPLC		
Module: 3	ALCOHOLIC BEVERAGES (STUDY AND ANALYSIS)	9 Hours
Introduction, Definition of alcohol and illicit liquor, Alcoholic and non-alcoholic beverages and their composition, Proof spirit, absorption, de-toxication and excretions of alcohol, problems in alcohol cases and difficulties in diagnosis, Alcohol and prohibition, Consequences of drunken driving, Estimation of ethyl alcohol in blood and urine, Analytical techniques in the analysis of alcohol and other articles, Crime scene management in illicit liquor cases.		
Module: 4	BASICS OF TOXICOLOGY AND POISONS	9 Hours
Classification of poisons-Plant Poison, Animal Poison, Metallic Poison, Physico-chemical characteristics and mode of action of poisons. Accidental, suicidal and homicidal poisonings. signs and symptoms of poisoning, mode of action and its effect on vital functions, medico-legal and post mortem examination report/finding studies, specific analysis plan/ approach to toxicological examination of poisoning samples, excretion of poisons, detection of poisons on the basis of their metabolic studies, interpretation of analytical data Animal poisons. Snake venom. Mode of action. Carbon monoxide poisoning. Significance of toxicological findings. Techniques used in toxicology. Toxicological analysis and chemical intoxication tests. Postmortem Toxicology. Human performance toxicology. Dose-response relationship.		
Module: 5	EXTRACTION AND ANALYSIS OF DRUG FROM VARIOUS MATRICES	9 Hours
Methods of extraction of drugs (from all the three major classes) from various matrices including viscera, stomach wash, vomit, urine, blood, suspected drinks/foods; subsequent detection and quantification of extracted drugs from spot test and instrumental methods. Testing of narcotics, drugs and psychotropic substances- thin layer chromatography, gas – liquid chromatography and high performance liquid chromatography.		
Total Lectures		45 Hours
Reference Books		
1.	A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, Scientific Evidence in Civil and Criminal Cases, 4 th Edition. The Foundation Press, Inc., New York, 1995.	
2.	R. Saferstein, Criminalistics, 8 th Edition, Prentice Hall, New Jersey, 2004	
3.	W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher’s , Techniques of Crime Scene Investigation, CRC Press, Boca Raton, 2013.	
4.	F.G. Hofmann, A Handbook on Drug and Alcohol abuse, 2 nd Edition, Oxford University Press, New York, 1983.	
5.	A. Poklis, Forensic toxicology in, Introduction of Forensic Sciences, 2 nd Edition, 1996.	
6.	S.B. Karch, The Pathology of Drug Abuse, CRC Press, Boca Raton. Laboratory procedure Manual, Forensic Toxicology: DFS, 2005.	
7.	Levine Barry, Principles of Forensic Toxicology, 2 nd Edition, 2006.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	INSTRUMENTAL METHODS OF ANALYSIS - I	L	T	P	C
23CH3032		3	0	0	3
Course Objectives					
Enable the student to:					
1. Articulate the fundamental principles of spectroscopy. 2. Analyze the principles underlying vibration and electronic spectroscopy thoroughly. 3. Apply spectroscopic techniques to the field of forensic sciences.					
Course Outcomes					
Student will be able to:					
1. Describe the fundamental principles of atomic spectroscopy. 2. Recognize and comprehend the principles underlying IR and Raman spectroscopy. 3. Apply the principles of electronic spectroscopy effectively. 4. Demonstrate a thorough understanding of the principles of NMR spectroscopy. 5. Anticipate and appreciate the significance of radiochemical methods in forensic science. 6. Utilize the role of electrochemical methods in forensic science to enhance their investigative skills.					
Module: 1	BASIC CONCEPT OF ATOMIC SPECTROSCOPY	9 Hours			
Electromagnetic spectrum, various source of radiation their utility and limitation. Interaction of radiation with matter - Detection of radiation - Forensic application of spectroscopy - Atomic Spectrometry – General properties of Electromagnetic Radiation – Optical Atomic Spectra – Principles, instrumentation, techniques and forensic applications of Atomic Absorption and Atomic Fluorescence Spectrometry – Atomic Emission Spectrometry – Atomic Mass Spectrometry - Atomic X-Ray Spectrometry					
Module: 2	PRINCIPLES OF UV-VISIBLE SPECTROSCOPY	9 Hours			
Absorbance – Beer’s Law – Instrumentation– Molar Absorptivity – Absorbing Species – Application to Qualitative Analysis – Quantitative Analysis – Photometric Titrations – Photoacoustic Spectroscopy – Molecular Luminescence Spectroscopy– Theory of Fluorescence and Phosphorescence – Instrumentation – Applications of Photoluminescence methods –Chemiluminescence					
Module: 3	PRINCIPLES OF IR AND RAMAN SPECTROSCOPY	9 Hours			
FT instruments - Techniques and Applications – Mid IR Absorption, Mid IR Reflection and Photoacoustic IR Spectroscopy – Near and Far IR Spectroscopy – IR Micro Spectroscopy – Forensic Applications of IR Spectroscopic methods- Raman Spectroscopy – Principles – Instrumentation – Techniques - Applications					
Module: 4	PRINCIPLES OF NMR SPECTROSCOPY	9 Hours			
Nuclear Magnetic Resonance Spectrometry – Principles, Instrumentation, Techniques (Proton NMR, Carbon13 NMR, FT- NMR, Magnetic Resonance Imaging) and Forensic Applications					
Module: 5	RADIOCHEMICAL METHODS AND THERMAL METHODS	9 Hours			
Radiochemical Methods – Radioactive Isotopes - Principles, Instrumentation, Techniques and Application of Neutron Activation Analysis and Isotope Dilution Methods -Application of radiochemical techniques in forensic science - Electrochemical techniques: General principles Electron transport process, Principles, instrumentation, techniques and applications of conductometry, potentiometry, coulometry, polarography and ion selective electrodes					
Total Lectures					45 Hours
Reference Books					

1.	P.W. Atkins, "Physical Chemistry", 8 th Edition, Oxford University Press, 2006.
2.	James W. Robinson, "Atomic Spectroscopy, 2 nd Edition. Revised & expanded, Marcel Dekkar, Inc, NY, 1996.
3.	Haswell, S. J. "Atomic Absorption Spectrometry", Elsevier, ISBN: 9780444882172, 1991.
4.	Barrow, G. M, "Introduction to Molecular Spectroscopy", McGraw-Hill Inc., USA, ISBN-10: 0070038708, ISBN-13: 978-0070038707, 1988.
5.	R. M. Silverstein, F. X. Webster, D. J. Kiemle, "Spectrometric identification of organic compounds", 7 th Edition, John Wiley, 2005.
6.	Skoog D. A, West D. M, Holler F. J & Crouch S. R, "Fundamentals of Analytical Chemistry", Cengage Learning India Pvt. Ltd", New Delhi, India, 8 th Edition, 2004.
7.	Day R. A. & Underwood A. L., "Quantitative Analysis", 6 th Edition, Printice Hall of India Pvt Ltd, New Delhi, 2006.
8.	James W. Robinson, "Atomic Spectroscopy, 2 nd Edition. Revised & expanded, Marcel Dekkar, Inc, NY, 1996.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	NANOMATERIAL SYNTHESIS AND CHARACTERIZATION	L	T	P	C
23CH3033		3	0	0	3
Course Objectives					
Enable the student to:					
1. Acquire the knowledge on nanomaterials synthesis.					
2. Analyze the nanomaterials using different characterization techniques.					
3. Utilize the nano sized materials for various applications.					
Course Outcomes					
Student will be able to:					
1. Describe the major classes of nanomaterials and their relevant chemistry.					
2. Asses the relationships among structure & composition, physical & chemical properties of nanomaterials.					
3. Analyze the sustainability of nanomaterial processing and applications.					
4. Apply appropriate laboratory techniques to process nanomaterials and determine their properties.					
5. Recommend new methods of synthesis and characterization of nanomaterials.					
6. Create application based innovative nanomaterials.					
Module: 1	INTRODUCTION OF NANOMATERIALS				9 Hours
Introduction: Nanoscale Science and Technology-Implications for Physics, Chemistry, Biology and Engineering; Classifications of Nanostructured materials, nano particles; Zero-dimensional, one-dimensional and two-dimensional nanostructures, size dependent properties – quantum confinement – optical properties - specific heat and melting point- mechanical properties – super plasticity - plastic deformation of ceramics - nanoceramics - catalytic properties.					
Module: 2	SYNTHESIS OF NANOMATERIALS				9 Hours
Synthesis of nanomaterials - bottom-up and top-down approaches - nanoparticles - colloidal technique - homogeneous and heterogeneous nucleation - synthesis of metallic and semiconductor nanoparticles - stabilization of nanoparticles - sonochemical method-synthesis and properties of core-shell nanoparticles. Nanowires and nanorods - spontaneous growth - vapor-liquid-solid growth – template-based synthesis – nanostructured films - self-assembly - molecular self-assembly in solutions – self assembly of nanoparticles - Langmuir-Blodgett films - electrochemical deposition. Synthesis of bulk nano structured materials - Sol Gel processing- bulk and nano composite materials - Grinding - high energy ball milling – injection moulding					

extrusion - melt quenching and annealing. Preparation methods: Bottom-up Synthesis-Top-down Approach: Precipitation, Mechanical Milling, Colloidal routes, Self-assembly, Vapor phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.		
Module: 3	ONE DIMENSIONAL AND TWO DIMENSIONAL NANOSTRUCTURES	9 Hours
Nanowires and Nanotubes: Evaporation-condensation - Vapor- liquid - solid (VLS) - surface and bulk diffusion – kinetics – growth of various nanowires –control of size –precursors and catalysts - single- and multi- wall CNT - Si nanowires – density and diameter – doping in nanowires - Carbon nanotube (CNT) and its Applications: Carbon nanotube (CNT), structure of CNT, synthesis and functionalization of CNT, electronic, vibrational, mechanical and optical properties of CNT; applications of CNT and Fullerenes. - Graphene and its Functionalization: Graphene, structure of Graphene, synthesis and functionalization of Graphene, electronic application of Graphene, Electrochemical deposition, Graphene Oxide. Fullerenes - graphene - carbon nanotubes (CNTs) - SWCNT- MWCNT – synthesis - prospects of all-CNT nanoelectronics.		
Module: 4	ADVANCED CHARACTERIZATION OF NANOMATERIALS	9 Hours
Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy, Optical Absorption and Emission Spectroscopy, Thermogravimetric Analysis, Differential Scanning Calorimetry, Thermo mechanical Analysis, X-Ray, neutron diffraction. interpretation of results of – XRD – XPS - AES – EDS - SEM - STM – AFM – TEM - HRTEM - BET surface area and porosimetry - UV-Vis - FTIR and Raman spectroscopy - Thermal analysis – TGA, DTA and DSC.		
Module: 5	APPLICATIONS OF NANOMATERIALS	9Hours
Dimension, Size and Shape based Applications –Energy materials – Biological and Environmental Applications – Nanomaterials in Healthcare - Nanomaterials for Day-to-day applications.		
Total Lectures		45 Hours
Reference Books		
1.	W. Gaddand, D. Brenner, S. Lysherski and G. J. Infrate (Eds), Handbook of nanoscience, Engg. and Technology, CRC Press, 2002.	
2.	G. Cao, Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperical College Press, 2004.	
3	J. George, Preparation of thin films, Marcel Dekker, InC., New York, 2005.	
4	C. N. R. Rao, A. Muller, A. K. Cheetham (Eds), The chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag Gmbh & Co, Weinheim, 2004.	
5	S. Subramony & S.V. Rotkins, Applied Physics of Carbon Nanotubes: Fundamentals of Theory, Optics And Transport Devices.	
6	CNR Rao and A Govindaraj, Nanotubes and Nanowires- RCS Publishing.	
7	Bergmann and Machado, Carbon Nanomaterials for Environmental and Biological Applications, Springer.	
8	Charles P Poole & Frank J. Ownes. Introduction to Nanotechnology.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	FORENSIC CHEMISTRY LAB	L	T	P	C
23CH3034		0	0	3	2
Course Objectives					

Enable the student to: 1. Identify liquors and corrosive chemicals from the crime scenes. 2. Administer the drug tests. 3. Deduce the techniques of explosives detection.	
Course Outcomes	
Student will be able to: 1. Recognize the importance of detection of drugs. 2. Differentiate inorganic explosives from organic explosives. 3. Apply the knowledge to detect organic explosives. 4. Evaluate the melting point of various substances. 5. Assess corrosive chemicals. 6. Develop novel analytical process to detect dyes and pigments.	
List of Experiments	
1. Detection of methanol, chloral hydrate and alprazolam in alcoholic liquors. 2. Extraction and detection of inorganic explosive / explosion residues by spot tests. 3. Extraction and detection of inorganic explosive / explosion residues by colour tests. 4. Extraction and detection of organic explosive / explosion residues by spot tests. 5. Extraction and detection of organic explosive / explosion residues by colour tests and TLC. 6. Analysis of Phenolphthalein in trap cases. 7. Analysis of forensically important cosmetics. 8. Analysis of Dyes, Pigments & Polymers. 9. Forensic analysis of oils and fats. 10. Analysis of chemical fertilizers, consumer items such as gold, silver, tobacco, tea, sugar, salts. 11. Analysis of Corrosive chemicals: Hydrochloric acid, sulphuric acid, and nitric acid and alkalis. 12. Detection of Narcotic Drugs and Psychotropic Substances (NDPS) eg. Opiates, barbiturates, benzodiazepines, amphetamines and cannabis by spot / colour tests. 13. Forensic Drug Testing by Color/spot test, Microcrystalline testing. 14. Melting Point determination of some substances of forensic interest. 15. Forensic analysis of arson related evidences. 16. Characterization and analysis of adulteration of Petroleum products. 17. Systematic analytical approach to pre-blast and post-blast explosives (Minimum 10 experiments to be conducted)	
Reference Books	
1.	Thomas Catalano, Good Laboratory Practices for Forensic Chemistry, Springer, 2014.
2.	Petraco, N and Kubic, T. "Forensic Science Laboratory Manual and Workbook", 3 rd Edition, CRC Press, 2009.
3.	Frank Lundquist, Methods of Forensic Science, Vol. 1, New York, Interscience, 1962.
4.	Frank A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, Upper Saddle River, 1997.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	ADVANCED FORENSIC CHEMISTRY	L	T	P	C
23CH3035		3	0	0	3
Course Objectives					
Enable the student to: 1. Assess the scope of forensic chemistry in crime investigation. 2. Summarize the methods of extraction of chemicals from various matrices. 3. Apply the relevant techniques for evidence analysis.					

Course Outcomes		
Student will be able to: 1. Determine the various types of explosives. 2. Discuss fire chemistry and analysis of arson evidences. 3. Interpret the investigation methods and techniques for analysis of trap cases. 4. Evaluate the principles of beverages analysis. 5. Conclude the adulterations in fertilizers, beverages and petroleum products in order to assist investigation. 6. Prepare the relevant procedures in order to apply for analysis of adulterated samples.		
Module: 1	EXPLOSIVES	9 Hours
Classification, improvised explosive devices, Analysis of pre-blast or unexploded material- bulk analysis; Analysis of post-blast or exploded material- trace analysis, Identification of low explosives- color tests, instrumental analysis. Identification of primary high explosive (initiator composition) and secondary high explosive (main charges)- color tests and instrumental analysis.		
Module: 2	FIRE DEBRIS ANALYSIS	9 Hours
Introduction to Arson, Chemistry of fire, Classes of fire, Phases of combustion, Examination of scene of fire, sample selection, Burn pattern, Electronic sniffers, Detectors used in sample selection, Sample Removal (direct and indirect), Packaging, methods of extraction from exhibit, direct extraction, distillation and micro diffusion methods, analysis of arson exhibits by color test, TLC, Head-space GC and GC-MS. Case studies.		
Module: 3	FORENSIC EXAMINATION OF ADULTERANTS AND TRAP CASES	9 Hours
Dyes: Different type of dyes, role of dyes in crime investigation, food colors (edible and non-edible dyes), and dyes used in cosmetic and pharmaceutical. Chemical and instrumental methods for analysis of dyes. Fertilizers: Introduction to fertilizer, different type of fertilizers and classification, substandard and sub-standard adulterated fertilizers, common adulterants. Chemical and Instrumental methods of analysis of fertilizers. Trap cases: Introduction and forensic significance, trap chemicals: phenolphthalein and anthracene, mechanism of color reaction, factor affecting the color, detection of phenolphthalein and alkali, method of detection of degraded product on conversion of pink color to colorless solution by TLC and UV visible spectrophotometer; Case studies.		
Module: 4	ANALYSIS OF CEMENT AND PETROLEUM PRODUCTS	9 Hours
Cement, Concrete and Mortar: chemical composition, different type of cements, methods of samplings of cements, mortar and concrete, common adulterant of cement and their detection, Chemical analysis of cement, instrumental method of analysis of by ICP, AAS and XRD Petroleum Products: Introduction, Analysis of petroleum products and residues: Distillation and fractionation, Adulteration of petroleum products, Comparison of petroleum products, Analysis of traces of petroleum products in forensic exhibits, characterization of petroleum products by flash point, aniline point, cloud point, pour point, GC & GC-DHA.		
Module: 5	ACTS RELATED TO ADULTERATION, DRUGS AND EXPLOSIVES	9 Hours
Relevant provisions of: The Poisons Act, 1919. Explosives Act 1984, (Definition, Powers of Central Govt. and Licensing Authority, Offences and Penalties), Explosive Substances Act 1908, (Definition, Offences and Penalties).		

Relevant provision of:- Prevention of Food Adulteration Act 1954 (Definition, Power of Food Inspector, Offences and Penalties), Narcotic Drugs & Psychotropic Substances Act 1985 (Definition, Licit Opium Cultivation, Minimum and Commercial Quantity in Narcotic Drugs, Offences and Penalties), Prevention of Illicit Trafficking in NDPS Act 1985 (Detention of a Person Under the Act), Drugs Control Act 1940 (Definition, Power of Chief Commissioner Under the Act), Drugs & Cosmetics Act 1945 (Definition, Adulterated, Misbranded, Spurious Drugs and Cosmetics, Offences and Penalties);	
Total Lectures	45 Hours
Reference Books	
1.	Daeid, N. N. Fire investigation. CRC Press, 2004.
2.	Lentini, J. J. Scientific protocols for fire investigation. CRC press, 2006.
3.	Garratt, D. C. The quantitative analysis of drugs. Springer Science & Business Media, 2012.
4.	Howard, J., & McKague, A. B. A fire investigation involving combustion of carpet material. Journal of Forensic Science, 29(3), 919-922, 1984.
5.	Parikh C.K; Text Book of Medical Jurisprudence Forensic Medicines and Toxicology. CBS Pub. New Delhi, 1999.
Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	GLASS FORENSIC SCIENCE	L	T	P	C
23CH3036		3	0	0	3
Course Objectives					
Enable the student to:					
1. Acquire knowledge on the composition of glass & techniques to determine the glass fractures. 2. Analyze the composition of glass by various techniques. 3. Examine the quality of the glass in practical studies.					
Course Outcomes					
Student will be able to:					
1. Examine the history of glasses in forensic field. 2. Assess the glass fracture examination. 3. Investigate glass densities and recovery of glass pieces. 4. Select appropriate instruments for analyzing the glass and complex mixture. 5. Analyze various study of glass by using spectroscopic techniques. 6. Recommend novel procedure on forensic glass detection.					
Module: 1	FUNDAMENTAL OF GLASS AND ITS HISTORY	9 Hours			
Glass – introduction – composition – types – history of glass – Properties of glass (optical and Non Optical) – Physical, Chemical, Optical properties - Glass and it heat response – Laboratory glass – Distillation (Ancient (Greek & Arabic) – present – Future) – Forensic Glass and its various tests					
Module: 2	GLASS FRACTURES AND ITS ANALYSIS	9 Hours			
Glass Fractures – Types (Compressive, Tensile, Shear) – Characteristic of Glass Fractures - Industrial (Tempered – Windshield Glass- Laminated) – Laboratory (Borosilicate – Soda- Lead) – Analysis of various Hardness of Glass – Forensic Examination of Glass fractures with simple case studies.					
Module: 3	GLASS EVIDENCE AND INVESTIGATION	9 Hours			

Glass density tests (Window, Pyrex, Leaded) – Gun Shot – Windshield Glass fragments – Glass (Evidence) collection of glass evidence (Recovery from Dry and Wet cloths) - Analysis of fragments – Direction of Force - 3R Rules (Radial Fracture, Right Angle, Reverse side of force) – Case studies.		
Module: 4	SPECTROSCOPIC STUDIES ON GLASS	9 Hours
Refractive index – Becke Line – Color – Elemental Analysis (Semi Quantitative Techniques – Xray Fluorescence, Scanning Electron Microscopy – Quantitative Techniques – Flameless Atomic Absorption spectroscopy – Oil Immersion Method – Emmons.		
Module: 5	SPECIAL TYPES OF GLASS IN FORENSIC MEDICAL FIELD	9 Hours
Application and properties of Bullet Proof glasses – Swap Test Glasses (Polymeric) – Glass ceramic – Glass fibre – Chromatic Glasses – Optical glass – Float glass (Gorilla Glass) – Case studies based on bullet proof glasses and Swap test glasses.		
Total Lectures		45 Hours
Reference Books		
1.	Brooke Weinger Kammrath , Andrew C. Koutrakos , Meghan E. McMahon, John A. Reffner. The Forensic Analysis of Glass Evidence: Past, Present, and Future, Wiley - VCH Verlag GmbH & Co. KGaA, 2016.	
2.	Jay. A. Seigel, Forensic science – Fundamentals and applications -, Wiley Blackwell, Academic press. 2012.	
3.	Khan, JaVed, Kennedy Thomas, Basic Principles of Forensic Chemistry, Springer 2012.	
4.	Forensic Examination of Glass and Paint: Analysis and Interpretation (Taylor & Francis Forensic Science Series) Edited by Brian caddy, 2012.	Forensic
5.	Jay. A. Seigel, Karthy Mirokovits. The third Edition of Forensic science – basics - Wiley Blackwell, 3 rd Edition, CRC press, 2016.	
6.	Forensic Interpretation of Glass Evidence- James Michale Curran – Tacha Natalie – John S. Buckleton, Taylor and Francis, 2014.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	CHROMATOGRAPHY	L	T	P	C
23CH3037		3	0	0	3
Course Objectives					
Enable the student to:					
1. Recognize the importance of various chromatographic techniques in chemistry. 2. Relate the principles of different separation techniques for various molecules. 3. Apply the respective chromatography techniques for compound purification.					
Course Outcomes					
Student will be able to:					
1. Illustrate the principles of chromatographic techniques. 2. Distinguish between different chromatographic techniques. 3. Apply the appropriate technique for separation of complex compounds. 4. Identify the exact chromatography technique to purify the synthesized compound. 5. Interpret the chromatogram obtained from various techniques. 6. Familiarize the chromatography skills in the laboratory.					

Module: 1	COLUMN CHROMATOGRAPHY	9 Hours
Polarity, Functional groups related polarity- Thin Layer Chromatography – Column chromatography – Silica gel Mesh- TLC applicator - Column Volume - repopole applications in chemical analysis- Applications of Column Chromatography.		
Module: 2	GAS CHROMATOGRAPHY	9 Hours
Introduction to gas Chromatography- Theory –Working Principles — Instrumentations- Detectors-Columns- Components of GC- GC for volatile substances – Applications of GC.		
Module: 3	LIQUID CROMATOGRAPY	9 Hours
Introduction to HPLC Chromatography- Theory –Working Principles Pumps, Injection portal, Column chemistry- Method developments–Detectors– Instrumentations- – Applications of HPLC. UHPLC and UPLC		
Module: 4	SUPER CRITICAL FLUID CHROMATOGRAPHY	9 Hours
Introduction of SFC- Theory- Principles of SFC, Instrumentations- CO2 as carrier Phase- Preparative approach- Method development and cost estimation-Components of SFC-Application of SFC		
Module: 5	FLASH CHROMATOGRAPHY	9 Hours
Introduction of Flash Chromatography- Semi-Preparative Approach- Theory- Principles of FC, Instrumentations- Four Solvent Systems- Detector-ELSD- Method development and translations – Fractional Collector- Flash Cartridges – Solvent and Time benefits -Components of FC-Application of FC.		
Total Lectures		45 Hours
Reference Books		
1.	Chatwal G. R &Anand S. K, “Instrumental Methods of Chemical Analysis”, Himalaya Publishing House, Mumbai, India, 5 th Edition, Reprint 2011.	
2.	G. Sharma, B K Chaturvedi, Richard E. Wolfe, Basic Analytical Chemistry, DK publishers, 2011.	
3.	Skoog D. A, West D. M, Holler F. J & Crouch S. R, “Fundamentals of Analytical Chemistry”, Cengage Learning India Pvt. Ltd, New Delhi, India, 8 th Edition, 2004.	
4.	Srivatsava A. K. & Jain P. C, “Chemical Analysis”, S. Chand Publications, New Delhi, 3 rd Edition, 1997.	
5.	Willard H, Merrit L, Dean J. A. & Settle F.A., “Instrumental methods of chemical analysis”, CBS Publishers and Distributers Pvt. Ltd, New Delhi, 7 th Edition, 1986.	
6.	Valcarcel, Miguel, Principles of Analytical Chemistry, Springer, 2000.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	BIOORGANOMETALLIC CHEMISTRY	L	T	P	C
23CH3038		3	0	0	3
Course Objectives					
Enable the student to: 1. Summarize the importance of bioorganometallic chemistry. 2. Describe the structure and function of bioorganometallic systems. 3. Examine the importance of bioorganometallics in medicinal chemistry.					
Course Outcomes					
Student will be able to: 1. Define the bioorganometallic complexes. 2. Identify the role of organometallic compounds in catalysis. 3. Analyze the factors affecting the catalysis.					

4. Recognize the importance of hydrogen energy.		
5. Evaluate the synthesized compounds for specific application.		
6. Apply the role of bioorganometallic complexes in medicinal chemistry.		
Module: 1	INTRODUCTION	9 Hours
Bioorganometallic chemistry – Definition – Examples - Proteins – Aminoacids – Vitamin B12 and its coenzymes –Structure - Coenzyme B12 dependent enzymes – Methyl cobalamin – catalysis – Mechanism – Homolysis – Heterolysis - Electrochemistry		
Module: 2	MODEL COMPLEXES OF VITAMIN B12 BASED ENZYMES	9 Hours
Model complexes – Vitamin B12 model complexes – Cobaloximes and other model complexes — Preparation – Characterization - Cis influence – trans influence – Catalysis - Applications – Tuning the catalyst – Organic transformation - Hydrogen production – Chain transfer catalyst		
Module: 3	THE BIOORGANOMETALLIC CHEMISTRY OF HYDROGENASE	9 Hours
Hydrogenase – Significance Types – [FeFe] Hydrogenase – [FeNi] Hydrogenase – [Fe] Hydrogenase – Active sites - Mechanism – Model complexes - Dihydrogen metal complexes		
Module: 4	BIO-ORGANOMETALLIC SYSTEMS FOR THE HYDROGEN ECONOMY	9 Hours
Introduction –Electrocatalysis - Electrode Materials for Hydrogen Evolution and Uptake – covalent attachment of catalyst to the electrode surface – Non-covalent attachment of a catalyst – Photocatalysis – Photocatalysts - Light driven system for hydrogen economy – Photoelectrodes - Examples – Iron based catalysts – Nickel based catalysts – Molecular based photocatalysts		
Module: 5	MEDICINAL PROPERTIES OF ORGANOMETALLIC COMPOUNDS	9 Hours
Organometallic pharmaceuticals - Anticancer and antimalarial drugs - Ruthenium complexes – Metallocene complexes – Half sandwich complexes - Tuning the activity of the catalyst		
Total Lectures		45 Hours
Reference Books		
1.	Advances in Bioorganometallic chemistry – Edited by Toshikazu Hirao and Toshiyuki Moriuchi, Elsevier, 2019.	
2.	Topics in Organometallic Chemistry, Vol-17- Bioorganometallic chemistry, Edited by G. Simonneaux, Springer-Verlag Berlin Heidelberg, 2006.	
3.	Bioorganometallic Chemistry- Applications in Drug Discovery, Biocatalysis, and Imaging, Edited by G. Jaouen and M.Salmain, Wiley-VcH-2015.	
4.	Bioorganometallics: Biomolecules, Labeling, Medicine, Edited by G. Jaouen, Wiley-VCH Verlag GmbH & Co, 2005.	
5.	A. L. Noffke, A. Habtemariam, A. M. Pizarro and P. J. Sadler, Designing organometallic compounds for catalysis and therapy, Chem. Commun. 2012, 48, 5219-5246, Royal Society of Chemistry, 2012.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	CHEMISTRY OF CARBENES	L	T	P	C
23CH3039		3	0	0	3
Course Objectives					
Enable the student to:					

1. Acquiring knowledge on generating carbene intermediates. 2. Assess the reactions of metal carbenoids. 3. Realize the applications of inorganic carbenes in organic transformations.		
Course Outcomes		
Student will be able to:		
1. Outline the preparation of carbene intermediate. 2. Elucidate the use of diazo compounds as precursor for metal carbenoids. 3. Demonstrate the reactions of metal carbenoids in insertion reactions. 4. Predict the cycloaddition and sigmatropic reactions of metal carbenes. 5. Illustrate the synthesis of NHC 6. and its application in organic transformations. 7. Realize the application of organometallic carbene in organic transformations.		
Module: 1	INTRODUCTION TO CARBENES AND CARBENOIDS	9 Hours
History, structure of carbene, 1,2-elimination, singlet and triplet, Reimer-Tiemann reaction, diazomethane preparation, from diazald, Esterification and methylation with CH ₂ N ₂ , Reaction of carbene with pyrrole, Ethyl diazoacetate from glycine ester, Regitz synthesis of diazo compound, Bamford Steven reaction. Wolf rearrangement and Arndt-Eistert reaction		
Module: 2	REACTIONS OF METAL CARBENOIDS - I	9 Hours
Insertion reactions of metal carbenoids, C-H insertion, intramolecular C-H insertion, mechanism, O-H insertion, N-H insertion, S-H insertion, Si-H insertion, cyclopropanation, cyclopropenation, reaction with aromatic ring		
Module: 3	REACTIONS OF METAL CARBENOIDS - II	9 Hours
1,2 sigmatropic rearrangement and 2,3 sigmatropic rearrangement, intramolecular sigmatropic rearrangement, reaction of metal carbenoids with ketone, carbonyl ylide, 1,3-dipolar cycloaddition, intramolecular 1,3-dipolar cycloaddition, applications in synthesis of complex molecules		
Module: 4	HETEROCYCLIC CARBENES	9 Hours
Preparation and reactions – Imidazole based NHC, Thiazole based NHC preparation, Benzoin reaction, Stetter reaction applications and advantages over KCN, Intramolecular Stetter reaction. NHC based metal catalyst and their applications in organic transformations		
Module: 5	METAL CARBENES	9 Hours
Grubb's catalyst-first and second generation catalyst, structure, ene metathesis, enyne metathesis and applications in macrolide synthesis- Tebbe reagent- Reaction with ester and amide, enol ether and enamine synthesis, Fischer carbene and Schrock carbenes, synthesis and reactions, metal carbynes from Fischer carbene.		
Total Lectures		45 Hours
Reference Books		
1.	J. March. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 4 th Edition, Wiley Student Edition, John Wiley & Sons Asia Pvt. Ltd., 2005.	
2.	Carey, F.A, and Sundberg. R. J, "Advanced Organic Chemistry Part – B: Reactions and Synthesis", Plenum Press, 2008.	
3.	Clayden, J; Greeves, N; Warren, S. Organic Chemistry, 2 nd Edition, Oxford University press, 2012.	
4.	Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4 th Edition, 2009.	
Recommended by Board of Studies		

Approved by Academic Council	25 Aug 2023

Course Code	FORENSIC SCIENCE AND CRIMINAL JUSTICE SYSTEM	L	T	P	C
23FS3001		3	0	0	3

Course Objectives

Enable the student to:

1. Recall the fundamental principles and scope of forensic science.
2. Identify the significance of forensic science in the deliverance of justice.
3. Deduce the role of forensic establishments in India.

Course Outcomes

Student will be able to:

1. Enumerate the scope of forensic science.
2. Summarize the fundamentals and principles of forensic science.
3. Interpret the role of criminology in forensic investigation.
4. Correlate penology with forensic science.
5. Assess the importance of criminal justice system.
6. Validate the recent advancements in Forensic science.

Module: 1	INTRODUCTION TO FORENSIC SCIENCE	9 Hours

Forensic Science – Introduction – History - The Role of the Forensic Laboratory, History and Development of Forensic Science in India & Abroad, Pioneers in Forensic Science, Multidisciplinary nature. Qualifications and duties of Forensic Scientists Ethical issue in Forensic Science: Definition of ethics, professional standards for practice of Criminalistics, sanction against expert for unethical conduct. Administration and Organizational Setup: DFSS, CFSL, GEQD, SFSL, RFSL, MFSL, FPB, NICFS, CDTs, NCRB, BPR&D, Academic centres of education and research: Indian and Academy of Forensic Science, American Board of Forensic Odontology, Interpol and FBI, Australian Academy of Forensic Sciences.

Module: 2	PHYSICAL EVIDENCE	9 Hours

Physical evidence and Locard's exchange principle – Classification of physical evidence - Role of Forensic Science in crime investigation - Crime scene – Types - Processing of crime Scene - Chain of custody - Probative value of physical evidence - Reconstruction of scene of crime - Investigation of crime- Modus operandi – Court Testimony – Introduction - Admissibility of expert testimony - Expert and lay witnesses – Giving testimony as an Expert

Module: 3	CRIMINOLOGY	9 Hours

Sociology – Introduction – Sociological causes of crime – Relation of sociology to other sciences Criminology – Introduction – Scope of Criminology – Concept and definition of crime – Criminal behaviour - Types of crimes – Schools of Criminology – Causes of crime – Juvenile delinquency - Criminal profiling Penology – Theories of punishment – Types of punishments – Capital punishment – Prisons and correctional institutions –Objectives – Administration – Functioning and limitations

Module: 4	CRIMINAL JUSTICE SYSTEM	9 Hours

Criminal Justice system in India – Introduction – Administration of civil and criminal justice – Hierarchy of courts – Powers of courts – Types of courts – Lok Ayukta system The structure of Police organizations in India – Functions and duties of police – Investigation of crimes and prosecution – Cognizable and Non-cognizable offences - Powers of police to search, seize and arrest – Role and responsibilities of prosecution – Third degree methods - Human rights – Scientific methods of investigation Introduction to constitution of India – Indian penal Code - Introduction – Sections 291, 292,293, 299, 300, 302, 304B, 308, 309, 362, 375, 376, 390, 391, 415, 420, 463, 465 - Criminal Procedure Code Introduction – Sections 291, 292, 293, 300 – Indian Evidence Act – Introduction- Sections 45, 46,47, 57, 58, 60, 73, 135, 136, 137 and 159

Module: 5	9 Hours
Advances in Forensic Science- Environmental Forensics: Definition, Legal processes involving environmental forensic science. Geo-forensics Global Positioning System; Basic principles and applications. Biometrics in Personal Identification: Introduction, Concepts of Biometric Authentication, Role in person Identification, Techniques and Technologies (Finger Print Technology, Face Recognition, IRIS, Retina Geometry, Hand Geometry, Speaker Recognition, Signature Verification and other forensic related techniques). Bioterrorism: Definition, Concepts of Biosecurity and microbial forensics, Weapons of mass destruction (WMD), mass-casualty weapons (MCW), NBC and CBRNE, Dirty Bombs.	
Total Lectures	45 Hours
Reference Books	
1.	James, S. H., Nordby, J. J. and Bell, S., "Forensic Science: An Introduction to Scientific and Investigative Techniques", 4 th Edition, CRC Press, USA, 2015.
2.	Saferstein, R., "Criminalistics: An Introduction to Forensic Science", 11 th Edition, Pearson, 2015.
3.	Siegel, J. A, Saukko, P. J., Knupfer, G. C., "Encyclopedia of Forensic Sciences, Vol I, II and III", Academic Press, 2000.
4.	Horswell, J., "The Practice of Crime Scene Investigation (International Forensic Science and Investigation)", CRC Press, 2004.
5.	Sharma, B.R., "Forensic Science in Criminal Investigation & Trials", Universal Law Publishing – An imprint of LexisNexis, 5 th Edition, 2014.
6.	Rao C.N. Shankar, "Sociology: Principles of Sociology with an Introduction to Social Thoughts" S Chand, 6 th Edition, 2019.
7.	Bhushan, V., Sachdeva, D.R., "An Introduction to Sociology," Kitab Mahal, 16 th Edition, 1986.
8.	Shapiro, D.L., "Forensic Psychological Assessment: An Integrative Approach", Allyn & Bacon, 1990.
9.	Turvey, B., "Criminal Profiling – An introduction to behavioral evidence analyses, 4 th Edition, Academic Press, 2011.
10.	Lal, R., Lal, D., "The Indian Penal Code", 28 th Edition, Wadhwa & Co., 2002.
Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	CRIME SCENE INVESTIGATION	L	T	P	C
23FS3002		3	0	0	3
Course Objectives					
Enable the student to: 1. State the concepts of criminalistics. 2. Identify the advancements in forensic science. 3. Explore crime scenes and evidence collection.					
Course Outcomes					
Student will be able to: 1. Categorize relevant evidences at the crime scene. 2. Predict the forensic techniques for detecting smuggled goods. 3. Develop proficiency in crime scene management and documentation. 4. Classify evidences using proper techniques. 5. Assess crime scene reconstruction. 6. Report the crime scene.					
Module: 1	CRIME AND CRIME SCENE				9 Hours
Definition of crime - IPC and crime – mens rea - reasons for committing crime in India and worldwide - Crime scene, Types of crime scenes: primary, secondary, indoor, outdoor - Role of different agencies involved					

in crime scene management: police medico legal experts, judicial officers. Actions of initial responding officer - objectives - Documentation: statements of victim, witness suspects, database and records, officer safety, emergency care, secure and control, release scene to appropriate authorities - Locards principle of exchange - concept of evidence – evidence classification - direct ,circumstantial physical, biological, corroborative, conclusive, trace, testimonial.		
Module: 2	CRIME SCENE INVESTIGATION	9 Hours
Crime scene investigation steps- Crime Scene Search methods. Locating, Collection & Preservation of various evidences. Crime Scene Documentation (Sketching, Photography, Videography and Notes-taking). Collection, packaging and preservation of evidences and general considerations. Crime Scene Management: Securing the crime scene, Avoiding contamination & cross contamination, Duties of various officers/experts on the crime scene, Evidence recovery log, Chain of Custody, Forwarding & Authorization letters and documentation. Report writing and Evidence Evaluation, Mobile FSL- Role & Functioning.		
Module: 3	CRIME SCENE RECONSTRUCTION	9 Hours
Crime scene reconstruction: introduction, importance, nature and principles: recognition, identification, individualization and reconstruction, stages: data collection, conjecture, hypothesis formulation, testing, theory. Cases of special consideration: Hit and Run, Accidents, Hanging (Suicidal/Homicidal), Ante-Mortem and Post-Mortem drowning, Strangulation, Chocking, Shooting, Burglary, arson, mass disasters,etc. Digital Aids in Reconstruction (3-D Photography/Videography, Computer aided Reconstruction),		
Module: 4	CRIMINALISTICS IN FORENSIC SCIENCE	9 Hours
Basics of Criminalistics: Definition of Criminalistics, Role of Criminalistics in Forensic investigation. Different types of evidences at the crime scene and their Forensic significance. Identification and Importance of Corpus Delicti, Modus operandi, Signature, trophy on the crime scene, admissibility of evidences.		
Module: 5	FORENSIC JOURNALISM AND SECURITY	9 Hours
Forensic Journalism: Introduction, History, Need and Scope of Forensic Journalism, Fundamentals of crime reporting, editing, and writing, Forensic journalism in criminal cases, photography in crime investigation. Role of journalism in Police investigation. Case studies for importance of role of Forensic journalism. Role of Media on the outcome of cases. Media trial, branding/labelling of the suspects/victims/accused, effect on the society. Forensic Security: Preventive Forensics and their aids, safety gadgets, alarm systems, surveillance systems, Fire precautions, Fire audit, safety of buildings. Need and Scope of internal security of India, Defence against internal and external threats. Surveillance and counter surveillance, honey traps, Ports security.		
Total Lectures		45 Hours
Reference Books		
1.	Barry A. J. Fisher, Barry A. J. Fisher, David R. Fisher, David R. Fisher, Techniques of crime scene investigation, CRC Press, 2012.	
2.	Tom Bevel, Ross M. Gardner, Bloodstain Pattern Analysis with an Introduction to Crime Scene Reconstruction, 3 rd Edition, CRC Press, 2008.	
3.	Suzanne Bell, Forensic Science: An Introduction to Scientific and Investigative Techniques, 5 th Edition, CRC Press, 2019.	
4.	W. Jerry Chisum and Brent E. Turvey, Crime Reconstruction, Elsevier academic press, 2011.	
5.	"Criminalistics: An Introduction to Forensic Science" by Richard Saferstein.	
6.	"Forensic Science: An Introduction to Scientific and Investigative Techniques" by Stuart H. James, Jon J. Nordby, and Suzanne Bell	
7.	"Forensic Science: The Basics" by Jay A. Siegel	
8.	"Forensic Science: From the Crime Scene to the Crime Lab" by Richard Saferstein	
9.	"Principles of Forensic Medicine and Toxicology" by Pritesh Kumar Singh and Ch. V. Rao	

10.	"Advances in Forensic Science: Celebrating 50 Years of the Southeastern Association of Forensic Scientists" edited by Ray H. Liu
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	FORENSIC BIOLOGY	L	T	P	C
23FS3003		3	0	0	3

Course Objectives

Enable the student to:

1. Establish the basic importance of forensic biology in Criminal Investigation.
2. Identify body fluids, stains and tissues for analysis.
3. Develop the concepts of forensic anthropology, odontology, microbial and wildlife forensics.

Course Outcomes

Student will be able to:

1. Discuss the basics of Forensic Botany.
2. Illustrate the methods of collection and preservation of bodily fluids and stains.
3. Determine the significance of Forensic Anthropology in Individualization.
4. Evaluate methods of hair analysis and significance of Entomology.
5. Assess the importance of wildlife forensics.
6. Facilitate the significance of forensic Biology in solving different crime cases.

Module: 1	INTRODUCTION TO FORENSIC BIOLOGY	9 Hours

Introduction to Forensic Biology- Types of Biological Evidences, Collection –preservation
Forensic Botany -Toxic principles of plants and their forensic significance - -Diatoms - Types – Morphology
- Methods of isolation from tissues and bones - Forensic significance in drowning cases - Identification of pollen grains

Module: 2	BODY FLUIDS, STAINS AND TISSUES	9 Hours

Blood - Composition, examination of blood and blood stains, Identification of lochial and menstrual stains by various methods. Semen - Composition, St. of spermatozoa, Forensic methods of detection and identification of semen and seminal stain examination - Identification and examination of other body fluids/stains- vaginal, saliva, urine, pus, faeces, vomit, milk, sweat & tears.

Module: 3	FORENSIC ANTHROPOLOGY	9 Hours

Forensic Anthropology – History - Sex determination from skull, pelvis, mandible – Collection and preservation of evidences - Determination of age, sex, stature- superimposition techniques and its application
- Facial reconstruction - Forensic Odontology: Introduction - Structure and types of teeth - Dentition and dental formula - Determination of age, sex and race from teeth — Forensic significance in mass disaster victim identification.

Module: 4	EXAMINATION OF HAIR AND FORENSIC ENTOMOLOGY	9 Hours

Introduction - Structure of hair - Growth and chemistry of hair - Identification and comparison of hair by microscopic –Identification of animal hair - Assessment of origin, age, sex, race and site of hair – Elemental analysis of hair – DNA typing of hair Fibre Examination – Introduction - Classification of fibres - Identification and comparison of fibres - Forensic significance
Forensic Entomology: Introduction - Collection and preservation - Common arthropod found on the dead body - Determination of time of death - Entomological succession or order of appearance. Life cycle of Blow fly.

Module: 5	WILD LIFE FORENSICS AND FORENSIC MICROBIOLOGY	9 Hours
Wild Life Forensics: Introduction - Importance of wild life - Wild life Protection Act – Endangered species – CITES - Wild life crime–Forensic Microbiology: Definition, Types and identification of Biowarfare agents, bioterrorism, Methods of detection. Anthrax incident.		
Total Lectures		45 ours
Reference Books:		
1.	Byers, S. N. Introduction to forensic anthropology. Taylor & Francis, 2016.	
2.	Li, R., Norman, S., & Schober, J. <i>Forensic biology</i> . CRC Press, 2015.	
3.	Gunn, A. <i>Essential forensic biology</i> . John Wiley & Sons, 2019.	
4.	Wild Life (Protection) Act, 1972, Universal Law Publishing - An imprint of LexisNexis, 2016.	
5.	Byrd, J. H., “Forensic Entomology: The Utility of Arthropods in Legal Investigations”, 2002.	
6.	Robertson, J., “Forensic Examination of Fibres”, Chichester, West Sussex, England: Ellis Horwood Ltd., 1992.	
7.	Saferstein, R., “Criminalistics. An Introduction to Forensic Science”, 11 th Edition. , Pearson, 2015.	
8.	Robertson, J.R., “Forensic Examination of Hair”, CRC Press, 1999.	
9.	Eckert, W.G., “Introduction to Forensic Sciences”, 2 nd Edition, CRC Press, 1996.	
10	Chowdhuri, S. “Forensic Biology”, B P R & D, Govt. of India, 1971.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	ADVANCED QUESTIONED DOCUMENTS	L	T	P	C
23FS3004		3	0	0	3
Course Objectives					
Enable the student to:					
1. Identify the forgery in the documents. 2. Examine the questioned documents using various detection techniques. 3. Apply the principles of handwriting examination.					
Course Outcomes					
Student will be able to:					
1. Classify the various types of documents. 2. Compare the questioned documents with standards. 3. Distinguish the different types of forgery in the documents. 4. Devise the method to examine questioned documents. 5. Recommend the decipherment methods of secret writings. 6. Prepare the forensic report.					
Module: 1	CLASSIFICATION OF DOCUMENTS	9 Hours			
Nature and problems of document examination – Classification of documents – Procurement of standard admitted / specimen writings –Handling and marking of documents – Preliminary examination of documents- Basics of handwriting identification – Individuality of handwriting – natural variations, process of comparison – Various types of documents – Various writing features and their estimation – General characteristics of hand writing – Individual characteristics of hand writing – Basic tools for forensic document examination.					
Module: 2	EXAMINATION OF SIGNATURES	9 Hours			
Disguised writing and anonymous letters – Identification of writer – Examination of signatures – Characteristics of genuine and forged signatures- Examination of seal impressions and other mechanical impressions					

Module: 3	EXAMINATION OF DOCUMENTS - 1	9 Hours
Examination of alterations, erasers, over writings, additions, and obliterations – Decipherment of secret, indented and charred documents-Examination of black and white, color Xeroxed copies, carbon copies, fax messages – Forgeries and their detection – Various types of forgeries and their detection – Examination of built-up documents –Determination of sequence of strokes, physical matching of documents- Examination of counterfeit currency notes, passports, visa, stamp papers, postal stamps etc.		
Module: 4	EXAMINATION OF DOCUMENTS - 2	9 Hours
Examination of computer print outs – dot-matrix, ink-jet and laser printers, electronic typewriters – Credit cards – e-documents – Digital signatures – Examination of built-up documents – Determination of sequence of strokes, physical matching of documents, identification of typewriter writings – Identification of typewriter – Identification of printed matter – Various types of printing of security documents, printing of currency notes –Determination of age of documents by examination of signatures, paper, ink, writing / signatures etc. Analytical instrumentation used in document examination – Video spectral comparators, Microscopes, TLC, HPLC, Spectrofluorimetry and X-ray fluorimetry etc.		
Module: 5	REPORT WRITING & COURT ROOM TESTIMONY	9 Hours
Opinion writing – Reasons for opinion – Court testimony Evidence and testimony in court, Information required by the Forensic expert, Components of Forensic Reports, Preparation of Report, Presenting findings in a Report format.		
Total Lectures		45 Hours
Reference Books		
1.	Morris, R., Morris, R.N., Forensic Handwriting Identification: Fundamental Concepts and Principles, Academic Press, 2000.	
2.	Huber, R.A., Headrick, A.M., Handwriting Identification: Facts and Fundamentals, CRC Press, 1999.	
3.	Osborn, A. S., “The Problem of Proof”, 2 nd Edition, Universal Law Publishers, 1998	
4.	Thomas, C.C., “I.S.Q.D. Identification System for Questioned Documents”, Billy Prior Bates, Springfield, Illinois, USA, 1971.	
5.	Harrison, W.R., “Suspect Documents: Their Scientific Examination”, Universal Law Publisher, 1997.	
6.	Levinson, J., “Questioned Documents: A Lawyer's Handbook”, Academic Press, 2000	
7.	Saferstein, R., “Criminalistics: An Introduction to Forensic Science”, Prentice-Hall; 5 th Revised Edition, 1994.	
8.	Day, S. P., Ellen, D., Davies, C., “The Scientific Examination of Documents: Methods and Techniques (Taylor & Francis Forensic Science Series), Taylor & Francis; 2 nd Edition, 1997.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	FORENSIC PSYCHOLOGY	L	T	P	C
23FS3005		3	0	0	3
Course Objectives					
Enable the student to:					
1. Recognize the scope and importance of Forensic Psychology.					
2. Associate forensic psychology with criminal behavior.					
3. Compile various psychological assessment tools.					
Course Outcomes					
Student will be able to					

- Record the basics of forensic psychology. - Explain ethical issues in forensic psychology. - Interpret the significance of psychological assessment. - Focus the principles of polygraph. - Consider the procedure for narco analysis. - Plan general procedure for conducting BEOS profiling.		
Module: 1	INTRODUCTION TO PSYCHOLOGY	9 Hours
Psychology – Introduction – Scope and importance – Principles of development – Attention and perception – Process of learning – Memory and forgetting – Motivation – Attitudes – Values of emotions – Behavioral problems – Conflict and use of defense mechanisms – Various types of mental disorders-(Attention deficit hyperactivity disorder) –Psychology of criminal behavior.		
Module: 2	FORENSIC PSYCHOLOGY	9 Hours
Forensic Psychology and Psychiatry – Narcoanalysis – Polygraphy –Brain fingerprinting -Forensic Psychology and the Law, Ethical Issues in Forensic Psychology, Civil and criminal case assessment, Assessing mental competency, Mental disorders and Forensic Psychology, Eye witness testimony, Criminal profiling- need and types, Forensic Scientific evidence, Crime and psychopathology, Genetics and Crime, Serial murders, Modus Operandi. Introduction to Antisocial Personality disorder and its relevance to crime.		
Module: 3	PSYCHOLOGICAL ASSESSMENT	9 Hours
Psychological Assessment Tools, Detection of deception, Various methods for detection of deception, Interview, Non-verbal detection, statement assessment, Hypnosis, Psychological assessment-(Tests used in Forensic Psychology Assessment: Intelligence Tests, Achievement and Aptitude Tests, Personality Tests, MMPI Test, Rorschach Test, Thematic Apperception Test, Neuropsychological tests, Men's rea, diminished capacity, Forensic Behavioral Analysis, Forensic Psychologists as an Expert) , voice stress analyzer, Thermal imaging, Brain Electrical Oscillation Signature Profiling, Functional Magnetic Resonance study, Current research in detection of deception/truth finding mechanisms.		
Module: 4	POLYGRAPH	9 Hours
Historical aspects of Polygraph, Principles of polygraph, psycho physiological aspects, operational aspects, Question formulation techniques, Interviewing technique procedure, The Art-Polygraph, Legal and Ethical aspects, Human rights of individual. Admissibility of Polygraph evidence in court of law.		
Module: 5	NARCOANALYSIS	9 Hours
Narco-Analysis - Historical aspects, Introduction to truth serum/drug (sodium thiopental), Principle and Theory, General Procedure –Legal and Ethical aspects, Human rights of individual. Brain Electrical Oscillation Signature (BEOS) Profiling - Principle and Theory, General Procedure –Legal and Ethical aspects, Human rights of individual.		
Total Lectures		45 Hours
Reference Books		
1.	Sharma, B.R., "Forensic Science in Criminal Investigation & Trials", Universal Law Publishing – An imprint of LexisNexis, 5 th Edition, 2014.	
2.	Weiner, I.B., Hess, A.K., "The Handbook of Forensic Psychology", John Wiley & Sons; 3 rd Revised Edition, 2005.	
3.	O'Donohue, W., Levensky, E., "Handbook of Forensic Psychology", Academic Press, 2003.	
4.	Mukundan, C.R., "Brain Experience: Neuroexperiential Perspectives of Brain-Mind", Atlantic; Nil Edition, 2007.	
5.	Turvey, B., "Criminal Profiling - An Introduction to Behavioral Evidence Analysis", Academic Press, 2011.	

Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	FORENSIC PHYSICS AND ADVANCED BALLISTICS	L	T	P	C
23FS3006		3	0	0	3

Course Objectives

Enable the student to:

1. Examine the importance and legal aspects of blood pattern analysis.
2. Discuss the causes of vehicular accidents, and its legal implications.
3. Develop a comprehensive understanding of firearms and their classification.

Course Outcomes

Student will be able to:

1. Examine the fundamental principles of handling physical evidence.
2. Illustrate the physics of blood.
3. Determine various types of crime scene materials relevance to Forensic Ballistics.
4. Classify the different types of firearms.
5. Distinguish between, internal, external and terminal ballistics.
6. Collaborate the procedure of writing ballistic report.

Module: 1	INTRODUCTION TO FORENSIC PHYSICS	9 Hours

Nature, collection, preservation & forwarding of physical evidence for scientific examinations. Forensic Engineering; Industrial accidents; Traffic accident reconstruction; Transportation disaster investigation; Civil engineering investigation; Investigation report. Road Accidents- Examination of scene, Filaments examination, Examination of skid marks,

Module: 2	PHYSICS OF BLOOD	9 Hours

Physics of Blood stain Pattern Analysis (BPA): Introduction, Terminologies and classification, Biological and physical properties of human blood, Droplet Directionality from bloodstain patterns, Determination of Point of Convergence and Point of Origin. Impact spatter and mechanisms. Importance and Legal aspects of BPA.

Module: 3	GLASS, SOIL AND PAINT	9 Hours

Glass -Types of glass and their composition, Glass fracture analysis, Laboratory exercises include refractive index measurements using immersion methods and classical chemical and physical methods of analysis. Soil- Formation and types of soil, Composition and color of soil, Forensic examination of soil, Interpretation of soil evidence. Paints- Types of paint and their composition, Forensic examination of paints, Interpretation of paint evidence. Tool Marks- Types of tool marks, Class characteristics and individual characteristics - Fiber analysis: Forensic significance, Classification, characteristics, Birefringence, Colors in textile, Color Assessment, Chemical properties, Miscellaneous Clue Materials- Examination of strings/ropes, Wires/cables, Seals, Counterfeit coins, Gem Stones: Analysis of crystalline substances.

Module: 4	FIRE ARMS AND INTERNAL BALLISTICS	9 Hours

Firearms: Introduction, history and types of firearms - Briefs of Indian Arms Act, Country Made/Improvised Firearms, Illegal firearms - Proof Marks of weapons - Types of ammunition- types of cartridges, types of primers and priming composition, propellants and their compositions, velocity and pressure characteristics under different conditions, Head stamp Markings. Internal Ballistics: Definition, Ignition of the propellant, Shapes of Propellants, Manner of the propellant burning, Piobert's law, Pressure space curve, Shot Start Pressure, All Burnt Point, Velocity, Le Du's formula, Muzzle velocity - factors affecting the internal ballistics - equation of motion of projectile, Measurement of strength of firearm, projectile velocity determination, theory of recoil, methods for measurement of recoil.

Module: 5	EXTERNAL BALLISTICS AND TERMINAL BALLISTICS	9 Hours
External Ballistics: Bullet Drop in the flight, Use of sight to compensate for bullet drop, Influence of Earth on Trajectory, Angle of Fall, Ballistic Coefficient and Air resistance-base drag, Sectional Density, Maximum effective range, Drift, Yaw ,Precession, Nutation, Terminal velocity, Ballistics tables, measurements of trajectory parameters, Escape velocity & Ricochet. Terminal Ballistics: Definition, Effect of projectile on hitting the target: function of Bullet shape, striking velocity, striking angle and nature of target, tumbling of bullets, effect of instability of bullet, effect of intermediate targets, function of bullet shape, striking velocity, striking angle and nature of target, tumbling of bullets, Brief introduction to Cavitations -Ricochet and its effects, stopping power - Introduction to Forensic Ballistics Report Writing		
Total Lectures		45 Hours
Reference Books		
1.	Hatcher J.S., Jury, F.J., Weller, J., “Firearms Investigation Identification and Evidence”, Ray Riling Arms Books Co. Philadelphia, PA; Reprint Edition, 2006.	
2.	Jauhri, M., “Monograph on Forensic Ballistics”, Govt. of India Publication, New Delhi, 1980.	
3.	Sharma, B.R., “Forensic Science in Criminal Investigation & Trials”, Universal Law Publishing – An imprint of LexisNexis, 5 th Edition, 2014.	
4.	Kumar, K., “Forensic Ballistics in Criminal Justice”, Eastern Book Company, Edition: 1987 Edition W/S 1990, Reprinted 2015.	
5.	Heard, B.J., “Handbook of Firearm and Ballistics Examination and Interpretation Forensic Evidence”, Wiley, 2008.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	FINGER PRINTS AND OTHER IMPRESSIONS	L	T	P	C
23FS3007		3	0	0	3
Course Objectives					
Enable the student to:					
1. Acquire knowledge about various types of finger print impressions.					
2. Analyze different types of impressions found on crime scene.					
3. Support the investigating officer to identify and examine various impressions.					
Course Outcomes					
Student will be able to:					
1. Identify the various elements of fingerprints.					
2. Distinguish the types of reprints.					
3. Analyze different types of prints such as footprints, tyre prints, lip prints etc.					
4. Apply various methods to collect and analyze prints.					
5. Recommend new procedures for proper collection and analysis of prints.					
6. Develop novel methods for the development of prints.					
Module: 1	INTRODUCTION TO FINGERPRINTS				9 Hours
Fingerprints- Introduction- History and development of fingerprints- Structure of skin- Elements of fingerprinting - Classification of fingerprint patterns- Classification of fingerprints- Identification and comparison- Poroscopy- AFIS- Introduction- History- Operation- Search technology- Palm prints – Administration and networking.					
Module: 2	DEVELOPMENT OF FINGERPRINTS – I				9 Hours

Types of evidentiary fingerprints- Development of latent fingerprints- Physical and chemical methods- Visualization methods of illumination- Photography- Preservation and lifting of fingerprints- Development techniques on porous and non-porous surfaces- Development on adhesive surface- Development with blood and grease contamination-		
Module: 3	DEVELOPMENT OF FINGERPRINTS – II	9 Hours
Multimetal deposition method (MMD), advances in multimetal deposition method, vacuum metal deposition, fluorescent metal deposition, single metal deposition, physical developer. Development of latent fingerprints on dead body- Digital imaging of fingerprints- Case histories.		
Module: 4	FOOTWEAR AND TIRE IMPRESSIONS	9 Hours
Footwear Impressions- Introduction- Forms of footwear impressions- Information from footwear impressions- Location and recovery - Enhancement methods- Preparation of Exemplars- The examination process- Case histories Tire Impressions- Introduction- Original equipment tires, Replacement tires and tire construction- Tread nomenclature and sidewall information- Tread wear indicators- Retreated tires- Tire reference material and databases- Tire track evidence and recovery- Known tires and exemplars- Tire impressions examination process- Case histories		
Module: 5	LIP PRINTS	9 Hours
Lip Prints- Introduction- History- Scope- Application in crime detection Ear Prints- Introduction- History- Morphology of ear – Ear prints location- Producing standards from suspects- Identification and comparison Bite marks- Introduction- Significance- Judicial Acceptance- Description of prototypical bite marks- Evidence collection on victim and suspects- Identification and comparison- Case histories.		
Total Lectures		45 Hours
Reference Books		
1.	Saferstein, R., “Criminalistics: An Introduction to Forensic Science”, Pearson Prentice Hall, 11 th Edition, 2014.	
2.	Eckert, W.G., “Introduction to Forensic Sciences”, 2 nd Edition, CRC Press, 1996.	
3.	James, S.H., Nordby, J.J., Bell, S., “Forensic Science: An Introduction to Scientific and Investigative Techniques”, 4 th Edition, CRC Press, 2015.	
4.	Siegel, J. A., Sukoo, R. J, Knupfer, G. C., “Encyclopedia of Forensic Science, Vol I, II and III, Academic Press, 2000.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	CYBER CRIME	L	T	P	C
23FS3008		3	0	0	3
Course Objectives					
Enable the student to: 1. Identify various cybercrime issues and their detection. 2. Articulate investigation procedure of cybercrimes in detail. 3. Combine the various laws related to cybercrime.					
Course Outcomes					
Student will be able to: 1. Recognize the types of cybercrime. 2. Distinguish the steps involved in cyber forensic investigation.					

3. Administer different concealment techniques.		
4. Assess information from volatile memory.		
5. Distinguish the various tools in cyber forensics.		
6. Combine different laws related to cyber crime.		
Module: 1	TYPES OF CYBER CRIME	9 Hours
Crimes targeting Computers: Unauthorized Access, Packet Sniffing, Malicious Codes including Trojans, Viruses, Logic Bombs, etc. Online based Cyber Crimes: Phishing and its variants, Web Spoofing and E-mail Spoofing, Cyber Stalking, Web defacement, financial crimes, ATM and Card Crimes etc. Spamming Commercial espionage and Commercial Extortion online, Software and Hardware Piracy Money Laundering.		
Module: 2	CYBER FORENSICS	9 Hours
Cyber Forensic Steps: Identification, Seizure, Acquisition, Authentication, Presentation, Preservation.- Qualities and skills of Computer forensics Expert - Goal of the Forensic Investigation - Why Investigate - Internet usage exceeds norm - Using email inappropriately - Use of Internet, email, or PC in a non-work-related manner - Theft of information - Violation of security policies or procedures - Intellectual property infractions - Electronic tampering - Establishing a Basis or Justification to Investigate - Determine the Impact of Incident - Auditing V/s Cyber Forensic Investigations		
Module: 3	CONCEALMENT TECHNIQUES	9 Hours
Spoofing - Hijacked session attacks – Polymorphism - Steganography - Reversing steganographic process – Counter or anti forensics - Anti forensics: A View from the Edge - Cloaking Techniques (Data Hide and Seek) - Renaming and Manipulating File System - Data Hiding on NTFS with Alternate data Stream		
Module: 4	LIVE FORENSICS	9 Hours
Live response, volatile memory analysis, volatility, PT Finder, the impact on investigated system, memory image analysis, recovering cached and internet artifacts, internet browsing artifacts, volatile data acquisition, volatile forensic method, runtime disk explorer, logical acquisition, memory dump analyzer, crash dump analyzer, cryptanalysis, MAC times, metadata issues, analyzing file time stamps.		
Module: 5	LAWS	9 Hours
Provisions in Indian Laws in dealing with Cyber Crimes and its critical analysis - Information Technology Act, 2000 - Penalties Under IT Act - Offences Under IT Act - Offences Related with Digital Signature and Electronic Signature - Under IT Act - Statutory Provisions Establishment of Authorities under IT Act and their functions, powers, etc – Controller - Certifying Authorities - Cyber Regulation Appellate Tribunal - Adjudicating officer		
Total Lectures		45 Hours
Reference Books		
1.	Cyber Law in India by Farooq Ahmad- Pioneer Books	
2.	Guide to Cyber and E- Commerce Laws by P.M. Bukshi and R.K. Suri- Bharat Law House, New Delhi.	
3.	Computer Forensics: Principles and Practices by Linda Volonino, Reynaldo Anzaldua and Jana Godwin -Pearson Prentice-Hall 2007.	
4.	Digital Evidence and Computer Crime, 2 nd Edition By Eoghan Casey- Acdemic Press, 2004.	
5.	Scene of the Cybercrime: Computer Forensics Handbook by Syngress.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	MEDICAL JURISPRUDENCE	L	T	P	C
23FS3009		3	0	0	3

Course Objectives		
Enable the student to:		
1. Identify legal procedures in Courts. 2. Administer personal identity. 3. Hypothesize cause of death from post-mortem examination.		
Course Outcomes		
Student will be able to:		
1. Enumerate various legal procedures. 2. Identify the parameters contributing to personal identification. 3. Examine the importance of post-mortem examination. 4. Differentiate the type of wounds. 5. Predict the modes of death. 6. Combine knowledge to estimate time since death.		
Module: 1	CONCEPT OF MEDICAL JURISPRUDENCE	9 Hours
Medical Jurisprudence: An overview of court procedures, inquests (Police inquest, Magistrate Inquest, Coroner's Inquest, etc.) criminal courts' jurisdiction and powers, subpoena, Perjury & oath of medical expert. Recording of Medical experts' evidence in courts. Types of Medical Documentary evidences- Medical Certificate, Medical report, Dying Declaration and Dying Deposition. Kinds of witness and rules for giving evidence.		
Module: 2	PERSONAL IDENTITY	9 Hours
Definition and significance. Parameters contributing to personal identity- Race, Sex, Age, Complexion, features & Photographs, Anthropometry, Fingerprints, Footprints, Tattoo marks, Occupational marks, Handwriting, Clothes & Ornaments, Voice & Speech, DNA, Superimposition techniques for skull. Disputed paternity.		
Module: 3	POST-MORTEM EXAMINATION	9 Hours
Importance, post-mortem report format, external & internal examination in brief. Viscera & its preservation. Examination of decomposed and mutilated bodies. Precaution to be taken during post mortem examination. Exhumation. Cause of death.		
Module: 4	WOUNDS	9 Hours
Wounds & its types, Medico-legal aspects, post mortem & ante mortem wounds, General characteristics of injuries from burns, scalds, lightning, electricity and radiation. Forensic importance of wounds.		
Module: 5	DEATHS IN ITS MEDICO-LEGAL ASPECTS	9 Hours
Medico legal aspects of death: Modes of Death (Coma, Syncope, Asphyxia), Types of Death – Somatic and Molecular, Signs of Death – Immediate, Early and Late signs of Death – Cooling of body, Changes in Eye, Post mortem Lividity, Rigor Mortis, Putrefaction, adipocere, mummification, autolysis and bacterial action. Factors effecting these changes. Determination of time since death.		
Total Lectures		45 Hours
Reference Books		
1.	Kannan, K., "Modi's A Textbook of Medical Jurisprudence and Toxicology", Lexis Nexis Butterworth India, 2019.	
2.	Smith, F.J., "Taylor's Principles and Practice of Medical Jurisprudence. Volume 2 of 2", Gale, Making of Modern Law, 2010.	

3.	Parick, C.K., "Parikh's Textbook of Medical Jurisprudence, Forensic Medicine and Toxicology", CBS, 6 th Edition, 2007.
4.	Knight, B., "Simpson's Forensic Medicine", CRC Press, 11 th Edition, 1996.
5.	Polson, C.J., Gee, D.J., "The Essentials of Forensic Medicine", Pergamon, 4 th Revised Edition, 1984.
6.	Reddy, K. S. N., Murthy, O.P., "The Essentials of Forensic Medicine and Toxicology", Jaypee Brothers Medical Publishers, 34 th Edition, 2017.
7.	Aggarwal, A., "APC Textbook of Forensic Medicine and Toxicology", Avichal Publishing Company, Delhi, 2014.
8.	Biswas, G., "Practical and Postmortem Record Book of Forensic Medicine and Toxicology", Jaypee Brothers Medical Publishers, 2016.
9.	Wilson, K.D., "Cause of Death: A Writer's Guide to Death, Murder and Forensic Medicine", Writers Digest Books, 1 st Edition, 1992.
10.	Joseph, M., Kaur, H., "A Handbook of Forensic Medicine and Toxicology: Question Answer Format with Illustrations", B. Jain Regular, First Edition, 2009.

Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	CRIME SCENE MANAGEMENT LAB	L	T	P	C
23FS3010		0	0	3	2

Course Objectives

Enable the student to:

1. Identify forensic case studies and their relevance in the field of forensics.
2. Employ the knowledge of complete case procedure.
3. Develop the techniques in writing forwarding letters in cases related to murder, rape, assault, HBT (homicide by beating), and asphyxia death.

Course Outcomes

Student will be able to:

1. Recognize complete case procedure in forensic evidence throughout the legal process.
2. Paraphrase in writing scientific reports and forwarding letters.
3. Apply techniques for searching and collecting physical evidence from mock crime scenes.
4. Analyze and interpret forensic evidence in relevant Forensic Science Laboratory (FSL).
5. Assess and interpret gait patterns of individuals, and its applications in identification and criminal profiling.
6. Adapt principles and process of polygraphs and the interpretation of polygraph test results.

List of Experiments

1. To study the Case Studies of Forensic relevance.
2. To study the Case procedure from the initial police report through the court's ruling.
3. To study the forwarding letter writing (in case of Murder/Rape/Assault/HBT/Asphyxial death)
4. To write scientific report (in case of Murder, Rape, death due to drowning, hit and run and HBT).
5. To review two case studies involving corporate frauds.
6. Searching of physical evidences from mock crime scene.
7. Photography of crime scene using manual & digital camera.
8. Sketching of an Indoor Crime Scene using Triangulation method.
9. Sketching of a Crime Scene using Baseline method.

10.	Collection and Preservation of evidences from mock crime scene (murder, Hit and Run crime scene, Hanging, etc)
11.	Forensic Evidence Analysis in relevant FSL division.
12.	Reconstruction of various types of crime scene.
13.	Collection of lip prints and Identification of minutiae's in lip prints.
14.	Comparison of Ear prints
15.	Analysis of Gait pattern of an individual.
16.	To learn the workings and process of polygraphs.
17.	Visit to Forensic Science Laboratory.
(Minimum 10 experiments to be conducted)	
Reference Books	
1.	"Case Studies in Forensic Science" by Richard Saferstein
2.	"Criminalistics: An Introduction to Forensic Science" by Richard Saferstein
3.	"Criminal Investigation: The Art and the Science" by Michael D. Lyman
4.	"Forensic Science in Criminal Investigation and Trials" by B.R. Sharma
5.	"Forensic Accounting and Fraud Examination" by Mary-Jo Kranacher, Richard Riley, and Joseph T. Wells
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	FORENSIC BIOLOGY LAB	L	T	P	C
23FS3011		0	0	3	2
Course Objectives					
Enable the student to:					
1. Examine blood and other body fluids.					
2. Differentiate biological evidences.					
3. Test the biological samples.					
Course Outcomes					
Student will be able to:					
1. Identify the biological evidences.					
2. Differentiate between body fluids.					
3. Interpret biological evidences.					
4. Evaluate preliminary and confirmatory tests.					
5. Validate the tests.					
6. Create report based on the results.					
List of Experiments					
1. To identify the origin of given hair sample.					
2. To calculate medullary index of human and animal hair.					
3. To determine ABO blood grouping from blood.					
4. To determine ABO blood grouping from saliva.					
5. To determine sex from skull.					
6. To determine sex from pelvis.					
7. To detect presence of urine in the sample.					
8. To identify the microorganism by staining techniques.					
9. To identify diatom by acid digestion method.					
10. To detect the presence of saliva by starch iodine test.					
11. To detect the saliva samples by radial diffusion method.					
12. To perform crystal test to detect blood in the given samples.					
13. To estimate protein by UV spectrometry.					

14. To perform cross electrophoresis. 15. To perform agar gel electrophoresis. (Minimum 10 experiments to be conducted)	
Reference Books	
1.	Li, R., Norman, S., & Schober, J. (2015). <i>Forensic biology</i> . CRC Press.
2.	Gunn, A. (2019). <i>Essential forensic biology</i> . John Wiley & Sons.
3.	Byers, S. N. (2016). Introduction to forensic anthropology. Taylor & Francis.
4.	Robertson, J.R., "Forensic Examination of Hair", 1st Edition, CRC Press, 1999.
5.	Willey J, Sandman K, Wood D, Prescott' Microbiology, 12 TH Edition, Mc Graw Hill, 2022.
Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	FORENSIC PSYCHOLOGY LAB	L	T	P	C
23FS3012		0	0	3	2
Course Objectives					
Enable the student to: 1. Recognize the personality traits using different psychological test. 2. Employ various types of personality and behavioral tests. 3. Analyze the basics of psychological tests to identify a personal and behavioral aspects of individual.					
Course Outcomes					
Student will be able to: 1. Define the basics of psychological tests. 2. Relate the knowledge in analyzing behavior of individuals. 3. Employ systematic analysis of different psychological tests. 4. Devise the usage of psychological tests in forensic science. 5. Appraise the importance of personality tests. 6. Integrate the basis of psychological test for understanding individual’s mindset.					
List of Experiments					
1. Draw a Person test. 2. Eyscenk Personality Inventory. 3. Sack’s Sentence Completion test. 4. Children Personality Questionnaire. 5. Level of Aspiration 6. Thinking and Problem Solving 7. Locus of control. 8. Bhatia Battery. 9. The Thematic Apperception Test (TAT) 10. The Rorschach Inkblot Test 11. Word association test. 12. 16 personality factor questionnaire. 13. DISC personality test. 14. Minnesota multiphasic personality inventory. 15. Non- verbal intelligence test. (Minimum 10 experiments to be conducted)					
Reference Books					
1.	General Psychology by Cicarelli				
2.	General Psychology by Vipan Kumar				
3.	Cognitive Psychology by Galloti				
4.	Mannuals of Respective Test				

5.	Psychological testing by Anastasi
6.	Abnormal Psychology by Barlow and Durand.
7.	Psychology and Work, by Schultz D, 8 th Edition, 2006.
8.	Experimental Psychology, Solso. R.L., 2008.
9.	Social Psychology, Barron and Barron
10.	Behavior Modification, Martin Garry, 7 th Edition, 2002.
11.	Introduction to Psychology, Morgan, King, Weiss and Schopler, 7 th Edition, McGraw Hill, India, 1989.
12.	Abnormal psychology & modern life, Carson RC & Butcher JN, 10 th Edition, Harper-Collins NY
13.	The Counseling process Patterson, Lewis E.; & Welfel, Elizabeth Reynold – Hilgard, 2000.
14.	Introduction to Psychology, Atkinson and Atkinson, Oxford IBH Publishing Co. Pvt. Ltd., 1975.
15.	Introduction to Forensic Science in Crime Investigation by Dr.(Mrs.) Rukmani Krishnamurthy
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	FORENSIC PHYSICS AND BALLISTICS LAB	L	T	P	C
23FS3013		0	0	3	2
Course Objectives					
Enable the student to:					
1. Discuss the analysis of soil, paint and glass samples. 2. Interpret the tool marks. 3. Devise the microscopic examination of different samples.					
Course Outcomes					
Student will be able to:					
1. Match paint sample. 2. Compare the soil sample. 3. Predict various types of tools from the tool mark. 4. Plan density gradient method. 5. Predict the origin of paint sample. 6. Assemble the methodology to collect digital evidences.					
List of Experiments					
1. Examination of glass fractures 2. Determination of refractive indices of glass & liquids 3. Physical examination of soil for color, moisture, organic matter, pH, presence of anthropogenic material and presence of biological material 4. Determination of particle size distribution of soils 5. Soil comparison by density gradient method 6. Examination of paint samples by microscopy 7. Examination of paint evidence by using TLC and spectrographic technique 8. Examination of counterfeit currency 9. Comparison of tool marks 10. Restoration of erased identification marks from metal surfaces using various methods 11. Determination of density, by density gradient tube techniques. 12. Comparison of paints, Soils and glass, Miscellaneous (Cloth and Bangles) 13. Bloodstain pattern analysis 14. Preparation of report of the examination. 15. Examination of Gunshot residue. (Minimum10 experiments to be completed)					
Reference Books					

1.	Robinson, J.W., “Undergraduate Instrumental Analysis, 5 th Edition, Marcel Dekker, Inc., New York, 1995.
2.	Redsicker, D.R., “The practical Methodology of Forensic Photography, 2 nd Edition, CRC Press, Boca Raton, 2000.
3.	Mirakovits, K., Londino, G., “The Basics of Investigating Forensic Science”, CRC Press, 2015.
4.	Franck, H., Franck, D., “Forensic Engineering Fundamentals”, 1 st Edition, CRC Press, Boca Raton, Florida, USA, 2013.
5.	Saferstein, R., “Criminalistics: An Introduction to Forensic Science”, Pearson, 2017.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	QUESTIONED DOCUMENTS AND FINGERPRINT ANALYSIS LAB	L	T	P	C
		0	0	3	2
23FS3014					
Course Objectives					
Enable the student to:					
1. Acquire knowledge on documentation of fingerprints.					
2. Gain a comprehensive understanding of forgery.					
3. Attain a broad understanding of footprints.					
Course Outcomes					
Student will be able to:					
1. Enumerate the identification and classification of the fingerprint.					
2. Differentiate and examine the fingerprint.					
3. Illustrate chemical methods to conduct an analysis of footprints.					
4. Evaluate the physical method to leverage the fingerprint.					
5. Summarize the pattern of footprints.					
6. Revise handwriting and detect forgery.					
List of Experiments					
1. To take plain and rolled inked fingerprints and to identify patterns.					
2. To carry out 10-digit classification of fingerprints					
3. To perform ridge tracing, ridge counting					
4. To identify ridge characteristics					
5. Comparison of fingerprints					
6. To develop latent fingerprints with powders and fuming method.					
7. To develop latent fingerprints with chemical method					
8. Footprint tracing, casting, and comparison					
9. Bite mark casting and comparison					
10. Identification of normal / disguise writing					
11. Detection of forgeries (traced, simulated, and built up)					
12. Examination of rubber stamps and other mechanical impressions like seals etc.					
13. Examination of type scripts and printed material					
14. Examination of alterations, additions, overwriting and obliterations in documents					
15. Examination of erasures (mechanical and chemical)					
16. Examination of inks by TLC & spectrophotometry					
17. To decipher secret writings					
(Minimum 10 experiments to be conducted)					
Reference Books					
1.	Erickson, E., “The Basic of Forensic Investigation”, Elsevier Inc., 2014				
2.	Ramotowski, R., “Lee and Gaensslen's Advances in Fingerprint Technology”, 3rd Edition, CRC Press, 2013				

3	Evidence Handling & Laboratory Capabilities Guide, Virginia Department of Forensic Science, 2012.				
4	Bridges, B.C., "Practical Fingerprinting", Funk & Wagnalls, 1963.				
5	Alvarez, M.G.P., "Forensic Examination of Questioned Documents", Chapterhouse Publishing Incorporated, Philippines, 2013.				
6	Ellen, D., Day, S., Davies, C., "Scientific Examination of Documents – Methods and Techniques", 4th Edition, CRC Press, 2018.				
7	Daluz, H.M., "Fingerprint Analysis – Laboratory workbook", Second Edition, CRC Press, 2019.				
8	Bleay, S.M., Croxton, R.S., de Puit, M., "Fingerprint Development Techniques", Wiley, 2017.				
9	Lee, H.C., Gaensslen, R.E., "Advances in Fingerprint Technology", Second Edition, CRC Press, 2001				
10	Mirakovits, K., Londino-Smolar, G., "The Basic of Investigating Forensic Science – A Laboratory Manual", CRC Press, 2016.				
Recommended by Board of Studies					
Approved by Academic Council			25 Aug 2023		
Course Code	CYBER CRIME LABORATORY			L	T
23FS3015				0	0
				P	C
				3	2
Course Objectives					
Enable the student to:					
1. Recognize different tools used for capturing evidence. 2. Apply all the tools for the analysis of cyber evidences. 3. Evaluate networking and security.					
Course Outcomes					
Student will be able to					
1. Identify different tools used in cyber forensic. 2. Distinguish steganography tools. 3. Apply concealment techniques. 4. Analyze networking tools and data capture process. 5. Evaluate email tracing tools. 6. Justify different evidence capture processes.					
List of Experiments					
1. Tracing E – mail – Finding senders IP Address of received e – mail, tracing route of e – mail received using tools available on internet e.g. Visual Trace Route etc. 2. Study of Encase software and its uses 3. Study of FTK software and its uses 4. Study of WinHex software and its uses. 5. Steganography using steganography tools (like Invisible Secret etc) 6. Concealment Techniques (Cloaking Techniques (Data Hide and Seek), Renaming Files, Manipulating File System, Data Hiding on NTFS 7. Networking commands – like ping, IPConfig, etc. with various switches. 8. Network evidence collection offline and online. 9. Log Collections and analysis. 10. Working with Wireshark for Network analysis. 11. Studying of packets and packet formats. 12. Study of wireless networks and wireless network analysis. 13. Firewalls, Intrusion Detection and Honeypots 14. Wireless Network attacks, Bluetooth attacks 15. Live system evidence Capture process 16. Live Network evidence Capture process					

(Minimum 10 experiments to be conducted)	
Reference Books	
1.	Cyber Law in India by Farooq Ahmad- Pioneer Books
2.	Guide to Cyber and E- Commerce Laws by P.M. Bukshi and R.K. Suri- Bharat Law House, New Delhi
3.	Computer Forensics: Principles and Practices by Linda Volonino, Reynaldo Anzaldua and Jana Godwin -Pearson Prentice-Hall 2007.
4.	Digital Evidence and Computer Crime, 2 nd Edition By Eoghan Casey- Academic Press, 2004.
5.	The Indian Cyber Law by Suresh T. Vishwanathan- Bharat Law House New Delhi
6.	Introduction to Forensic Science in Crime Investigation By Dr.(Smt) Rukmani Krishnamurthy
7.	Walrand.J. Varaiya, High Performance Communication Network, Morgan Kauffman - Harcourt Asia Pvt Ltd, 2 nd Edition, 2000.
Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	FORENSIC DNA TYPING	L	T	P	C
23FS3016		3	0	0	3
Course Objectives					
Enable the student to: 1. Acquire the basics of the DNA Typing. 2. Summarize different methods for extraction. 3. Apply the concepts of STR and STR analysis for DNA Typing.					
Course Outcomes					
Student will be able to: 1. Outline the basic structure of DNA. 2. Distinguish various methods of DNA extraction. 3. Implement the concepts of STR and STR analysis for paternity testing. 4. Determine admissibility of DNA evidence in court. 5. Compare different genetic markers and their forensic significance in establishing the paternity. 6. Prepare a forensic report.					
Module: 1	EUKARYOTIC GENOME				9 Hours
Eukaryotic Genome: Structure of chromosome, Structure DNA (A, B, Z forms of DNA) Replication, Transcription and Translation. Karyotype, chromosome banding pattern, types of chromosomes, Giant chromosomes- polythene and lamp brush chromosome. Normal chromosome set.					
Module: 2	DNA EXTRACTION METHODS				9 Hours
DNA extraction methods: organic (Phenol-chloroform) extraction, chelex extraction, FTA paper; Solid phase extraction, Differential extraction, Direct PCR. DNA quantification: Slot blot, Pico-green microtiter plate assay, Aluquant human DNA quantification system, endpoint PCR, real time quantitative PCR (QPCR). Determining quality and Quantity of DNA and RNA, Gel elution technique. DNA Amplification: Basic PCR cycle, Components of PCR Types of PCR: PCR inhibitors & solutions, Contamination Issues, Factors affecting PCR etc. Restriction Fragment Length Polymorphism (RFLP), AFLP, VNTR					
Module: 3	GENETIC MARKERS				9 Hours
Genetic markers and their forensic significance, Types of STR markers, STRs used in forensic DNA typing, core and common STR markers. Structure of STR loci, Development of STR multiplexes,. Interpretation of DNA typing results: Complicating Factors (Multiple contributors, degradation, and extraneous substances), Likelihood Ratios.					
Module: 4	FACTORS AFFECTING DNA ANALYSIS				9 Hours

Ethics of DNA analysis and Post - conviction DNA analysis. Interpretation of STR profiles, Assessment of STR profiles, Stutter peaks, split peaks, pull up, template DNA, overloaded profiles, low template DNA typing, peak balance, mixtures, degraded DNA, PCR inhibition		
Module: 5	FORENSIC GENETICS	9 Hours
Introduction to Forensic Genetics. Species identification: mtDNA cytochrome b gene, mtDNA 12S rRNA gene, mtDNA COI gene, Wildlife DNA testing: genetic markers, geographic origin identification. DNA banks for endangered animals and DNA databases. Case studies		
Total Lectures		45 Hours
Reference Books		
1.	Li, R., Norman, S., & Schober, J. <i>Forensic biology</i> . CRC Press, 2015.	
2.	Gunn, A. <i>Essential forensic biology</i> . John Wiley & Sons, 2019.	
3.	Butler, J. M. <i>Fundamentals of forensic DNA typing</i> . Academic press, 2009.	
4.	Butler, J. M. <i>Forensic DNA typing: biology, technology, and genetics of STR markers</i> . Elsevier, 2005.	
5.	Butler, J. M. <i>Advanced topics in forensic DNA typing: methodology</i> . Academic press, 2011.	
6.	Houck, M. M., & Siegel, J. A. <i>Fundamentals of forensic science</i> . Academic Press, 2009.	
7.	Roberts, J., & Márquez-Grant, N. (Eds.). <i>Forensic ecology handbook: from crime scene to court</i> . John Wiley & Sons, 2012.	
8.	Saferstein, R. <i>Criminalistics: An introduction to forensic science</i> (Vol. 201, No. 1). Upper Saddle River, NJ: Prentice Hall, 2001.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	FORENSIC ANTHROPOLOGY, ODONTOLOGY AND BITEMARK ANALYSIS	L	T	P	C
23FS3017		3	0	0	3
Course Objectives					
Enable the student to:					
1. Recognize importance of forensic anthropology and personal identification. 2. Articulate identification through dental evidence. 3. Examine the bite-marks analysis and its forensic significance.					
Course Outcomes					
Student will be able to:					
1. Identify theories of anthropology. 2. Differentiate living and dead person through anthropological evidences. 3. Illustrate forensic odontology and its significance. 4. Select different methods and techniques used in forensic odontology. 5. Assess types of bite marks. 6. Infer factors affecting bite mark analysis.					
Module: 1	THEORIES OF ANTHROPOLOGY	9 Hours			
Scope,Fossil formation, taphonomy, dating techniques, bio-cultural evolution. Role of anthropology in mass disaster, Age at death, sex, ancestry, height and weight, premortem injury and disease, taphonomy, perimortem trauma, postmortem trauma, Time since death, ante-mortem records and positive ids, facial reconstruction					
Module: 2	IDENTIFICATION OF INDIVIDUAL	9 Hours			

Personal Identification of Living & Dead- Identification of human and non-human remains, Somatometry, Craniometry, Skull photo superimposition, facial reconstruction, Identification through somatometric and somatoscopic observation, Genetic traits of forensic significance: Skeletal age (Earlier years): Prenatal ossification, union of centers of ossification,		
Module: 3	INTRODUCTION OF FORENSIC ODONTOLOGY	9 Hours
Definition and Scope of Forensic Odontology, History of forensic Dentistry Types of dentition, Basic structure of human teeth, types of teeth & their morphology, and determination of age from teeth using various methods, dental anomalies and their role in Personal Identification. Role of Forensic Odontology in mass disaster victim identification.		
Module: 4	IDENTIFICATION THROUGH DENTAL EVIDENCE	9 Hours
Dental Charting. Comparison of Ante-mortem and postmortem dental records. DNA isolation from bones and teeth.: Gustafson method, Root transparency, cementum annulations, tooth wear, third molar formation, aspartic acid racemization, dental trauma and its forensic application, individualization from odontological samples, ABFO guidelines and standards.		
Module: 5	ANALYSIS OF BITE MARKS	9 Hours
Bite-mark analysis History of bite-mark analysis, anatomy of human bite-mark, types of bite-marks, collection of bite-mark evidences: non-invasive Forensic dental photography & invasive techniques, differential diagnosis of bite marks including carnivore bite-marks, bite-mark as biological evidence, reliability of bite-mark evidences.		
Total Lectures		45 Hours
Reference Books		
1.	Li, R., Norman, S., & Schober, J. Forensic biology. CRC Press, 2015.	
2.	Byers, S. N. Introduction to forensic anthropology. Taylor & Francis, 2016.	
3.	Gunn, A. Essential forensic biology. John Wiley & Sons, 2019.	
4.	Houck, M. M., & Siegel, J. A. Fundamentals of forensic science. Academic Press, 2009.	
5.	Li, R., Norman, S., & Schober, J. Forensic biology. CRC Press, 2015.	
6.	Roberts, J., & Márquez-Grant, N. (Eds.). Forensic ecology handbook: from crime scene to court. John Wiley & Sons, 2012.	
7.	Kaur, S., Krishan, K., Chatterjee, P. M., & Kanchan, T. Analysis and identification of bite marks in forensic casework. Oral Health Dent Manag, 12(3), 127-31 2013.	
8.	Bhargava, K., Bhargava, D., Rastogi, P., Paul, M., Paul, R., HG, J., & Singla, A. An overview of bite mark analysis. Journal of Indian Academy of Forensic Medicine, 34(1), 61-66, 2012.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	FORENSIC ASPECTS OF POISONS	L	T	P	C
23FS3018		3	0	0	3
Course Objectives					
Enable the student to:					
1. Classify the various types of poisons.					
2. Examine the animal, plant and food poisons.					
3. Assess the specific poison in matrices.					
Course Outcomes					
Student will be able to:					
1. Identify the nature of various types of poisoning.					

2. Discuss the management of poisoning cases. 3. Categorize different types of plant and animal poisons. 4. Summarize the food poisons. 5. Analyze the poisons by chemical methods. 6. Identify the poisons by instrumental methods.		
Module: 1	CLINICAL MANAGEMENT AND STORAGE OF SPECIMENS	9 Hours
Poisoning: accidental, homicidal, suicidal and miscellaneous. Case studies. Clinical management of poisoning- General Measures- Storage of samples; latest methods of storage and preservation. Signs and symptoms of poisoning- Toxicological investigation of poisoned death- Interpretation of toxicological data- Courtroom testimony in toxicological cases. Case Histories. Administration of antidotes- Types of antidotes		
Module: 2	PLANT AND ANIMAL POISONS	9 Hours
Plant poisons: Nature, active constituents, mode of action, extraction, isolation and identification TESTS of the following: <i>Abrusprecatorius, Calotropisgigantea, Croton tiglium, Argemone Mexicana.</i> <i>Atropa belladonna, Cerberathevetia, Daturafastuosa, Ricinuscommunis.</i> Animal Poisons: Snake venom: composition, mode of action and tests for identification; Scorpions, Bees and wasps, Centipedes; Case studies		
Module: 3	FOOD POISONING	9 Hours
Classification: bacterial and non-bacterial, bacterial: infection type, toxin type and botulism, non-bacterial: viruses, fungus and poisonous foods; Case studies. Bio-toxins: types, case studies.		
Module: 4	EXTRACTION AND IDENTIFICATION METHODS-I	9 Hours
Extraction and isolation of metallic poisons from various biological matrices by dry ashing, wet digestion and microwave digestion methods and their subsequent identification by Reinsch's test, Gutzeit Test and instrumental techniques; Case studies. Extraction of toxic anions from biological matrices by dialysis method and their identification using color tests and other methods		
Module: 5	Extraction and Identification Methods-II	9 Hours
Extraction of alkaloids from various matrices using stass-otto, modified stass-otto and ammonium sulphate methods. Extraction of organophosphorus, carbamates and organochlorine compounds from various biological matrices including viscera, blood and urine and their subsequent identification using color tests and instrumental techniques. Extraction of volatile poisons including alcohol from various matrices and their subsequent identification; Case studies. Extraction of gaseous poisons including ammonia, phosphine, sulfur dioxide, hydrogen sulphide, chlorine from various Biological matrices and their subsequent identification. Carbon monoxide poisoning: sample collection, extraction of sample and tests for identification; Case studies.		
Total Lectures		45 Hours
Reference Books		
1.	Bell, S. Drugs, poisons, and chemistry. Infobase Publishing, 2009.	
2.	Cooper, G., & Negrusz, A. (Eds.). Clarke's analytical forensic toxicology. Pharmaceutical Press, 2013.	
3.	Klaassen, C. D. (Edition). Casarett and Doull's toxicology: the basic science of poisons (Vol. 1236, p. 189). New York: McGraw-Hill, 2013.	
4.	Flanagan, R. J. Fundamentals of analytical toxicology, 2007.	
5.	Goutam, M. P., & Goutam, S. Analysis of plant poisons. Selective & Scientific Books, 2006.	
6.	Moffat, A. C., Osselton, M. D., Widdop, B., & Watts, J. Clarke's analysis of drugs and poisons (Vol. 3). London: Pharmaceutical press, 2011.	

7.	Dr.K.S.N.Reddy- The essential of Forensic Medicine & Toxicology 21 st Edition, 2002.
8.	Dr. C.K.Parikh- A text book of Medical Jurisprudence, Forensic Medicine & Toxicology, CBS Publishers, Delhi, 6 th Edition, 1999.
Recommended by Board of Studies	
Approved by Academic Council	
25 Aug 2023	

Course Code	MODERN INSTRUMENTATION LAB	L	T	P	C
23FS3019		0	0	3	2

Course Objectives

Enable the student to:

1. Observe experiments based on chromatography.
2. Predict the importance of chromatographic techniques for separation.
3. Deduce the SEM photograph.

Course Outcomes

Student will be able to:

1. Recall color test for the identification of drugs.
2. Interpret the SEM photograph.
3. Determine the presence of pesticides by TLC.
4. Classify the drugs by TLC.
5. Evaluate the use of HPLC in Forensic Science.
6. Adapt GC technique for the drug identification.

List of Experiments

1. Identification of basic drugs (from the extract) by colour tests and TLC -1
 2. Identification of basic drugs (from the extract) by colour tests and TLC -2
 3. Identification of neutral and acidic drugs (from the extract) by colour tests and TLC -1
 4. Identification of neutral and acidic drugs (from the extract) by colour tests and TLC -2
 5. Identification of pesticides (from the extract) by TLC
 6. Detection of (NDPS) by TLC
 7. Determination of a drug / pesticide in toxicological specimen by GC -1
 8. Determination of a drug / pesticide in toxicological specimen by GC -2
 9. Determination of a drug / pesticide in toxicological specimen by HPLC
 10. GC-MS / LC-MS of a poison of forensic interest (Demo only)
 11. Determination of a drug of forensic interest by GC
 12. Determination of a drug / explosive of forensic interest by HPLC
 13. SEM Analysis-1(Metal fragment/Hair/Fiber/Paint/Ink)
 14. SEM Analysis-2(Metal fragment/Hair/Fiber/Paint/Ink)
- (Minimum 10 experiments to be completed)

Reference Books

1.	Petraco, N and Kubic, T. "Forensic Science Laboratory Manual and Workbook", 3 rd Edition, CRC Press, 2009
2.	Frank <i>Lundquist</i> , <i>Methods of Forensic Science</i> , Vol. 1, New York, Interscience, 1962.
3	Frank A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, Upper Saddle River, 1997.
4	S.H. James and J.J. Nordby, Forensic Science: An Introduction to scientific and Investigative Techniques, 2 nd Edition, CRC Press, Boca Raton, 2005.
5	Thomas Catalano, Good Laboratory Practices for Forensic Chemistry, Springer, 2014.
6	Alexeyev, V: Quantitative Analysis, CBS Pub, New Delhi, ISBN-10: 812390293X, ISBN-13: 978-8123902937, 2007.

7	J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas “Vogel’s Quantitative Chemical Analysis”, 6 th Edition, 7 th Impression, Dorling Kindersley limited, New Delhi, India, 2012.
Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	FORENSIC BOTANY, ENTOMOLOGY AND MICROBIAL FORENSICS	L	T	P	C
23FS3020		3	0	0	3

Course Objectives

Enable the student to:

1. Identify various botanical evidences.
2. Explore the basics of forensic entomology and its significance.
3. Investigate the relevance of microbial forensics.

Course Outcomes

Student will be able to:

1. Acquire knowledge about the essentials of forensic plant science.
2. Explore alternative kinds of botanical evidence.
3. Illustrate the basics of forensic entomology.
4. Summarize the basics of microbial forensics.
5. Anticipate importance of microbial forensics in health care.
6. Preserve various biological evidences.

Module: 1	FORENSIC BOTANY	9 Hours
Introduction, types, location, collection evaluation and forensic significance of fungi and plants in forensic science; wood and pollen grains- various types of planktons, diatoms and their forensic importance; Diatoms:- types, morphology and Forensic significance, identification of pollen grains		
Module: 2	BOTANICAL EVIDENCES	9 Hours
Different botanical evidences of forensic significance; Leaves, seeds, pollens, Limnology. Study of Various types of Poisonous PlantsPoisonous plants- Abrus precatorius, Argemone mexicana, Calotropis, Atropa belladonna, Gloriosa superba, Jatropha curcas, Nerium indicum, Nicotiana tabacum, Ricinus communis. Types of plants yielding drugs of abuse – opium, cannabis, coco, tobacco, Dhatura, Psilocybin mushrooms. Examination of plant foods (starch, herbs, spices & flavorings, fruits, vegetables).		
Module: 3	FORENSIC ENTOMOLOGY	9 Hours
Collection of entomological evidence during legal investigations, Laboratory rearing of forensic insects: Larval rearing, rearing containers, monitoring growth, larval dispersal in laboratory, Adult emergence, rearing aquatic insects, unique species requirements, rearing beetles in the laboratory, External factors affecting insect succession on carrion. Role of aquatic insects in forensic investigations, estimating the postmortem interval, soil environment and forensic entomology, Entomo-toxicology.		
Module: 4	MICROBIAL FORENSICS	9 Hours
Microbial Forensics: Epidemiology, Microbial forensic tools; Dynamics of disease transmission, Outbreak Investigation; Deliberate introduction of a biological agent; <i>Bacillus anthracis</i> , <i>Yersinia pestis</i> , <i>Francisella tularensis</i> , <i>Brucella spp.</i> , <i>Burkholderia Pseudomallei</i> , <i>Clostridium botulinum</i> , <i>Listeria monocytogenes</i> . DNA of microbes in soil for crime detection. Fungi of forensic importance: Opportunistic mycoses, <i>Chytridiomycota</i> <i>zygomycota</i> , <i>Aspergillus fumigates</i> , <i>Microsporidium</i> , <i>Pneumocytosis jiroveci</i> , <i>Asp.flavus</i> & <i>Candida</i> sp, epidemiology, Antifungal agents. Food borne – shigella, salmonella. Etc. Forensic Aspects of Biological Toxins.		
Module: 5	ANALYSIS OF MICROBIAL EVIDENCES	9 Hours

Microbial Forensic Analysis of Trace and Unculturable Specimens. Biological agents in warfare: Collection, transportation and preservation of microbial forensic samples. Diagnosing and tracking microbial diseases, Cholera, Influenza, Botulism, TB, hepatitis, SARS Role of microorganisms in body putrefaction process, Microbial profiles as identification tools, Microbial infections and human behavior (Rabies, polio, Syphilis, AIDS, filariasis).	
Total Lectures	45 Hours
Reference Books	
1.	Roberts, J., & Márquez-Grant, N. (Eds.). <i>Forensic ecology handbook: from crime scene to court</i> . John Wiley & Sons, 2012.
2.	Houck, M. M., & Siegel, J. A. <i>Fundamentals of forensic science</i> . Academic Press, 2009.
3.	Mozayani, A., & Noziglia, C. (Eds.). <i>The forensic laboratory handbook procedures and practice</i> . Springer Science & Business Media, 2010.
4.	Hall, D. W., & Byrd, J. <i>Forensic botany: a practical guide</i> . John Wiley & Sons, 2012.
5.	Coyle, H. M. <i>Forensic botany: principles and applications to criminal casework</i> . crc press, 2004.
Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	WILDLIFE AND ENVIRONMENTAL FORENSICS	L	T	P	C
23FS3021		3	0	0	3
Course Objectives					
Enable the student to:					
1. Recognize the application of forensics in protection of wildlife and endangered species.					
2. Articulate the emergence of environmental forensics.					
3. Summarize environmental pollutants and their detection.					
Course Outcomes					
Student will be able to:					
1. State the concepts of wildlife forensics and investigations involving wildlife.					
2. Explore and contribute to environmental forensics.					
3. Improve the methods for detecting environmental pollutants.					
4. Correlate crime detection with environmental legislation.					
5. Outline the Acts related to wildlife forensics.					
6. Validate the existing system for management of issues related to environment.					
Module: 1					
INTRODUCTION TO WILDLIFE				9 Hours	
Protected and endangered species of animals and plants; Sanctuaries and their importance; Importance of wild life and Environment. Types of wildlife crimes, different methods of killing and poaching of wildlife animals; Trade in wild animals Recovering evidence at poaching scenes, Locating the burial.; Development of wildlife forensic laboratories,. Enforcement of wildlife protection policy, relevant provision of wild life and environmental act; Wildlife (Protection) Act-1972.Forest Conservation Act 1981, Environment (protection) Act 1986.					
Module: 2					
ENVIRONMENTAL FORENSICS				9 Hours	
Introduction to Environmental Forensics. Mercury- Natural and anthropogenic sources, detecting mercury in indoor environment and forensic aspects. Asbestos-sources and detection in air, water, fibres etc. Sewage. Lead, Arsenic, Pesticides, Polycyclic aromatic hydrocarbons (PAHS), Crude oil and refined products - sources, compounds, analytical methods and lead forensics, sources, compounds.					

Module: 3	CONCEPT OF ECOSYSTEM	9 Hours
Ecosystem characteristics structure and function; environmental pollution , xenobiotic and recalcitrance, Introduction to BOD and COD, use of biosensors to determine the quality of environment, Concept of biosphere, communities and ecosystems; Bioremediation using microorganisms and plants, Genetically Modified Organisms to treat effluents; bioremediation of solid waste, industrial effluent containing organic pollutants and metal ions.		
Module: 4	ENVIRONMENTAL LEGISLATION	9 Hours
Environmental Legislation: central and state boards for the prevention and control of environmental pollution, powers and functions of pollution control boards, penalties and procedure, duties and responsibilities of citizens for environmental protection. The Water (Prevention and Control of Pollution) Act 1974. Prevention and Control of Air Pollution Act 1981, Hazardous waste (Management and Handling) Rules, 1989, Bio-Medical Waste (Management and Handling) Rules, 1998. Issues involved in enforcement of environmental legislation, public awareness, and public interest litigations (PILs) and its role in control of environmental pollution in India.		
Module: 5	ENVIRONMENTAL MANAGEMENT	9 Hours
Introduction and scope of environmental management, basic concepts of sustainable development, Environmental Impact Assessment (EIA), general guidelines for the preparation of environmental impact statement (EIS), international organization for standardization (ISO), ISO 14000 standards and certification, environmental safety, risk management and emergency preparedness, international summit and treaties, important dates dedicated to environmental management.		
Total Lectures		45 Hours
Reference Books		
1.	Gunn, A. Essential forensic biology. John Wiley & Sons, 2019.	
2.	THE WILDLIFE (PROTECTION) ACT, 1972	
3.	Huffman, J. E., & Wallace, J. R. Wildlife forensics: methods and applications. John Wiley & Sons, 2012.	
4.	Wildlife Crime A guide to the use of forensic and specialist techniques in the investigation of wildlife crime	
5.	James, S. H., & Nordby, J. J. Forensic science: an introduction to scientific and investigative techniques. CRC press, 2002.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	NARCOTIC AND PHARMACEUTICAL DRUG ANALYSIS	L	T	P	C
23FS3022		3	0	0	3
Course Objectives					
Enable the student to:					
1. Articulate the intricate pathways involved in drug metabolism. 2. Acquire proficiency in the diverse techniques employed for drug extraction from different matrices. 3. Summarize the methodologies utilized in drug analysis.					
Course Outcomes					
Student will be able to:					
1. Catalogue various types of drugs of abuse. 2. Classify sport drugs and prohibited substances in sports. 3. Illustrate narcotic drugs and its analysis.					

4. Summarize the principles of forensic pharmacology. 5. Practice the methods of extraction of drugs from various biological matrices. 6. Employ the methods of identification of drugs metabolites from various matrices.		
Module: 1	DRUG OF ABUSE	9 Hours
Introduction of drugs of abuse in sports, prohibited classes of substances, prohibited substances in Sport (alcohol and Beta Blockers), in competition (Narcotics, Stimulants, Cannabinoids, Glucocorticosteroids). Introduction of WADA, doping control policies and operational guidelines, identification of sport drugs by Instrumental, techniques such as GC, GC-MS, and HPLC; Case studies.		
Module: 2	DRUGS OF ABUSE IN SPORTS	9 Hours
Introduction of drugs of abuse in sports, prohibited classes of substances, prohibited substances in Sport (alcohol and Beta Blockers), in competition (Narcotics, Stimulants, Cannabinoids, Glucocorticosteroids). Introduction of WADA, doping control policies and operational guidelines, identification of sport drugs by Instrumental, techniques such as GC, GC-MS, and HPLC; Case studies.		
Module: 3	NARCOTIC DRUGS	9 Hours
Introduction to narcotic drugs, Classification of narcotic drugs, analysis of NDPS evidence by various procedures prescribed by DFS manual, spot tests, microcrystal tests, extraction methods and identification by TLC, UV-Vis spectrophotometry, IR spectrophotometry, GC-HPLC, MS, GC-MS, NMR and XRD as exemplified by cocaine, cannabis, amphetamines, opiates and hallucinogens (LSD, psilocybin and mescaline), evidence handling & sampling techniques, clandestine laboratory investigation and designer drugs; Case studies		
Module: 4	FORENSIC PHARMACOLOGY	9 Hours
Introduction to Forensic Pharmacology, routes of drug administration, Pharmacokinetics: membrane transport, absorption and distribution, metabolism and excretion of drugs. Pharmacokinetics parameters: clearance, volume of distribution, bioavailability and half-life. Therapeutic drug monitoring. Pharmacodynamics: mechanism of drug action. Adverse drug effect.		
Module: 5	EXTRACTION AND ANALYSIS OF DRUG FROM VARIOUS MATRICES	9 Hours
Methods of extraction of drugs (from all the three major classes) from various matrices including viscera, stomach wash, vomit, urine, blood, suspected drinks/foods; subsequent detection and quantification of extracted drugs from spot test and instrumental methods; Case studies.		
Total Lectures		45 Hours
Reference Books		
1.	Moffat, A. C. Osselton, M. D, Widdop, B and Watts, J, "Clarke's Analysis of Drugs and Poisons" Fourth Edition, Pharmaceutical Press: London, 2011.	
2.	Curtis D. Klaassen, "Casarett & Doull's Toxicology: The Basic Science of Poisons" 9th Edition, McGraw-Hill Education, 2019.	
3.	Modi, "Text Book of Medical Jurisprudence Forensic Medicines and Toxicology" CBS Pub. New Delhi, 1999.	
4.	Saferstein. R, "Forensic Science Handbook", Volumes I, II and III, 2 nd Edition, Pearson, 2001.	
5.	Clark E.G C; Isolation and Identification of drugs Vol. I and Vol.2, Academic Press, 1986.	
6.	K.S.N.Reddy- The essential of Forensic Medicine & Toxicology 21 st Edition 2002.	
7.	C.K.Parikh- A text book of Medical Jurisprudence, Forensic Medicine & Toxicology, CBS Publishers, Delhi, 6 th Edition 1999.	
8.	DFS manual- Narcotics	

Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	FORENSIC SEROLOGY	L	T	P	C
23FS3023		3	0	0	3

Course Objectives

Enable the student to:

1. Acknowledge the different types of body fluids.
2. Enumerate the variations, grouping, and concepts of antigen-antibody interactions.
3. Illustrate the techniques used for the examination of serological evidence.

Course Outcomes

Student will be able to:

1. Define and categorize the diverse range of bodily fluids.
2. Differentiate the contents of blood, blood variations and blood grouping.
3. Establish the fundamental principles underlying antigen-antibody interactions.
4. Illustrate the theory of techniques involved in examination of serological evidences.
5. Realize the antigen-antibody interaction.
6. Report on various diseases related to immune-deficiencies.

Module: 1	BODY FLUIDS ANALYSIS	9 Hours
Body fluid analysis: Types and distribution of body fluids, formation and function. urine formation, composition, properties, abnormal constituents and clinical significance, Beta HCG; CSF, lymph, synovial fluid, gastrointestinal secretions composition, formation and function; serous fluid, , aqueous humour. Collection and preservation of biological fluids. Identification of body fluids		
Module: 2	ABO BLOOD GROUPING SYSTEM	9 Hours
Blood and its variants Blood composition, Blood group antigens the classification of blood cell antigens, Blood transfusions and the immune. Transfusion reactions: Immune-mediated, Transfusion reactions: Non-immune, Haemolytic disease of the new-born (HDN), significance of maternal antibodies, Coombs test, Background information, Basic biochemistry, Molecular information , Clinical significance of ABO blood group , Hh blood group, Rh blood group,		
Module: 3	OTHER BLOOD GROUP SYSTEMS	9 Hours
Kell blood group, Duffy blood group, Kidd blood group, Diego blood group, MNS blood group. Examination of Menstrual blood, amniotic fluid and parturition stains. Haemoglobin variants- Hbf – Hbs– Hbc – HbA - Determination of sex and race from blood- White blood group system HLA and its forensic significance.		
Module: 4	ANTIGEN-ANTIBODY INTERACTION	9 Hours
Antigens, Antibodies, Antigen-Antibody interactions Antigen-antibody interactions; Major Histocompatibility complex and MHC restriction, structure and functions; B-cell receptor and T-cell receptor, Cytokines, Hypersensitivity, immunity to microbes (protozoa, bacteria, fungi, intracellular parasites, Helminthes & viruses); AIDS and other immune-deficiencies. Hybridoma technology and monoclonal antibodies; Vaccine: natural, synthetic & genetic,		
Module: 5	BLOTTING TECHNIQUES	9 Hours
Blotting techniques: Theory and general principles, Various factors affecting electrophoresis, low and high voltage electrophoresis, horizontal and vertical Electrophoresis; Serological techniques primary binding assays-ELISA Immunochromatographic Assays, Secondary Binding Assays precipitin-based Assays (Immunodiffusion, electrophoretic methods).Agglutination based Assays (Direct agglutination Assay, passive agglutination Assay, Agglutination Inhibition assay)		

Total Lectures	45 Hours
Reference Books	
1.	Gunn, A. (2019). <i>Essential forensic biology</i> . John Wiley & Sons, 2019.
2.	Li, R., Norman, S., & Schober, J. <i>Forensic biology</i> . CRC Press, 2015.
3.	Saferstein, R. <i>Criminalistics: An introduction to forensic science</i> (Vol. 201, No. 1). Upper Saddle River, NJ: Prentice Hall, 2001.
4.	Houck, M. M., & Siegel, J. A. <i>Fundamentals of forensic science</i> . Academic Press, 2009.
5.	Miller, M. T. <i>Crime scene investigation</i> . <i>Forensic science: An introduction to scientific and investigative techniques</i> , 115-135, 2003.
6.	Gaensslen, R. E. <i>Sourcebook in forensic serology, immunology, and biochemistry</i> (p. 628). Washington, DC: US Department of Justice, National Institute of Justice, 1983.
7.	Mozayani, A., & Noziglia, C. (Eds.). <i>The forensic laboratory handbook procedures and practice</i> . Springer Science & Business Media, 2010.
Recommended by Board of Studies	
Approved by Academic Council	25 Aug 2023

Course Code	ANALYTICAL TECHNIQUES IN FORENSIC SCIENCE	L	T	P	C
23CH3024		3	0	0	3
Course Objectives					
Enable the student to: 1. Acknowledge the various fields of analytical chemistry. 2. Recognize the methods of qualitative methods of analysis. 3. Enunciate the principles of quantitative methods of analysis.					
Course Outcomes					
The student will be able to: 1. Describe the methods involved in analytical techniques in forensic analysis. 2. Group the terms used in analytical chemistry. 3. Interpret the results from analytical tests. 4. Evaluate the importance of volumetric analysis. 5. Justify the significance of gravimetric analysis in forensic. 6. Devise the various types of separation methods.					
Module: 1	SIGNIFICANCE OF ANALYTICAL CHEMISTRY	9 Hours			
Nature and scope of analytical chemistry in Forensic chemical analysis -Concept of Mole, Molecular Mass and Molecular Weight,- Classification of analytical methods - Conventional and instrumental methods of analysis - Theoretical principles of analytical chemistry – Law of mass action and its application – Le Chatelier and Braun principle –Dissociation theory – Electrolytes and non-electrolytes – Classification of acids, bases and salts according to their degree of dissociation – Dissociation of acids, bases and salts – Dissociation constants – Common ion effect – Solubility product – Ionization of water – pH value – pOH value – Relation between pOH & pH scale – pH scale - Buffer solutions - Buffer action – Preparation of buffer solutions –Scientific Calculations: Scientific volume and weight measurements, Density, Specific gravity, Specific Volume, Percentage, Ratio Strength, and other Expressions of Concentration					
Module: 2	QUALITATIVE ANALYSIS	9 Hours			

Organic reagents in detection of inorganic ions – Oxidizing and reducing agents in organic chemistry – Inorganic and organic spot tests – Micro chemical tests – Physical tests –Colour spot tests in Forensic Biological, Chemical and Physical analysis, Microcrystalline test -Centrifugation Techniques, Basic principles of sedimentation, types of centrifuges - Group separations for cations and anions – Interfering radicals - Elemental analysis of organic compounds– Functional group analysis – Schemes of identification of unknown solids, liquids and gases (inorganic and organic)		
Module: 3	VOLUMETRIC METHOD OF ANALYSIS	9 Hours
Titrimetric methods of analysis – General principle – Equivalence point and end point –Fundamental requirement of a titrimetric method – Standard solution – Detection of end point – Indirect titrations– Calculations in titrimetry – Aqueous acid-base titrimetry –Preparation of standard solutions – Primary standards – Indicators – Theory of indicators –Acid-base titrimetry in nonaqueous solvents – Redox titrimetry – Oxidation and reduction – Oxidant and reductant – Iodimetry and iodometry Permanganometry – Dichromatometry – Precipitation methods –Argentometry – Complexometry – EDTA methods		
Module: 4	GRAVIMETRIC METHOD OF ANALYSIS	9 Hours
Gravimetric methods of analysis – Basic Digestion of precipitates – Washing of precipitates – Drying and ignition of precipitates – Thermal decomposition of precipitates – Organic precipitants – examples - Factors affecting gravimetric analysis – Requirements of quantitative separation – The process of precipitation – Saturated and supersaturated solution – Nucleation – Crystal growth – Conditions of precipitation – Completeness of precipitation – Factors influencing solubility – Purity of a precipitate – Adsorption of ions on precipitates - Coprecipitation – Occlusion and post-precipitation		
Module: 5	CHEMICAL SEPARATION TECHNIQUES	9 Hours
Physical separation methods – Distillation – Extraction – Precipitation –Crystallization - Solvent extraction (Liquid-liquid extraction), Solid phase extraction, Solid phase microextraction (SPME). Phenolphthalein in trap case: Chemistry and Forensic examination of Phenolphthalein used in Bribe trap cases, and related legal issues.		
Total Lectures		45 Hours
Reference Books		
1.	Alexeyev, V. N: Qualitative Chemical Semi micro Analysis, CBS Pub., New Delhi, ISBN10: 9788123902791, ISBN-13: 978-8123902791, 2004.	
2.	Alexeyev, V: Quantitative Analysis, CBS Pub, New Delhi, ISBN-10: 812390293X, ISBN13: 978-8123902937, 2007.	
3.	Feigl, F and Anger, V, “Spot Tests in Inorganic Analysis”, Elsevier, ISBN10: 0444409297; ISBN-13: 978-0444409294, 1982.	
4.	F. Feigl and Anger, V, “Spot Tests in Organic Analysis”, 7 th Edition, Elsevier, 1983	
5.	Harris, D. C “Quantitative Chemical Analysis”, 9 th Edition., W. H. Freeman Publishers; ISBN-13: 978-1464135385, ISBN-10: 146413538X, 2015.	
6.	Vogel, A: Qualitative Organic Analysis, 2 nd Edition., CBS Pub, New Delhi, 2002	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

Course Code	NANOTECHNOLOGY APPLICATIONS IN FORENSIC SCIENCE	L	T	P	C
23FS3025		3	0	0	3
Course Objectives					
Enable the student to:					
1. Acquire knowledge about nanomaterials.					
2. Analyze the synthesis of nanomaterials.					

3. Identify the use of nanomaterials in Forensic Science.		
Course Outcomes		
The student will be able to		
1. Comprehend the evolution of nanotechnology.		
2. Classify nanomaterials.		
3. Assess the various types of synthetic methodologies of nanomaterials.		
4. Characterize the nanomaterials using different techniques.		
5. Explore the applications of nanomaterials.		
6. Fabricate nanomaterials for forensic science.		
Module: 1	BASICS OF NANOTECHNOLOGY	9 Hours
Historical landmarks - terminology-scales. Classification of nanomaterials based on dimension - Topdown and bottom-up approaches - Comparison. – Challenges in nanotechnology - Top down methods – Core shell nanomaterials – Toxic effect of nanomaterials- Existing laws and regulations of nanotechnology- regulatory agencies- green nanotechnology- nanoethics - future of nanotechnology.		
Module: 2	SYNTHESIS OF NANOMATERIALS	9 Hours
Synthesis of metallic, semiconductor and oxide nanoparticles – sol-gel- method – Synthesis by reduction - One dimensional nanoparticles – nanowires and nanorods – VLS method – electrospinning – Lithography – Two dimensional nanomaterials – PVD – Molecular beam epitaxy - CVD - Self Assembly		
Module: 3	SPECIAL NANOMATERIALS AND METHODS	9 Hours
Fullerenes – types - carbon nanotubes – types - Micro and mesoporous nanomaterials – Soft lithography - Dip pen nanolithography		
Module: 4	APPLICATIONS OF NANOTECHNOLOGY-I	9 Hours
Applications of nanotechnology in various fields – Electronics, Catalysis and Biology - Nanobiology and its applications- Nanomedicines- immuno targeted drug delivery-- nanoparticle drug systems for oral, nasal, and ocular administration- nanomaterials in medical diagnosis - therapeutic applications. Nanosensors- smart dusts.		
Module: 5	APPLICATIONS OF NANOTECHNOLOGY-II	9 Hours
Utilization of nanotechnology in analysis of physical evidences, selectivity of nanoparticles with compatibility and feasibility, Application of nanotechnology in forensic evidence analysis- Forensic Applications: Collection and analysis of evidence of different types of crime scenes including drugs, DNA analysis, blood splattering, serology, toxicology		
Total Lectures		45 Hours
Text Books		
1.	Guozhong Cao,Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial press, 2004.	
2.	Pradeep, Nano: The Essentials, Mc Graw Hill Publishing Company, New Delhi, 2007.	
3.	V. S. Muraleedharan and A. Subramania, Nanosciece and nanotechnology, Ane Books Pvt. Ltd. New Delhi, 2009.	
4.	C. N. R. Rao and A. Govindraj, Nanotubes and Nanowires, Royal Society of Chemistry, 2005.	
5	J. M. M. Duart, R. J. M. Palma and F.A. Rueda, Nanotechnology and Microelectronics and optoelectronics, Elsevier, 2002.	
Recommended by Board of Studies		
Approved by Academic Council		25 Aug 2023

ERRATA IN THE CURRICULUM OF B.Sc. (Optometry) 2020 batch onwards

The one-year internship for 40 credits mentioned in the Academic Handbook 2020 is changed as follows. This is to be followed from 2020 batch onwards.

SEMESTER VII

Course code	Name of the Course	Credit
20OP2998	Clinical Internship - I	0:0:20

SEMESTER VIII

Course code	Name of the Course	Credit
20OP2999	Clinical Internship - II	0:0:20

The internal assessment and end semester marks distribution for internship will be carried out as follows for both the above codes.

CLINICAL INTERNSHIP – MARK DISTRIBUTION

Online Review	Marks
Intermittent Reviews – I to III	30
Report with the final Review	30
End semester seminar and Viva Voce	40
Total	100

DIVISION OF PHYSICAL SCIENCES (PHYSICS)

M.Sc (Physics) – 2023-2024 Batch

COURSE COMPONENTS

Table 1 (Program core – 61 credits & a part semester project)

S.No	Course Code	Course Title	Credits
1	23PH3001	Classical Mechanics	3:0:0
2	23PH3002	Thermodynamics and Statistical Mechanics	3:1:0
3	23PH3003	Mathematical Physics I	3:1:0
4	23PH3004	Semiconductor Physics	3:0:0
5	23PH3005	Quantum Mechanics I	3:0:0
6	23PH3006	Mathematical Physics II	3:1:0
7	23PH3007	Spectroscopy I	3:0:0
8	23PH3008	Electromagnetic Theory	3:0:0
9	23PH3009	Quantum Mechanics II	3:0:0
10	23PH3010	Spectroscopy II	3:0:0
11	23PH3011	Nuclear and Particle Physics	3:0:0
12	23PH3012	Solid State Physics	3:0:0
13	23PH3013	Physics of Nanomaterials	3:0:0
14	23PH3014	Thin Film Technology	3:0:0
15	23PH3015	Astronomy and Astrophysics	3:0:1
16	23PH3016	General Physics Lab I	0:0:2
17	23PH3017	General Physics Lab II	0:0:2
18	23PH3018	Advanced Physics Lab I	0:0:2
19	23PH3019	Advanced Physics Lab II	0:0:2
20	23PH3020	Computational Physics Lab	0:0:2
21	23PH3021	Materials Characterization Lab	0:0:2
		Total Credits	61
18	PSP3998	Part Semester Project	12
		Total	73

Table 2

S.No	Subject Code	Electives Min. of 12 credits to be earned from Electives	Credits
		Name of the Subject	
1	23PH3022	Material Characterization	3:0:0
2	23PH3023	Nanoelectronics	3:0:0
3	23PH3024	Renewable and Sustainable Energy Sources	3:0:0
4	23PH3025	Lasers and Fiber Optics	3:0:0
5	23PH3026	Space Physics	3:0:0
6	23PH3027	Atmospheric Physics	3:0:0
7	23PH3028	Forensic Physics	3:0:0
8	23PH3029	Defence Physics	3:0:0
9	23PH3030	Introduction to IPR and Entrepreneurship	3:0:0
10	23PH3031	Solid State Batteries	3:0:0
11	23PH3032	Quantum Computing in AI	3:0:0
12	23PH3033	Relativity and Cosmology	3:0:0
13	23PH3034	Crystal Growth Techniques	3:0:0
14	23PH3035	Radiation Physics	3:0:0

Table 3 (Credit Distribution)

Courses	Credits
Core	73
Elective	18
Total Credits	91

SEMESTERWISE CURRICULUM**SEMESTER-I**

S.No	Course Code	Course Title	Credits
1	23PH3001	Classical Mechanics	3:0:0
2	23PH3002	Thermodynamics and Statistical Mechanics	3:1:0
3	23PH3003	Mathematical Physics I	3:1:0
4	23PH3004	Semiconductor Physics	3:0:0
5	23PH3014	Thin Film Technology	3:0:0
6	23PH3028	Forensic Physics	3:0:0
7	23PH3016	General Physics Lab I	0:0:2
8	23PH3017	General Physics Lab II	0:0:2
		TOTAL	24

SEMESTER-II

S.No	Course Code	Course Title	Credits
1	23PH3005	Quantum Mechanics I	3:0:0
2	23PH3006	Mathematical Physics II	3:1:0
3	23PH3007	Spectroscopy I	3:0:0
4	23PH3008	Electromagnetic Theory	3:0:0
5	23PH3013	Physics of Nanomaterials	3:0:0
6	23PH3024	Photovoltaics	3:0:0
7	23PH3018	Advanced Physics Lab I	0:0:2
8	23PH3019	Advanced Physics Lab II	0:0:2
		TOTAL	23

SEMESTER-III

S.No	Course Code	Course Title	Credits
1	23PH3009	Quantum Mechanics II	3:0:0
2	23PH3010	Spectroscopy II	3:0:0
3	23PH3011	Nuclear and Particle Physics	3:0:0
4	23PH3012	Solid State Physics	3:0:0
5	23PH3022	Material Characterization	3:0:0
6	23PH3030	Introduction to IPR and Entrepreneurship	3:0:0
7	23PH3020	Computational Physics Lab	0:0:2
8	23PH3021	Materials Characterization Lab	0:0:2
		TOTAL	22

SEMESTER-IV

S.No	Course Code	Course Title	Credits
1	23PH3015	Astronomy and Astrophysics	3:0:1
2	23PH3026	Space Physics	3:0:0
3	23PH3027	Atmospheric Physics	3:0:0
4	PSP3998	Part Semester Project	12
		Total	22
		Total	91

LIST OF NEW COURSES

S.No	Course Code	Course Title	Credits

1	22PH3001	Solid State Ionics and Energy Devices	4:0:0
2	23PH3001	Classical Mechanics	3:0:0
3	23PH3002	Thermodynamics and Statistical Mechanics	3:1:0
4	23PH3003	Mathematical Physics I	3:1:0
5	23PH3004	Semiconductor Physics	3:0:0
6	23PH3005	Quantum Mechanics I	3:0:0
7	23PH3006	Mathematical Physics II	3:1:0
8	23PH3007	Spectroscopy I	3:0:0
9	23PH3008	Electromagnetic Theory	3:0:0
10	23PH3009	Quantum Mechanics II	3:0:0
11	23PH3010	Spectroscopy II	3:0:0
12	23PH3011	Nuclear and Particle Physics	3:0:0
13	23PH3012	Solid State Physics	3:0:0
14	23PH3013	Physics of Nanomaterials	3:0:0
15	23PH3014	Thin Film Technology	3:0:0
16	23PH3015	Astronomy and Astrophysics	3:0:1
17	23PH3016	General Physics Lab I	0:0:2
18	23PH3017	General Physics Lab II	0:0:2
19	23PH3018	Advanced Physics Lab I	0:0:2
20	23PH3019	Advanced Physics Lab II	0:0:2
21	23PH3020	Computational Physics Lab	0:0:2
22	23PH3021	Materials Characterization Lab	0:0:2
23	23PH3022	Material Characterization	3:0:0
24	23PH3023	Nanoelectronics	3:0:0
25	23PH3024	Renewable and Sustainable Energy Sources	3:0:0
26	23PH3025	Lasers and Fiber Optics	3:0:0
27	23PH3026	Space Physics	3:0:0
28	23PH3027	Atmospheric Physics	3:0:0
29	23PH3028	Forensic Physics	3:0:0
30	23PH3029	Defence Physics	3:0:0
31	23PH3030	Introduction to IPR and Entrepreneurship	3:0:0
32	23PH3031	Solid State Batteries	3:0:0
33	23PH3032	Quantum Computing in AI	3:0:0
34	23PH3033	Relativity and Cosmology	3:0:0
35	23PH3034	Crystal Growth Techniques	3:0:0
36	23PH3035	Radiation Physics	3:0:0
37	23PH3036	Biomaterials	4:0:0
38	23PH3037	Radiation Treatment and Planning	4:0:0
39	23PH3038	Medical Radiation Dosimetry	4:0:0

Course Code	SOLID STATE IONICS AND ENERGY DEVICES	L	T	P	C
22PH3001		4	0	0	4
Course Objectives:					
Enable the student to:					
1. Explain the role of ionic and mixed conductors in energy devices.					
2. Analyze the electrical properties of materials used in energy devices.					
3. Compare the types of energy storage devices and their testing methods.					
Course Outcomes:					
The student will be able to:					
1. Investigate the types of materials based on their structure.					
2. Distinguish the electrical properties of mixed and ionically conducting materials.					

3. Analyze the electrical and electrochemical properties of materials. 4. Apply the knowledge of materials for making energy devices. 5. Evaluate the energy storage devices. 6. Design advanced energy devices.		
Module: 1	MATERIALS FOR ENERGY STORAGE	12 Hours
Major Types of Solids: Crystalline Solids- Definition; Ionic, Molecular, Covalent and Metallic solids- their comparison based on interaction, properties and examples-properties of major classes of solids. Ionic and Molecular Solids- London Dispersion Forces; Hydrogen bonding; Metallic bonding- Metallic solids; molecular solids –covalent network solids- Diamond-Graphite-Graphene structure and properties-Carbon-Fullerenes-Carbon nanotubes structure and properties-single and multi-walled; lattice energy in ionic solids. Polymers-synthetic and natural polymers-biodegradable and non-biodegradable polymers- examples-advantages and disadvantages of synthetic and natural polymers; polymer blending-immiscible- compatible and miscible polymer blending.		
Module: 2	TYPES OF CONDUCTORS FOR ENERGY STORAGE	12 Hours
Fast ion conductors and superionic conductors- definition and examples; Beta alumina in solid electrolyte-history, structure, conduction and production-application; lithium ion conductor- LISICON and sodium ion conductor- NASICON; mixed conductors – definition and examples. Polymer membranes for ionic transport; types – solid, gel, plasticized, composites- mechanism of ion transport: crystalline and amorphous region in polymer electrolyte- liquid like ionic transport-Walden Rule- Glass transition temperature-need for polymer with low glass transition temperature-solid like ionic transport in polymer electrolytes-Anderson Stuart model- inclusion of ion jump length- need for increase in dielectric constant of polymer; plasticizers vs. inorganic fillers – their role in ionically conducting polymer electrolytes.		
Module: 3	ELECTRICAL PROPERTIES OF MATERIALS FOR ENERGY STORAGE	12 Hours
Electrical conductivity of ionically conducting materials: AC Impedance spectroscopy – non-destructive method-impedance plot of sample sandwiched between two blocking electrodes vs. sandwiched between two non-blocking electrodes - Impedance plots of simple circuits-A pure resistance, A Pure capacitor, R & C connected in series and parallel, formula and concepts of Nyquist plot- conductivity plot- calculation of conductivity; dielectric constant, dielectric loss, modulus – real and imaginary, loss tangent-temperature dependent Arrhenius plot and calculation of activation energy. Modulus vs. frequency – calculation of ion relaxation time; Transference number measurements – Wagner Polarization method-Four probe method.		
Module: 4	TYPES OF ENERGY STORAGE DEVICES	12 Hours
Applications of ionically conducting and mixed materials: Nanoionics-definition- difference between 1 D, 2D and 3 D nanostructures- changes in band gap- role of nanofillers in ionically conducting polymer electrolytes – Quantum dot materials for solid state devices. Properties of electrode materials for energy devices- nano scale effect- potential application in electrochemical devices- Supercapacitor: types & definitions; Electrical Double Layer Capacitor (EDLC) - activated carbon- carbon quantum dots-properties of carbon materials as an electrode for EDLC-design of EDLC with carbon electrodes and ionically conducting polymer electrolytes – working mechanism- application. Symmetric vs. Asymmetric supercapacitors; Design of supercapacitor devices with pseudocapacitive materials-Role of ionically conducting polymer electrolyte in Battery applications: sodium ion battery with polymer electrolyte – working mechanism; Hard carbon – structure and properties- application in batteries.		
Module: 5	TESTING OF ENERGY STORAGE DEVICES	12 Hours
Testing of solid state devices: Three electrode system for testing materials- role of working, reference and counter electrodes; two electrode system- solid state device testing- difference between Faradaic and non-Faradaic process- difference in cyclic voltammetry of EDLC, pseudocapacitor, hybrid capacitor, supercapattery, and battery. Differences in Electrochemical signature of Charge-discharge process of solid state devices-Analysis of Electrochemical impedance spectroscopy of solid state devices.		

Total Lectures		60 Hours
Reference Books		
1.	Anish Khan, Abdullah M. Asiri, Rajender Boddula, Aleksandr Kolosov, "Handbook of Supercapacitor Materials: Synthesis, Characterization, and Applications", Wiley publishers, 2021, ISBN 9783527346875	
2.	Guozhen Shen, Zheng Lou, Di Chen, "Flexible Supercapacitors: Materials and Applications", Wiley publishers, 2022, ISBN: 978-1-119-50616-4	
3.	Aiping Yu, Victor Chabot, Jiuju Zhang, "Electrochemical supercapacitors for energy storage and delivery: fundamentals and applications", CRC press, 2017, ISBN 9781315216942	
4.	Ashok Kumar, Shyamal Kumar Das, "Energy Storage and Conversion: Materials and Devices", 2017, Narosa Publishing House, 2017, ISBN- 978-8184875782	
5.	Seth Fletcher, "Bottled Lightning: Super batteries, electric cars and the new lithium economy", Kindle edition, 2020, ISBN 978-0-8090-3053-8	
Recommended by Board of Studies		5.5.2023
Approved by Academic Council		03 June 2023

Course Code	CLASSICAL MECHANICS	L	T	P	C
23PH3001		3	0	0	3
Course Objectives:					
Enable the student to:					
1. Examine the equations of motion for complex systems using the Lagrangian and Hamiltonian formulations. 2. Operate on the systems with central force problem and rigid body motion. 3. Choose the theoretical methods like variation principle and Hamilton Jacobi theory for elementary mechanical systems.					
Course Outcomes:					
The student will be able to:					
1. Employ the Lagrangian concept to deduce the physical significance of linear, angular momentum and energy. 2. Assess the mathematical results in physical terms using central force problem. 3. Demonstrate the kinematics of rigid body and oscillating system. 4. Apply the techniques and results of classical mechanics to real time problems. 5. Evaluate the motion of physical systems with Hamilton formulation and Hamilton Jacobi equation. 6. Correlate classical mechanics with the special theory of relativity.					
Module: 1	LAGRANGIAN FORMULATION	9 Hours			
One and many particle systems - Constraints – Generalized co-ordinates – Lagrange’s equations of motion from D’Alembert’s principle - Applications of the Lagrangian formulation.					
Module: 2	CENTRAL FORCE PROBLEM	9 Hours			
Reduction to an equivalent one body problem – The equation of motion and first integral – Kepler Problem: Inverse square law of force and classification of orbits –Scattering in a central force field.					
Module: 3	THE HAMILTON FORMULATION	9 Hours			
Canonical Transformations and the Hamilton equation of motion – Cyclic coordinates – Hamiltonian-Jacobi Theory - Hamilton-Jacobi equations for principle function-Harmonic Oscillator problem as an example of the Hamilton-Jacobi method.					
Module: 4	RIGID BODY DYNAMICS AND SMALL OSCILLATIONS	9 Hours			

The independent coordinates of a rigid – The Euler Angles – Symmetric top and its applications – General theory of Small Oscillations – normal coordinates and normal modes of vibration - Example of coupled oscillator– normal modes of a linear triatomic molecule.		
Module: 5	SPECIAL THEORY OF RELATIVITY	9 Hours
Internal frames – principle and postulate of relativity – Michelson-Morley Experiment- Lorentz transformations – length contraction, time dilation and the Doppler effect – velocity addition formula – relativistic invariance of physical laws.		
Total Lectures		45 Hours
Reference Books		
1.	H. Goldstein, “Classical Mechanics” , Narosa publishing house, 3rd Edition 2011 ISBN-9788131758915	
2.	Matthew J. Benacquista, Joseph D. Romano “Classical Mechanics”, Springer International Publishing, 2018, ISBN – 9783319687803.	
3.	H.C. Corben, Philip Stehle “Classical Mechanics”, Dover Publications 2013, ISBN – 9780486140780.	
4.	P. C. Deshmukh “Foundations of Classical Mechanics”, Cambridge University Press, 2019, ISBN – 9781108480567.	
Recommended by Board of Studies		05.05.2023
Approved by Academic Council		03 June 2023

Course Code	THERMODYNAMICS AND STATISTICAL MECHANICS	L	T	P	C
23PH3002		3	1	0	4
Course Objectives:					
Enable the student to:					
1. Apply the laws of thermodynamics and thermodynamic relationships.					
2. Deduce the statistical basis of thermodynamic principles.					
3. Analyze the principles of the three types of statistics that form the base of statistical mechanics.					
Course Outcomes:					
The student will be able to:					
1. Investigate a system based on the four laws of thermodynamics and their consequences.					
2. Assess the various thermodynamic relationships based on Maxwell’s thermodynamic equations.					
3. Apply the statistical basis of thermodynamics to various systems and understand their nature.					
4. Analyze the principles of Maxwell Boltzmann Statistics and how they are applied to classical systems.					
5. Evaluate the importance of quantum statistics to fundamental particles such as bosons and fermions.					
6. Design new mechanical thermodynamic systems with greater efficiency based on thermodynamic principles.					
Module: 1	THE LAWS OF THERMODYNAMICS	12 Hours			
Introduction – Thermodynamic System – Zeroth Law of Thermodynamics – Concept of Heat – Internal Energy – First Law of Thermodynamics – Specific Heats of a Gas – Applications of the First Law – Reversible and Irreversible Processes – Carnot’s Ideal Heat Engine – Carnot’s Cycle – Refrigerator – Second Law of Thermodynamics – Carnot’s Theorem – Concept of Entropy – Change and Increase in Entropy – The T-S Diagram – Zero of Absolute Scale – Third Law of Thermodynamics: Nernst’s Heat Theorem – Zero Point Energy – Negative Temperatures – Heat Death of Universe.					
Module: 2	THERMODYNAMIC RELATIONSHIPS	12 Hours			

Introduction – Thermodynamic Variables – Extensive and Intensive Variables – Maxwell’s Thermodynamic Relations – Applications – Clausius-Clapeyron’s Equation – Thermodynamic Potentials – Internal Energy – Helmholtz Free Energy – Enthalpy – Gibbs Free Energy – Relation of Thermodynamic Potentials with their Variables – The T.dS Equations – Clausius Inequality – Entropy and the Second Law of Thermodynamics – First Order Phase Transitions – Second Order Phase Transitions: Ehrenfest’s Equations – EMF of a Reversible Cell.		
Module: 3	STATISTICAL BASIS OF THERMODYNAMICS	12 Hours
Introduction – Statistical Basis – Probability – Permutations and Combinations – Macrostate and Microstate – Thermodynamic Probability – Static and Dynamic Systems – Most Probable State – Ensemble and Average Properties – Degrees of Freedom – Fundamental Postulates of Statistical Mechanics – Density of Quantum States – Statistical Ensembles – Comparison of Ensembles – Equilibrium between Two Systems in Thermal Contact – Bridge with Macroscopic Physics – Entropy and Probability – Boltzmann’s Canonical Distribution Law – The Equipartition of Energy – Statistical Interpretation of Second Law of Thermodynamics – Gibb’s Paradox.		
Module: 4	MAXWELL BOLTZMANN STATISTICS	12 Hours
Introduction – Three Kinds of Particles – M.B. Statistics Applicable to Ideal Gas – Maxwell-Boltzmann Energy Distribution Law – Applications of Maxwell-Boltzmann Distribution Law – Mean, RMS and Most Probable Speeds – Maxwell’s Distribution Law of Velocities – Doppler Broadening of Spectral Lines – Limitations of Maxwell-Boltzmann’s Method –Experimental Verification of Maxwellian Distribution of Molecular Speeds.		
Module: 5	QUANTUM STATISTICS	12 Hours
Introduction – Need for Quantum Statistics – Development of Quantum Statistics – ‘h’ as a Natural Constant – Indistinguishability of Particles and its Consequences – Bose-Einstein Distribution Law – Photon Gas – Planck’s Radiation Law – Fermi-Dirac Distribution Law – Free Electrons in Metal: Electron Gas – Fermi Level and Fermi Energy – Fermi-Dirac Velocity Distribution – Application to Liquid Helium – Comparison and Differences between Classical and Quantum Statistics.		
Total Lectures		60 Hours
Reference Books		
1.	Brij Lal, N.Subrahmanyam, and P.S. Hemne, Heat, Thermodynamics, and Statistical Physics, New Delhi: S. Chand, 2023, ISBN – 978-8121928137.	
2.	Daniel Blankschtein, Lectures in Classical Thermodynamics with an Introduction to Statistical Mechanics, Switzerland: Springer Nature, 2022, ISBN – 978-3030492007.	
3.	Richard Fitzpatrick, Thermodynamics and Statistical Mechanics, New Delhi: World Scientific, 2021, ISBN – 978-0000990396.	
4.	S.C.Garg, R.M. Bansal, and C.K. Ghosh, Thermal Physics: With Kinetic Theory, Thermodynamics, and Statistical Mechanics, New Delhi: McGraw Hill Education, 2017, ISBN – 978-1259003356.	
5.	M.Scott Shell, Thermodynamics and Statistical Mechanics, London: Cambridge University Press, 2015, ISBN – 978-1107656789.	
Recommended by Board of Studies		05.05.2023
Approved by Academic Council		03 June 2023

Course Code	23PH3003 MATHEMATICAL PHYSICS I	L	T	P	C
23PH3003		3	1	0	4
Course Objectives:					

Enable the student to:		
1. Articulate knowledge of basic and advanced levels of vectors and matrices. 2. Demonstrate the use of differential equations and special functions in solving physics problems. 3. Solve the problems in physics using mathematical principles.		
Course Outcomes:		
The student will be able to:		
1. Analyze the physics problems based on vector calculus using Gauss's, Green's, and Stoke's theorems. 2. Evaluate linear systems, matrix inverses, Eigen values, and Eigen vectors. 3. Solve ordinary differential equations of second order. 4. Express any physical law in terms of tensors and coordinate transforms. 5. Correlate the theory of probability, various distribution functions, errors, and residuals. 6. Apply mathematical concepts to solve the problems in physics.		
Module: 1	VECTOR ANALYSIS	12 Hours
Addition, Subtraction, multiplication of vectors –Simple Problems –Magnitude of Vectors – Linear Combination of vectors –Simple problems – Product of two vectors – Triple product of vectors - Simple applications of vectors to Mechanics – Work done by force - Torque of a force-Force on a particle in magnetic field-Force on a charged particle- Angular velocity - Differentiation of vectors – Scalar and vector fields - Gradient, Divergence and Curl operators – Integration of vectors – Line, surface and volume integrals – Gauss's Divergence theorem – Green's theorem – Stoke's theorem		
Module: 2	MATRICES	12 Hours
Equality of matrices – Matrix Addition, multiplication and their properties –Special matrices –Definitions: Square matrix, Row matrix, Null matrix, Unit matrix, Transpose of a matrix, Symmetric and skew symmetric matrices, Conjugate of matrix Adjoint of matrix (Simple problems)- Unitary matrix, Orthogonal matrix (simple problems) –Inverse of matrix – Problems- Rank of matrix –Problems - Solutions of linear equations –Cramer's rule – Cayley-Hamilton Theorem – Eigen Values and Eigen vectors of matrices and their properties –Quadratic forms and their reduction - Diagonalisation of matrices.		
Module: 3	TENSOR ANALYSIS	12 Hours
Definition of tensors – Transformation of coordinates – The summation convention and Kronecker Delta symbol –Covariant Tensors – Contravariant tensors – Mixed Tensors - Rank of a tensor – Symmetric and anti-symmetric tensors –Quotient law of tensor - Invariant Tensors - Algebraic operations of tensors - Addition, subtraction and multiplication(inner and outer product) of tensors Derivative of tensors.		
Module: 4	LINEAR DIFFERENTIAL EQUATIONS	12 Hours
Linear differential equations of second order with constant and variable coefficients – Homogeneous equations of Euler type – Equations reducible to homogeneous form – method of variation of parameter – Problems.		
Module: 5	PROBABILITY AND THEORY OF ERRORS	12 Hours
Definition of probability – Compound Probability – Total Probability – The multinomial law – Distribution functions - Binomial, Poisson and Gaussian distribution– Mean (Arithmetic - Individual observations ,Discrete series, Continuous series) – Median (Individual observations ,Discrete series, Continuous series) – Mode (Individual observations ,Discrete series, Continuous series) -Mean Deviation and Standard Deviation(Individual observations ,Discrete series, Continuous series) – Different types of errors – Errors and residuals —The principle of Least squares fitting a straight line.		
Total Lectures		60 Hours

Reference Books	
1.	Mathematical Physics – B.D.Gupta – Vikas Publishing House, 4th edition, 2022, ISBN:9788125930969
2.	Mathematical Physics – B.S.Rajput – PragatiPrakashan – Meerut, 17 th edition, 2020, ISBN: 978-9350063002
3.	Mathematical Methods for Engineers and Scientists – K.T.Tang – Springer Berlin Heidelberg New York, 2007, ISBN: 978-3540302735
4.	Mathematical Methods for Physics and Engineering – K.F.Riley, M.P.Hobson and S.J.Bence, Cambridge University Press. 2004, ISBN: 978-0521679718
5.	Essential Mathematical Methods for Physicists – Hans J.Weber and George B.Arftken – Academic Press, U.S.A.2003, ISBN 978-0120598779
6.	Mathematical Physics Including Classical Mechanics, SatyaPrakash, Sultan Chand & Sons, New Delhi, 2007, ISBN,13: 9788180544668
Recommended by Board of Studies	05.05.2023
Approved by Academic Council	03 June 2023

Course Code	SEMICONDUCTOR PHYSICS	L	T	P	C
23PH3004		3	1	0	4
Course Objectives:					
Enable the student to:					
1. Construct different special-purpose semiconductor devices.					
2. Demonstrate the fabrication process of integrated circuits.					
3. Analyze the parameters for fabricating nanogenerators and optoelectronic devices.					
Course Outcomes:					
The student will be able to:					
1. Operate special-purpose semiconductor devices.					
2. Interpret the Properties and characteristics of nanogenerators.					
3. Explain the types of transducers and their applications.					
4. Analyze the types of optoelectronic and fifth-generation electron devices.					
5. Illustrate the fabrication and manufacturing process involved in integrated circuits.					
6. Develop special-purpose diodes and transistors for device applications.					
Module: 1	SPECIAL PURPOSE SEMICONDUCTOR DEVICES	9 Hours			
Uni-Junction Transistor- – FET – Construction of N Channel JFET - MOSFET and types – FET as a voltage variable resistor – SCR – TRIAC – DIAC – Tunnel Diode Characteristics.					
Module: 2	FABRICATION OF INTEGRATED CIRCUITS	9 Hours			
Integrated circuits fabrication – Photolithographic process– epitaxial growth, diffusion, masking, metallization and etching,– Diffusion of impurities – Monolithic diodes, integrated resistors, – large scale integration (LSI), medium scale integration (MSI) and small scale integration (SSI)					
Module: 3	TRANSDUCERS AND NANOGENERATORS	9 Hours			
Transducers: Active and Passive transducers – Different types – Thermistor – Seebeck, Thomson coefficients, Thermistors, Photoelectric transducers, Nanogenerators-(PENG)Piezoelectric, Thermoelectric, Tribo-electric Nanogenerators					
Module: 4	OPTOELECTRONIC DEVICES	9 Hours			

Optoelectronic Sensors - Photodetector – Junction type Photoconductive cell – Construction and characteristics – Photovoltaic sensors – Solar Cell – Construction, working, Characteristics and applications – UV,IR sensors, Thermal image sensors		
Module: 5	FIFTH GENERATION ELECTRONICS	9 Hours
Spintronics, Memristers, Micro electro mechanical systems, NEMS, Haptic sensors and Actuators, Virtual reality and 3D imaging techniques.		
Total Lectures		60 Hours
Reference Books		
1.	Integrated Electronics-Analog circuits and Devices-Jacob Milman, Christoher Halkias 2nd Edition July 2017 ISBN-978-0070151420.	
2.	Electron Devices and Circuits-Allan Motershed, 2020, -Prentice-Hall of India Pvt.Ltd, ISBN-9788120301245.	
3.	Recent Advances in Nanogenerators, Ya Yang and Zhang Lin Wang, Aug 2022, MDPI Publishers.	
4.	Spintronics-Puja Dey, and Jitendra Nath Roy, Apr 2022, Springer, ISBN-978-981-16-0068-5.	
5.	MEMS/NEMS Sensors-Goutham Kolay and Afat Jahankir, 2019, ISBN-ISBN 978-3-03921-634-5.	
Recommended by Board of Studies	05.05.2023	
Approved by Academic Council	03 June 2023	

Course Code	QUANTUM MECHANICS I	L	T	P	C
23PH3005		3	0	0	3
Course Objectives:					
Enable the student to:					
1. Enumerate on the general formulation of quantum mechanics 2. Solve the wave function that represent different physical systems 3. Debate on the theoretical aspects of various time independent perturbed systems					
Course Outcomes:					
The student will be able to:					
1. Correlate on the central concepts and principles of quantum mechanics. 2. Express their mathematical skills to solve the eigenvalue problems using the operator formalism. 3. Apply the Schrodinger wave equation on systems such as particle in a box, harmonic oscillator and hydrogen atom. 4. Develop the concepts of angular momentum and obtain the eigen values. 5. Assess different time independent perturbed systems. 6. Solve the quantum mechanical systems that involve many electrons.					
Module: 1	GENERAL FORMALISM OF QUANTUM MECHANICS				9 Hours
Linear vector space-Linear operator-Eigen functions and Eigenvalues-Normalized and orthogonal wave function-Particle flux-Expectation values-postulates of quantum mechanics - Hermitian operator-Theorems-Equations of motion-Schrodinger, Heisenberg and Dirac representation.					
Module: 2	ENERGY EIGEN VALUE PROBLEMS				9 Hours
The free particle-Particle in a potential well-One dimensional Harmonic oscillator- Rectangular potential barrier -Schrodinger’s equation in polar coordinates-Rigid rotator- Rigid rotator in a fixed plane-Hydrogen atom.					
Module: 3	ANGULAR MOMENTUM				9 Hours

Components of angular momentum operator - Total angular momentum operators- Commutation relation of J^2 - Commutation relation of J_+ and J_- Eigen values of J^2 and J_z - Eigen values of J_+ and J_- - Addition of angular momenta: Clebsch Gordon coefficients (no derivation).		
Module: 4	APPROXIMATE METHODS	9 Hours
Time Independent Perturbation Theory in Non-Degenerate Case - Application of first order perturbation theory for a non-degenerate system – Zeeman effect (without electron spin) – Degenerate case – Stark effect -Rayleigh-Ritz method – Application to ground state Helium atom - WKB approximation.		
Module: 5	MANY ELECTRON ATOMS	9 Hours
Indistinguishable particles-The Pauli's exclusion principle-Inclusion of spin –Electron spin hypothesis-The Helium Atom-Central Field Approximation-Thomas Fermi Statistical model- Hartree equation –Hartree Fock equation.		
Total Lectures		45 Hours
Reference Books		
1.	Walter Greiner, D. Allan Bromley, "Quantum Mechanics – An Introduction" Springer, 2000, ISBN: 9783540674580.	
2.	Dr. Bhaskar Jyoti Hazarika, "Quantum Mechanics: Concepts and Applications" Mahaveer Publications, 2022 ISBN: 978-9394095497.	
3.	Richard Fitzpatrick, "Quantum Mechanics", World Scientific Publishing Co Pte Ltd, 2015, ISBN: 978-9814689946.	
4.	Nouredine Zettili, "Quantum Mechanics – Concepts and Applications", Wiley; 3 rd edition, 2022, ISBN: 978-1118307892.	
5.	David J. Griffiths, "Introduction to Quantum Mechanics", Cambridge India, 2016, ISBN: 978-1316646519.	
Recommended by Board of Studies		05.05.2023
Approved by Academic Council		03 June 2023

Course Code	MATHEMATICAL PHYSICS II	L	T	P	C
23PH3006		3	1	0	4
Course Objectives:					
Enable the student to:					
1. 2. 3. Compute the values of integrals using complex variables. Estimate the solutions of partial differential equations using Fourier series and Green’s functions. Formulate new concepts with the help of numerical methods.					
Course Outcomes:					
The student will be able to:					
1. 2. 3. 4. 5. 6. Synthesize applications to real world physical problems based on the concepts of complex variables and functions. Develop solutions to boundary value problems using the Fourier series and transforms. Apply partial differential equations to multi-dimensional wave motions and heat conduction equations. Analyze the fundamental concepts of group theory and their implications in physics. Evaluate the principles and applications of numerical differentiation and integration. Create new methodologies to solve real world problems by the application of mathematical principles.					
Module: 1		COMPLEX VARIABLES			12 Hours

Introduction – Functions of a Complex Variable – Analytic Functions – Cauchy-Riemann Conditions– Conjugate Functions – Complex Integration – Cauchy’s Integral Theorem – Cauchy’s Integral Formula – Taylor’s Series and Laurent Series – Poles, Residues and Contour Integration - Cauchy’s Residue Theorem – Computation of Residues - Evaluation of Integrals.		
Module: 2	FOURIER SERIES AND FOURIER TRANSFORMS	12 Hours
Introduction – Fourier Series – Dirichlet Conditions – Complex Representations – Sine and Cosine Series – Half Range Series – Properties of Fourier Series – Physics Applications of Fourier Series – The Fourier Transforms – Applications to Boundary Value Problems.		
Module: 3	PARTIAL DIFFERENTIAL EQUATIONS & GREENS FUNCTION	12 Hours
Introduction – Solutions of One Dimensional Wave Equation - One Dimensional Equation of Heat Conduction – Two Dimensional Heat Equations – Steady State Heat Flow in Two Dimensions – Green’s Function – Symmetry Properties - Solutions of Inhomogeneous Differential Equation - Green’s Functions for Simple Second Order Differential Operators.		
Module: 4	GROUP THEORY	12 Hours
Introduction – Basic Definition of a Group – Subgroups – Classes – Isomorphism Homomorphism – Cayley’s Theorem – Endomorphism and Automorphism – Important Theorems of Group Representations – Unitary Theorem – Schur’s Lemma – Equivalent Theorem – Orthogonality Theorem – Some Special Groups – Unitary Group – Point Group – Translation Group – Homogenous and Inhomogeneous Lorentz Groups – Direct Product Group.		
Module: 5	NUMERICAL METHODS	12 Hours
Introduction – Finite Differences – Shifting Operator – Numerical Interpolations – Newton’s Forward and Backward Formula – Central Difference Interpolation – Lagrange’s Interpolation – Numerical Differentiation – Newton’s and Stirling’s Formula – Numerical Integration – Trapezoidal Rule – Simpson’s 1/3 and 3/8 Rule – Numerical Solution of Ordinary Differential Equations – Runge-Kutta Methods – Piccard’s Methods.		
Total Lectures		60 Hours
Reference Books		
1.	Kwong-Tin Tang, Mathematical Methods for Engineers and Scientists (Vol.1, 2 &3), New York: Springer, 2023, ISBN – 978-3642079474.	
2.	B.D.Gupta, Mathematical Physics, New Delhi: S.Chand and Co. Ltd., 2022, ISBN – 978- 9354535062.	
3.	H.K.Das, and Rama Verma, Mathematical Physics, New Delhi: S.Chand and Co. Ltd., 2019, ISBN – 978-9352837229.	
4.	K.F.Riley, M.P.Hobson, and S.J.Bence, Mathematical Methods for Physics and Engineering, London: Cambridge University Press, 2018, ISBN – 978- 0521139878.	
5.	V.Balakrishnan, Mathematical Physics with Applications, Problems, and Solutions, New Delhi: Ane Books, 2017, ISBN – 978-9386761118.	
Recommended by Board of Studies		05.05.2023
Approved by Academic Council		03 June 2023

Course Code	SPECTROSCOPY I	L	T	P	C
23PH3007		3	0	0	3
Course Objectives:					
Enable the student to:					

1. Explain the physical and chemical properties of matter through spectroscopy. 2. Illustrate the principles and the theoretical framework of different spectroscopic techniques. 3. Demonstrate the spectroscopic techniques in solving the structure of molecules.		
Course Outcomes:		
The student will be able to:		
1. Examine the electronic spectra of hydrogen atoms. 2. Apply the knowledge of rotational spectroscopy in solving molecular structures. 3. Analyze the infrared spectra of diatomic molecules. 4. Distinguish classic and quantum Raman spectroscopy. 5. Evaluate the optical band gap of materials through electronic spectroscopy. 6. Create new concepts and applications using spectroscopy.		
Module: 1	ELECTRONIC SPECTROSCOPY OF ATOMS	9 Hours
Electromagnetic radiation-quantization of energy-absorption and emission process-continuous and line spectra- representation of spectra-instrument-signal to noise ratio-resolving power-width and intensity of spectral lines-concept of fourier transform-Electronic wave functions-atomic quantum numbers-electronic angular momentum-orbital-spin-total angular momentum-spin- orbit interaction and Fine structure of hydrogen atom spectrum-XPS-Zeeman effect-influence of spin.		
Module: 2	MICROWAVE SPECTROSCOPY	9 Hours
Rotation of molecules- Diatomic Molecules-the rigid diatomic molecule- Intensities of Spectral Lines- Effect of Isotope Substitution- Non-rigid Rotator- Polyatomic Molecules- Techniques and Instrumentation- Microwaves in space communication-chemical analysis in industries by microwave spectroscopy.		
Module: 3	INFRA-RED SPECTROSCOPY	9 Hours
Vibration of Diatomic Molecules- Simple harmonic Oscillator-Anharmonic Oscillator- the diatomic vibrating rotator- Vibration- Breakdown of Born-Oppenheimer Approximation- Vibration of Polyatomic Molecules- H ₂ O and CO ₂ -Vibration-Rotation Spectra of Polyatomic Molecules-Techniques and Instrumentation-applications: automobile components analysis for automobile industries, forensic department, environmental applications: food and water industries.		
Module: 4	RAMAN SPECTROSCOPY	9 Hours
Quantum Theory of Raman Effect- Classical Theory- Molecular Polarizability-Rotational Raman Spectra-linear molecules-Vibrational Raman Spectra-Rule of mutual exclusion- Techniques and Instrumentation-application in pharmaceutical and cosmetic industries.		
Module: 5	ELECTRONIC SPECTROSCOPY OF MOLECULES	9 Hours
Electronic Spectra of Diatomic Molecules- Born-Oppenheimer Approximation- vibrational coarse structure-progressions-intensity of vibrational-electronic spectra-Franck-Condon Principle- Dissociation Energy and dissociation products-Re-emission energy from Excited Molecules-optical band gap of materials- UV-Vis spectroscopy.		
Total Lectures		45 Hours
Reference Books		
1.	Colin N.Banwell and Elaine M, "Fundamentals of Molecular Spectroscopy", Indian Edition, 2017, ISBN- 978-9352601738	
2.	John Lindon, George E. Tranter, David Koppenaal, "Encyclopedia of Spectroscopy and Spectrometry", Elsevier Publications, 2017, 3 rd Edition, ISBN- 9780128032244	
3.	Donald L Pavia, "Introduction to Spectroscopy" Cengage Learning, ISBN-9788131529164	
4.	H Kaur, "Spectroscopy" Pragati Edition, 2017, ISBN-978-9386306425	
5.	Alka L. Gupta, Mukesh Kumar, "Group Theory and Spectroscopy", Pragati Edition, 5 th edition, 2019, ISBN: 978-93-88438-64-3	
Recommended by Board of Studies		5.5.2023

Approved by Academic Council	03 June 2023

Course Code		ELECTROMAGNETIC THEORY		L	T	P	C
23PH3008				3	0	0	3
Course Objectives:							
Enable the student to:							
1. Categorize the basics of electrostatics and magnetostatics through equations governing them. 2. Demonstrate electromagnetic field theory using Maxwell's equations. 3. Assess formulations for electromagnetic wave propagation systems and solve the associated problems.							
Course Outcomes:							
The student will be able to:							
1. Explain the concept of different laws of electromagnetic fields. 2. Solve static electric and magnetic field problems using coordinate systems. 3. Facilitate applications of EM Waves in different domains and time average power density. 4. Determine the Maxwell's equation for time-varying electric and magnetic fields. 5. Establish the wave equation and parameters for a conductor, dielectric and magnetic medium. 6. Analyse moving charges and radiation from an oscillating dipole antenna.							
Module: 1		ELECTRO STATICS				9 Hours	
Electric field, Gauss Law and Coulomb's Law – Surface, Line and Volume charge distributions - Scalar potential – Multipole expansion of electric fields – Poisson's equation – Laplace's equation – Green's theorem – Uniqueness theorem – electrostatic potential energy and energy density. Electrostatics in matter- Polarization and electric displacement vector- Electric field at the boundary of an interface.							
Module: 2		MAGNETO STATICS				9 Hours	
Biot and Savart law – Lorentz force law - Differential equations of magnetostatics and Ampere's law – The magnetic vector potential – The magnetic field of distant circuit – Magnetic moment – The magnetic scalar potential – Macroscopic magnetization – Magnetic fields in matter.							
Module: 3		TIME VARYING FIELDS				9 Hours	
Electromagnetic induction – Faraday's law – Maxwell's equations – Displacement current – Vector and Scalar potentials – Gauge transformation – Lorentz gauge – Columb's gauge – Gauge invariance – Poynting's theorem, Plasma confinement.							
Module: 4		PLANE ELECTROMAGNETIC WAVES				9 Hours	
Boundary conditions – Reflection and refraction of e.m. waves at a plane interface between dielectrics – Polarization by reflection and total internal reflection – Electromagnetic waves in vacuum, Waves in a dielectric, non-conducting and conducting medium.							
Module: 5		ELECTRODYNAMICS				9 Hours	
Radiation from an oscillating dipole – Radiation from a half wave antenna – Radiation damping – Thomson cross section – Lienard-Wiechert Potentials – The field of a uniformly moving point charge.							
Total Lectures						45 Hours	
Reference Books							
1.	Classical Electrodynamics, J. D. Jackson, John Wiley & Sons, 2007. ISBN: 978-8126510948						
2.	Foundations of Electro Magnetic Theory – John R. Reits, Fredrick J. Milford & Robert W. Christy.Narosa Publishing House, 2008. ISBN: 978-0321581747						

3.	Electromagnetics: B. B. Laud, New Age International 3 rd Edition, 2011. ISBN: 978-8122430554
4.	Electromagnetic Waves and Radiating Systems, E. C. Jordan, K. G Balmain, PHI Learning Pvt. Ltd., 2015. ISBN: 978-9332551770
5.	Engineering Electromagnetics, W. H. Hayt, J. A., Buck, Tata McGraw-Hill, 2017, ISBN: 978-9339203276
Recommended by Board of Studies	
05.05.2023	
Approved by Academic Council	
03 June 2023	

Course Code	QUANTUM MECHANICS II	L	T	P	C
23PH3009		3	0	0	3
Course Objectives:					
Enable the student to: 1. Differentiate the problems in quantum mechanics. 2. Solve the equations based on time dependent perturbation theory. 3. Examine the formulation of quantum field theory.					
Course Outcomes:					
The student will be able to: 1. Operate the systems subjected to time dependent perturbations such as harmonic, sudden and adiabatic. 2. Interpret on the quantum mechanical systems that involve scattering problem. 3. Solve the systems related to radiation using the semiclassical theory. 4. Apply relativistic wave equation on hydrogen like atom and free particle. 5. Debate on the quantization of wave field, electromagnetic field energy and momentum. 6. Select the appropriate quantum mechanical theory to obtain solutions for quantum problems.					
Module: 1	TIME DEPENDENT PERTURBATION THEORY				9 Hours
Method of variation of constants - Perturbation constant in time-Physical Interpretation - Transition to Continuum of States - - Harmonic Perturbation-Selection Rules –Adiabatic Approximation – Sudden approximation.					
Module: 2	SCATTERING THEORY				9 Hours
Definition of cross sections Stationary scattering wave -General formulation of the scattering theory - Green’s Function-Born approximation-Condition for validity of Born approximation – Scattering by square-well potential in Born approximation - Partial wave analysis - Phase Shifts -Scattering by Coulomb field - Scattering by Yukawa Potential using first Born approximation.					
Module: 3	THEORY OF RADIATION				9 Hours
Introduction to semi classical treatment - Absorption and emission of radiation –Interpretation – Electric dipole approximation-Selection rules-Radiation Field as an Assembly of Oscillators- Density Matrix.					
Module: 4	RELATIVISTIC WAVE EQUATION				9 Hours
Klein Gordon wave equation for a free particle – Application of Klein Gordon equation - Dirac Relativistic Equation - Dirac Relativistic Equation for a Free Particle- Electromagnetic potentials: magnetic moment of the electron –Negative Energy States.					
Module: 5	QUANTUM FIELD THEORY				9 Hours
Quantization of Wave Fields- Classical Lagrangian Equation- Classical Hamiltonian Equation - System of Bosons – System of Fermions -Creation, annihilation and Number Operators-Anti Commutation Relations- Energy quantum of electromagnetic field.					
Total Lectures					45 Hours

Reference Books	
1.	Prakash, "Advanced Quantum Mechanics", Arihant; 2021st edition (1 January 2012), ISBN: 978-8190701167.
2.	Dr. Bhaskar Jyoti Hazarika, "Quantum Mechanics : Concepts and Applications" Mahaveer Publications, 2022 ISBN: 978-9394095497.
3.	Sakurai, J. J, "Modern quantum mechanics", Pearson, 2014, ISBN: 9789332519008.
4.	Nouredine Zettili, "Quantum Mechanics – Concepts and Applications", Wiley; 3 rd edition, 2022, ISBN: 978-1118307892.
5.	Ghatak Ajoy, "Quantum mechanics theory and application", Trinity press, 2015, ISBN: 9789351382966.
Recommended by Board of Studies	
05.05.2023	
Approved by Academic Council	
03 June 2023	

Course Code	SPECTROSCOPY II	L	T	P	C
23PH3010		3	0	0	3
Course Objectives:					
Enable the student to: 1. Describe the physics of advanced spectroscopic techniques. 2. Elucidate the concepts of magnetic and electric fields in spectroscopic methods. 3. Demonstrate the working principle of different spectroscopic methods.					
Course Outcomes:					
The student will be able to: 1. Investigate the role of nuclei spin in the NMR technique. 2. Distinguish the types of sources and detectors used in the ESR technique. 3. Apply knowledge of NQR spectroscopic technique to solve the molecular structure. 4. Analyze the role of the Doppler Effect in Mossbauer spectroscopy. 5. Evaluate the structure of matter using mass spectroscopy. 6. Create new applications involving advanced spectroscopic methods.					
Module: 1	NMR SPECTROSCOPY				9 Hours
Nature of spinning particles-interaction between spin and a magnetic field-nuclei spin-population of energy levels-the Larmor precession-NMR – Basic principles – Classical and Quantum mechanical description – Bloch equation –Spin – Spin and spin lattice relaxation times – Experimental methods – Single Coil and double coil methods – Pulse method.					
Module: 2	ESR SPECTROSCOPY				9 Hours
ESR basic principles – Radiation Sources-High Resolution ESR Spectroscopy – Double Resonance in ESR- ESR spectrometer-working principle-advantages-drawbacks.					
Module: 3	NUCLEAR QUADRUPLE RESONANCE SPECTROSCOPY				9 Hours
NQR Spectroscopy – Basic Principles – Quadruple Hamiltonian Nuclear Quadrupole energy levels for axial and nonaxial symmetry – N Q R spectrometer – chemical bonding – molecular structural and molecular symmetry studies.					
Module: 4	MOSSBAUER SPECTROSCOPY				9 Hours
Basic principles, spectral parameters and spectrum display, applications to the study of bonding and structure of Fe ²⁺ compounds. Isomer shift, quadruple splitting, hyperfine interaction, instrumentations and applications.					
Module: 5	MASS SPECTROSCOPY				9 Hours
Introduction- ion production- fragmentation- ion analysis- ion abundance- common functional groups- high resolution mass spectroscopy- instrumentation and application.					

Total Lectures		45 Hours
Reference Books		
1.	Colin N.Banwell and Elaine M, “Fundamentals of Molecular Spectroscopy”, Indian Edition, 2017, ISBN- 978-9352601738.	
2.	John Lindon, George E. Tranter, David Koppenaal, “Encyclopedia of Spectroscopy and Spectrometry”, Elsevier Publications, 2017, 3 rd Edition, ISBN- 9780128032244.	
3.	Donald L Pavia, “Introduction to Spectroscopy” Cengage Learning, ISBN-9788131529164.	
4.	Joseph B. Lambert, Eugene P. Mazzola, Clark D. Ridge, “Nuclear Magnetic Resonance Spectroscopy: An Introduction to Principles, Applications, and Experimental Methods”, Wiley, 2 nd Edition, 2018, ISBN-978-1119295235.	
5.	D.Goldfarb, “EPR Spectroscopy - Fundamentals and Methods”, Wiley publishers, 2018, ISBN: 978-1119162995.	
Recommended by Board of Studies		5.5.2023
Approved by Academic Council		03 June 2023

Course Code	NUCLEAR AND PARTICLE PHYSICS	L	T	P	C
23PH3011		3	0	0	3
Course Objectives:					
Enable the student to:					
1. Describe the basic properties and the structure of the nucleus. 2. Elucidate the concepts of nuclear forces and radioactive decay modes. 3. Demonstrate the working principles of various nuclear reactions and nuclear reactors and the fundamental concepts of particle physics.					
Course Outcomes:					
The student will be able to:					
1. Investigate the structure of the nucleus and apply Weizsacker semi-empirical mass formula for determining nuclear stability. 2. Construct applications based on the nature of nuclear forces and develop new nuclear models. 3. Apply quantum mechanical understanding to various types of radioactive decay. 4. Analyze different types of nuclear reactions with reference to nuclear fission and fusion reactions and their applications to nuclear reactors. 5. Evaluate the classification scheme of fundamental forces and particles and their relevance to various applications in physics. 6. Create new concepts in physics by comprehending advanced concepts in nuclear and particle physics.					
Module: 1	BASIC NUCLEAR STRUCTURE	9 Hours			
Introduction – Rutherford’s Alpha Scattering Experiment – Nuclear Properties – Elements of Quantum Mechanics – Quantum Behaviour – Problems in 1 D and 3D – Transition between States – Nuclear Properties – Size, Mass and Abundance of Nuclides – Nuclear Binding Energy – Angular Momentum and Parity – Electromagnetic moments – Excited States.					
Module: 2	NUCLEAR FORCE AND NUCLEAR MODELS	9 Hours			
Introduction – The Deuteron Problem – Nucleon-Nucleon Scattering – Proton-Proton and Neutron-Neutron Interactions – Properties of the Nuclear Forces – Nucleon-Nucleon Interactions – The Exchange Force Model – Nuclear Models – The Fermi Gas Model – The Shell Model – Collective Models – Nuclear Spin – Nuclear Moments – Hyperfine Structure.					
Module: 3	RADIOACTIVE DECAY	9 Hours			

Introduction – The Radioactive Decay Law – Quantum Theory of Radioactive Decays – Types of Decay – Alpha Decay – Basic of Alpha Decay Process – Gamow’s Theory of Alpha Emission – Angular Momentum and Parity – Beta Decay – Energy Release – Fermi Theory of Beta Decay – Experimental Tests – Angular Momentum and Parity Selection Rules – Forbidden Decays – Non-Conservation of Parity – Gamma Decay – Energetics – Transition from Classical to Quantum Mechanics – Angular Momentum and Parity Selection Rules – Internal Conversion.		
Module: 4	NUCLEAR REACTIONS	9 Hours
Introduction – Types of Reactions and Conservation Laws – Kinematics – Isospin – Reaction Cross Section – Experimental Techniques – Nuclear Scattering – Scattering Cross Section – The Optical Model – Compound Nucleus Reactions – Direct Reactions – Resonance Reactions – Nuclear Fission – Characteristics – Energy – Controlled Fission Reactions – Fission Reactors – Nuclear Fusion – Basic Processes – Characteristics – Solar Fusion – Controlled Fusion Reactions.		
Module: 5	PARTICLE PHYSICS	9 Hours
Introduction – Particle Interactions and Families – Symmetries and Conservation Laws – CP Violation in K-Meson Decay – The Quark Model – Colored Quarks and Gluons – Reactions and Decays in the Quark Model – Quark Dynamics – Neutrino Physics – Grand Unified Theories.		
Total Lectures		45 Hours
Reference Books		
1.	Kenneth S. Krane, Introductory Nuclear Physics, New Delhi: Wiley India Pvt. Ltd., 2022, ISBN – 978-9354640834.	
2.	Satadal Bhattacharyya, Nuclear and Particle Physics: An Introduction, New Delhi: University Press, 2020, ISBN – 978- 9389211153.	
3.	S.N.Ghoshal, Nuclear Physics, New Delhi: S.Chand Publishing, 2019, ISBN – 978- 9352837274.	
4.	V.K.Mittal, R.C.Verma, and S.C. Gupta, Introduction to Nuclear and Particle Physics, New Delhi: PHI Learning, 2018, ISBN – 978- 9387472617.	
5.	D.C.Dayal, Nuclear Physics, New Delhi: Himalaya Publishing House, 2018, ISBN – 978- 9350978306.	
Recommended by Board of Studies		05.05.2023
Approved by Academic Council		03 June 2023

Course Code	SOLID STATE PHYSICS	L	T	P	C
23PH3012		3	0	0	3
Course Objectives:					
Enable the student to:					
1. Establish knowledge of the crystal, dielectric and ferroelectric properties, and their theories. 2. Correlate the concepts of solid-state physics with the magnetic and optical properties of materials. 3. Illustrate the properties of superconducting materials and their applications.					
Course Outcomes:					
The student will be able to:					
1. Examine the crystal properties and elementary models for the bonding of atoms and molecules. 2. Explain the concepts leading to dielectric and ferroelectric properties in detail. 3. Summarize the fundamental ideas of magnetic properties in solid-state phenomena. 4. Evaluate the crystal defects and imperfections in solid crystals and discuss their applications. 5. Illustrate the optical properties of materials and their importance in luminescence applications. 6. Apply the solid-state physical phenomena in the areas of superconductors and their applications.					

Module: 1	CRYSTAL PROPERTIES AND LATTICE VIBRATIONS	9 Hours
Bravais lattices and crystal systems - Reciprocal lattice - Bonding in solids- Brillouin zones – Density of states - Phonons - acoustic and optical branches- -scattering of phonons. Electron motion in a periodic potential - Band Theory of Solids - Kronig-Penney model - Effective mass of electron.		
Module: 2	DIELECTRIC AND FERROELECTRIC PROPERTIES	9 Hours
Dipole Moment and Polarization – Types of Polarization – Ionic, Electronic and Orientation - Langevin function- Dielectric constant and polarizability – Local field – Clausius – Mosotti relation –Elemental dielectrics- Polarization of Ionic crystals- Polar Solids- Measurement of dielectric constant - Ferroelectricity – General properties – Dipole theory – Classification of ferroelectric materials - Antiferroelectricity		
Module: 3	MAGNETIC PROPERTIES	9 Hours
Magnetic Permeability- Magnetization – Bohr Magneton – Electron Spin and Magnetic Moment – Diamagnetism – Langevin’s theory of diamagnetism- Para magnetism – Weiss theory of Para magnetism – Determination of Susceptibilities – Quincke’s method – Ferromagnetism – Weiss Molecular Field – Curie-Weiss law Ferromagnetic domains – Magnetization Curve –Antiferromagnetism – Neel temperature – Ferrimagnetism.		
Module: 4	CRYSTAL DEFECTS AND OPTICAL PROPERTIES	9 Hours
Crystal defects - Point imperfections – Concentrations of Vacancy, Frenkel and Schottky imperfections - Line Imperfections – Burgers Vector – Presence of dislocation – surface imperfections- Polarons – Excitons- Colour centers – Optical absorption in Metals, Insulators and Semiconductors - Luminescence – Excitation and emission – Decay mechanism – Thermo luminescence and glow curves – Electroluminescence – Phosphors in Fluorescent Lights.		
Module: 5	SUPERCONDUCTIVITY	9 Hours
Properties of Superconductors – Effects of magnetic field – The Meissner effect – Thermal properties of Superconductors - Type I and II superconductors - London equations : Electrodynamics — B.C.S. theory – Quantum Tunneling - A.C. and D.C. Josephson effect – Macroscopic Quantum interference — High temperature super conductors – Squids – Magnetic levitation and Power applications		
Total Lectures		45 Hours
Reference Books		
1.	Introduction to Solid State Physics- Kittel, John wiley, 8th edition, 2012, ISBN:978-8126535187	
2.	Introductory solid state Physics, H.P.Myers, Second edition, Taylor and Francis, 2014, ISBN:978-0850667592	
3.	Advanced Solid State Physics, P.Philips, Cambridge University Press, 2012, ISBN:978-0521194907	
4.	Solid State Physics, Neil W. Ashcroft, N. David Mermin, Cengage Learning, 2021, ISBN:978-0357670811	
5.	Solid State Physics, R.J.Sing, Pearson, 2012, ISBN:978-8131754016	
Recommended by Board of Studies		05.05.2023
Approved by Academic Council		03 June 2023

Course Code	PHYSICS OF NANOMATERIALS	L	T	P	C
23PH3013		3	0	0	3
Course Objectives:					

Enable the student to: 1. Classify the Quantum states in the nanoscale materials. 2. Demonstrate different nanofabrication methods. 3. Compare the electrical, magnetic, mechanical, and optical properties of nanomaterials.		
Course Outcomes:		
The student will be able to: 1. Categorize quantum confinement effects in nanomaterials. 2. Demonstrate different fabrication techniques of nanomaterials. 3. Analyze the characteristics of nanomaterials. 4. Develop nanodevices using different Fabrication and characterization tools. 5. Evaluate the nano fingerprints present in the samples through advanced techniques. 6. Formulate the parameters of nanoscale devices for specific applications.		
Module: 1	INTRODUCTION TO QUANTUM STATES	9 Hours
Basic concepts of nano materials – Density of states of 1,2 and 3D quantum well, wire, dot-Schrodinger wave equation for quantum wire, Quantum well, Quantum dot-Formulation of super lattice- Quantum confinement- Quantum cryptography		
Module: 2	FABRICATION TECHNIQUES FOR NANO MATERIALS	9 Hours
Top-down versus Bottom-up –ball milling, Photo Lithography- Physical and chemical route of nonmaterial synthesis –Self assembly -Growth modes, Stransky-Krastinovec –Ostwald ripening		
Module: 3	ELECTRICAL AND MAGNETIC PROPERTIES	9 Hours
Electronic and electrical properties-One dimensional systems-Metallic nanowires and quantum conductance - Carbon nanotubes and dependence on chirality -Quantum dots –Two dimensional systems -Quantum wells and modulation doping -Resonant tunnelling –Magnetic properties Transport in a magnetic field - Quantum Hall effect. -Spin valves -Spin-tunnelling junctions -Domain pinning at constricted geometries -Magnetic vortices.		
Module: 4	MECHANICAL AND OPTICAL PROPERTIES	9 Hours
Mechanical properties hardness – Nano indentation -Individual nanostructures -Bulk nanostructured materials- Ways of measuring- Optical properties-Two dimensional systems (quantum wells)-Absorption spectra - Excitons - Coupled wells and superlattices -Quantum confined Stark effect		
Module: 5	CHARACTERIZATION TECHNIQUES	9 Hours
X ray diffraction-Scherrer equation, SEM- grain size and grain boundary- Particle size analyser and Zeta potential, Atomic force microscopy- Tunneling probe microscopy, Transmission electron Microscope.		

Total Lectures		45 Hours
Reference Books		
1.	Charles P.Poole, Jr. and Frank J.Owens, “Introduction to Nanotechnology”, Wiley, 2015.	
2.	J.D.Plummer, M.D.Deal and P.B. Griffin, “Silicon VLSI Technologies”, Prentice Hall, 2000.	
3.	C.Kittel, “Introduction to Solid State Physics”, Wiley, 2004.	
4.	Hartmut Frey and Hamid R.Khan, “Handbook of Thin Film Technology”, Springer, 2015.	
5.	Biswajit Mukjerjee and Niladri Shekhar, “Physics of Nanomaterials”, Intelliz Press, 2016.	
Recommended by Board of Studies		05.05.2023
Approved by Academic Council		03 June 2023

Course Code	THIN FILM TECHNOLOGY	L	T	P	C
23PH3014		3	0	0	3
Course Objectives:					
Enable the student to: 1. Describe the functioning of vacuum pumps, measuring gauges, and thin film coating techniques. 2. Explain the influence of different substrate materials and the growth process. 3. Interpret the properties of thin films and apply them for device fabrication.					
Course Outcomes:					
The student will be able to: 1. Identify the vacuum pumps and measure the vacuum level. 2. Explain the mechanism of thin film deposition. 3. Illustrate the influence of substrates on the growth of thin films. 4. Analyze the thin film characteristics through different tools. 5. Experiment with the latest thin film device fabrication and testing. 6. Design and construct thin film-based devices like solar cells and gas sensors.					
Module: 1	VACUUM SYSTEM	9 Hours			
Categories of deposition process, basic vacuum concepts, pumping systems- rotary, diffusion and turbo molecular, monitoring equipment –McLeod gauge, pirani, penning, capacitance diaphragm gauge.					
Module: 2	THIN FILM COATING TECHNIQUES	9 Hours			
Physical vapour deposition, sputtering - dc, rf, magnetron, molecular beam epitaxy, pulsed laser deposition, chemical vapour deposition, electroplating, sol gel – spin coating, dip coating, spray Pyrolysis.					
Module: 3	SUBSTRATE MATERIALS AND GROWTH PROCESS	9 Hours			

Substrate materials, material properties – surface smoothness, flatness, porosity, mechanical strength, thermal expansion, thermal conductivity, resistance to thermal shock, thermal stability, chemical stability, electrical conductivity -Substrate cleaning, substrate requirements, buffer layer, metallization control, lattice mismatch, surface morphology, Growth process- Adsorption, surface diffusion, nucleation, surface energy, texturing, structure development, interfaces, stress, adhesion.		
Module: 4	STRUCTURAL, OPTICAL AND ELECTRICAL STUDIES ON THIN FILMS	9 Hours
X- Ray Diffraction studies –Bragg’s law – particle size – Scherrer’s equation – crystal structure – UV Vis NIR Spectroscopy, Photoluminescence (PL) studies –Fourier Transform Infrared Spectroscopy (FTIR) - Electrical properties: dc electrical conductivity as a function of temperature - Hall effect – types of charge carriers – charge carrier density, C-V/I-V characteristics.		
Module: 5	DEVICE FABRICATION, TESTING AND VALIDATION	9 Hours
Design fabrication and testing of Flexible transistor, CNT based transistor, Multilayer solar cell, flexible gas sensors, Project presentation and report submission.		
Total Lectures		45 Hours
Reference Books		
1.	Hartmut Frey and Hamid R.Khan, “Handbook of Thin Film Technology”, Springer, 2015, ISBN: 978-3-642-05429-7.	
2.	Kasturi Lal Chopra, Inderjeet Kaur, “Thin Film Device Applications”, Springer, 2012, eBook ISBN: 978-1-4613-3682-2.	
3.	Kasturi Lal Chopra, “Thin Film Phenomena”, Krieger Pub Co, 1979, ISBN-13: 978-0882757469	
4.	AichaElshabini, AichaElshabini-Riad, Fred D., “Thin Film Technology Handbook”, McGraw-Hill Professional, 1997, ISBN 13: 9780070190252	
5.	Donald L. Smith, “Thin-film deposition: principles and practice”, McGraw-Hill Professional, 1995, ISBN, 0070585024.	
6.	Krishna Seshan, “Handbook of Thin-film Deposition Processes and Techniques: Principles, Method, equipment and Applications”, William Andrew Inc., 2002, ISBN: 6612253193	
Recommended by Board of Studies		
05.05.2023		
Approved by Academic Council		03 June 2023

Course Code	ASTRONOMY AND ASTROPHYSICS	L	T	P	C
23PH3015		3	0	1	4
Course Objectives:					
Enable the student to:					
1. Discover the knowledge about ancient astronomy, solar system models, various types of stars, and their evolution.					
2. Assess the formation of galaxies, concepts of big bang theory, and the possibility of life in the universe.					

3. Discern the theoretical and experimental tools available to study the cosmos.		
Course Outcomes:		
The student will be able to:		
1. Distinguish between the various solar system models, earth's immediate cosmic neighborhood, and other constituents of the solar system. 2. Differentiate the types of stars and their evolution, and the intricate details about the Sun. 3. Analyze the shape and size of the Milky Way galaxy and various types of galaxies, their formation, and cosmic distant scales. 4. Evaluate the formation of the universe through the big bang theory and comprehend how the universe is likely to end. 5. Apply modern-day telescopes to explore the cosmos. 6. Formulate novel techniques and theorems to explore the space to solve problems yet to be solved.		
Module: 1	THE SOLAR SYSTEM	9 Hours
Introduction – The Celestial Sphere – The Celestial Coordinate System – Precession and Time – The Laws of Planetary Motion – The Universal Law of Gravitation – Various Models of the Solar System – Planets and their Properties – Natural Satellites – Asteroids – Comets – Meteoroids, Meteors, and Meteorites – The Kuiper Belt and the Oort Cloud.		
Module: 2	THE SUN AND THE STARS	9 Hours
Introduction – The Sun and its Properties – The Solar Wind – The Sunspot Cycle – Solar Prominences, and Solar Flares – Stellar Luminosity – Stellar Distances – Trigonometric Parallax – The Apparent and Absolute Magnitude Scale – The Hertzsprung-Russel Diagram – The Life and Deaths of Stars – Variable Stars – White Dwarfs – Supernova Explosions – Neutron Stars and Black Holes.		
Module: 3	THE MILKY WAY GALAXY	9 Hours
Introduction – Open Star Clusters – Globular Star Clusters – The Interstellar Medium – Size, Shape and Structure of the Milky Way – Supermassive Black Holes – Elliptical Galaxies – Spiral Galaxies – Irregular Galaxies – The Hubble Classification – The Cosmic Distance Scale – Standard Candle Method – Starburst Galaxies – Active Galaxies – Groups, Clusters, and Superclusters of Galaxies.		
Module: 4	THE ORIGIN AND EVOLUTION OF THE UNIVERSE	9 Hours
Introduction – The Birth of the Universe – The Big Bang Model – The Expansion of the Universe – The Steady State Model – Quasi-Steady State Model – The Big Bounce Model – The Cosmic Microwave Background – Inflation – Dark Matter – Dark Energy – Multiverse – The Search for Intelligent Life in the Universe – The Drake Equation – The Hunt for Exoplanets – The Fate of the Universe.		
Module: 5	OBSERVING THE UNIVERSE	9 Hours
Introduction – The Human Eye – Optical Telescopes – Powers of a Telescope – Refracting and Reflecting Telescopes – Active and Adaptive Optics – Significant Optical Telescopes – The Hubble Space Telescope – Other Windows to Observe the Heavens – Radio Telescopes – Observing in other Wavebands – The James Webb Space Telescope – Gravitational Waves Astronomy.		
Total Lectures		45 Hours
Reference Books		
1.	Rohan Gharate, Book of Astronomy and Astrophysics, Chennai: Notion Press, 2022, ISBN – 978-8886679687.	
2.	Stan Owocki, Fundamentals of Astrophysics, London: Cambridge University Press, 2021, ISBN – 978-1108844390.	

3.	Mohit Kumar Sharma and Suresh Chandra, A Textbook of Astronomy and Astrophysics, New Delhi: Dreamtech Press, 2019, ISBN – 978- 9389520903.
4.	A.B.Bhattacharya, S.Joardar, and R. Bhattacharya, Astronomy and Astrophysics, New Delhi: Arihant, 2010, ISBN – 978- 8189938413.
5.	Ian Morison, Introduction to Astronomy and Cosmology, Barcelona: Wiley, 2008, ISBN – 978-0470033340.
Recommended by Board of Studies	05.05.2023
Approved by Academic Council	03 June 2023

Course Code	ASTRONOMY AND ASTROPHYSICS LAB	L	T	P	C
23PH3015L		0	0	1	1
Course Objectives:					
Enable the student to:					
1. Demonstrate night sky-watching skills. 2. Observe significant events in the space environment. 3. Design new and novel telescopes.					
Course Outcomes:					
The student will be able to:					
1. Apply astronomical knowledge to note the patterns of the night sky. 2. Observe the different types of stars and analyze their important characteristics. 3. Apply national and international instrumentation facilities to analyze the characteristics of astronomical objects. 4. Demonstrate advanced experimental skills in observing the night sky. 5. Design novel concepts and observational methods to study the physics behind deep-space objects. 6. Develop excellent practical skills to observe details of heavenly objects.					
List of Experiments					
1. Night Sky Watch Session at Karunya Institute of Technology and Sciences, Coimbatore. 2. Observation of a key constellation in a month and its salient features. 3. Observation of the Milky Way Galaxy at radio wavelengths at Radio Astronomy Center, Ooty. 4. Measurement of cosmic ray particles and their characteristics at Cosmic Ray Observatory, Ooty. 5. Measurement of sunspots and other characteristics of the Sun at Kodaikanal Solar Observatory. 6. Tabulation of astronomical events in a month for five years. 7. Observation of a significant event in the night sky. 8. Making of a Newtonian reflecting telescope.					
Recommended by Board of Studies		05.05.2023			
Approved by Academic Council		03 June 2023			

Course Code	GENERAL PHYSICS LAB I	L	T	P	C
23PH3016		0	0	2	2
Course Objectives:					
Enable the student to:					
1. Estimate practical skills in advanced optical experiments.					
2. Demonstrate quantum concepts on lasers and optics.					
3. Experiment with practical skills in advanced ultrasonics.					
Course Outcomes:					
The student will be able to:					

7. Acquire knowledge of optics to solve practical problems. 8. Apply practical skills in lasers and optics to design instruments for specific problems. 9. Analyze scientific data from spectroscopic methods. 10. Demonstrate physics concepts through experiments. 11. Design experiments, and analyze and interpret data on quantum concepts. 12. Measure practical skill in analyzing optical, thermal, and magnetic properties.	
List of Experiments 1. Determine the size of the particle using Laser Diffraction method. 2. Calculate the Planck's constant using LED's 3. Study the attenuation and numerical aperture of optical fiber cable. 4. Determine the value of Rydberg's constant using spectrometer. 5. Determine Cauchy's constant value using spectrometer. 6. Calculate the thickness of glass plates using single optic lever method. 7. Study the dielectric constant values and determine Curie temperature. 8. Illustrate Frank-Hertz experiment and analyze the quantum nature of electrons 9. Determine of Planck's constant value using various color filters. 10. Calculate the velocity of the ultrasonic sound using ultrasonic interferometer.	
Recommended by Board of Studies	05.05.2023
Approved by Academic Council	03 June 2023

Course Code	GENERAL PHYSICS LAB II	L	T	P	C
23PH3017		0	0	2	2
Course Objectives:					
Enable the student to:					
1. Develop practical skills in digital electronics. 2. Demonstrate practical skills in studying the characteristics of low-power semiconductor devices. 3. Analyze the characteristics of the diode and transistor.					
Course Outcomes:					
The student will be able to:					
1. Examine the practical difficulties in measuring the standard parameters. 2. Analyze the architecture of microprocessors and the methodology of programming. 3. Design basic electric circuits using software tools. 4. Assess engineering problems and formulate new solutions with simulation. 5. Illustrate in building and troubleshooting electronic circuits. 6. Apply simple programs using microprocessors for practical applications.					
List of Experiments					
1. Study the current and voltage characteristics of PN diode 2. Analyze the I – V Characteristics of Zener diode 3. Design the half wave rectifier using PN diode. 4. Determine the full wave rectifier using PN diode. 5. Construct the half adder and full adder circuits using logic gates. 6. Construct the half subtractor and full subtractor digital circuits using logic gates. 7. Analyze the input and output signals of multiplexers. 8. Examine the input and output signals of De-multiplexers. 9. Determine the arithmetic operation of addition using logic gates. 10. Determine the arithmetic operation of subtraction using logic gates.					

Recommended by Board of Studies	05.05.2023
Approved by Academic Council	03 June 2023

Course Code	ADVANCED PHYSICS LAB I	L	T	P	C
23PH3018		0	0	2	2

Course Objectives:

Enable the student to:

1. Apply knowledge and practice practical skills in thin film coating devices.
2. Demonstrate the ability to analyze the operation of the physical method of thin film preparation.
3. Illustrate and explain the chemical method of thin film preparation.

Course Outcomes:

The student will be able to:

1. Explain the preparation techniques of thin films
2. Understand the physical method of thin film preparation
3. Identify the chemical method of thin film preparation
4. Evaluate the electrical properties of thin films
5. Estimate the hall measurements
6. Analyze the optical properties and find the band gap.

List of experiments

1. Preparation of metal oxide thin films by Successive Ionic Layer Adsorption and Reaction (SILAR) Method
2. Deposition of metallic thin film by D.C Sputtering
3. Physical vapour deposition of semiconductor thin films
4. Preparation of metal oxide thin films by Chemical bath deposition method
5. Pulsed laser deposition of semiconductor thin films
6. Deposition of oxide thin film by Doctor blade technique
7. Metal oxide thin film preparation by Spin coating
8. Preparation of nanofibres by using Electrospin coating
9. Preparation of nanofluids and determination of its velocity
10. Synthesis of metal oxide nanoparticles using chemical precipitation method
11. Fabrication of polymer films by solvent casting method
12. Preparation of metal oxide thin films by using Spray pyrolysis method

Recommended by Board of Studies	05.05.2023
Approved by Academic Council	03 June 2023

Course Code	ADVANCED PHYSICS LAB II	L	T	P	C
23PH3019		0	0	2	2

Course Objectives:

Enable the student to:

1. Understand the fabrication techniques of nanodevices.
2. Demonstrate the ability to assess and analyze the efficiency of devices.
3. Examine and evaluate the output properties of devices.

Course Outcomes:

The student will be able to:

1. Design and create innovative nanostructures through the application of advanced fabrication techniques.
2. Examine and evaluate the properties of nano-thin films.
3. Explain practical application and synthesis skills by fabricating nanodevices.
4. Apply knowledge and practical skills in fabricating electronic devices.

5. Analyze and solve the output properties of the devices. 6. Evaluate the efficiency of the devices.	
List of experiments	
1. I-V Measurements using NI work Station for a Diode. 2. I-V Measurements using KEETHLEY meter. 3. I-V Measurements using NI work Station for a Transistor/FET. 4. Measurement of Viscosity for a Nanofluid. 5. Measurement of Thermal conductivity of Nanofluids. 6. Measurement of impedance through solartron impedance analyser. 7. Cyclic voltametric analysis using C-H instrument. 8. Demonstration of Ultracentrifuge equipment for Exfoliation of MWCNT. 9. Impedance analysis using C-H instrument. 10. Determination of Charge Carrier Density of Thin films Hall Effect. 11. I-V characteristics of PN junction diode. 12. Determination of the Resistivity of Semiconductor Thin Films by Four Probe Method.	
Recommended by Board of Studies	05.05.2023
Approved by Academic Council	03 June 2023

Course Code	COMPUTATIONAL PHYSICS LAB	L	T	P	C
23PH3020		0	0	2	2
Course Objectives:					
Enable the student to: 1. Examine the key principles of computational physics. 2. Interpret the computational skills with the requirements of theoretical physics courses. 3. Develop the programming ability to solve physics problems.					
Course Outcomes:					
The student will be able to: 1. Describe the essential methods and techniques in computational physics. 2. Design the programs to solve practical problems. 3. Apply numerical and statistical problem solving skills to resolve research problems. 4. Choose the suitable numerical method required to study the dynamics of physical systems. 5. Classify the methods in computational physics to solve probabilistic physical problems. 6. Employ appropriate program to interpolate and extrapolate data collected from physics experiments.					
List of Experiments					
1. Write a C++ Program to arrange given numbers in ascending order. 2. Write a C++ Program to add two matrices. 3. Write a C++ Program to multiply two matrices. 4. Write a C++ Program to find the transpose of a matrix. 5. Write a C++ Program to compute the time difference. 6. Write a C++ Program to obtain the Young’s modulus of the material using uniform bending. 7. Write a C++ Program to convert decimal to binary. 8. Write a C++ Program to confirm the given numbers are prime numbers. 9. Write a C++ Program to construct the forward difference table. 10. Write a C++ Program to solve the differential equation using Euler’s method. 11. Write a C++ Program to find the roots of a quadratic equation. 12. Write a C++ Program to execute Simpsons 1/3rd rule. 13. Write a C++ Program to execute Trapezoidal method. 14. Write a C++ Program for curve fitting a linear equation. 15. Write a C++ Program for temperature conversion.					

Recommended by Board of Studies	05.05.2023
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Course Code	MATERIALS CHARACTERIZATION LAB	L	T	P	C
23PH3021		0	0	2	2
Course Objectives:					
Enable the student to: 1. Recognize the different spectrophotometers. 2. Explain the operation and application of the X-Ray diffractometer. 3. Examine the samples using a scanning electron microscope.					
Course Outcomes:					
The student will be able to: 1. Interpret the optical properties of the material from the spectra obtained through a spectrophotometer. 2. Evaluate the structure of a material through XRD. 3. Identify the morphology of a material using SEM. 4. Calculate the surface roughness through AFM. 5. Estimate the dielectric constant using an impedance analyzer. Demonstrate the IV characteristics of materials using NI workstation.					
List of Experiments					
1. XRD- Identification of planes and crystal structures.					
2. XRD- Structural parameters.					
3. XRD- Determination of crystallite size and micro strain.					
4. SEM- Determination of morphology.					
5. EDAX- Composition Analysis.					
6. UV-Vis Spectrophotometer- Determination of optical properties (Absorbance, Transmittance and Reflectance).					
7. PL Spectrometer- Analysis of PL spectra.					
8. DLS- Particle size Analysis.					
9. Determination of Zeta Potential value of colloidal nanoparticles.					
10. Determination of dielectric constant using impedance analyzer.					
11. Understanding the IV characteristics using NI workstation.					
12. Study the surface roughness of a material using AFM.					
HoD can give any 10 relevant experiments at the beginning of the course in each semester.					
Recommended by Board of Studies		05.05.2023			
Approved by Academic Council		03 June 2023			

Course Code	MATERIAL CHARACTERIZATION	L	T	P	C
23PH3022		3	0	0	3
Course Objectives:					
Enable the student to:					
Demonstrate and evaluate fundamental techniques for materials characterization.					
Explain the underlying theories and principles behind different material characterization techniques.					
Evaluate materials using electron microscopy and optical methods.					
Course Outcomes:					
The student will be able to:					
Identify suitable techniques for specific materials characterization.					
Apply knowledge and skills in utilizing diverse instrumentations to scan and test materials, assessing their properties.					
Examine the structural and compositional properties of materials using XRD, SEM, XPS, EDAX, and AFM.					
Understand microscopic and macroscopic property analysis for various materials.					
Analyze the magnetic properties of materials and functions.					
Recognize and select appropriate tests for analyzing the thermal properties of materials.					
Module: 1	MICROSCOPIC METHODS				9 Hours
Optical Microscopy: Optical Microscopy Techniques – Bright & dark field optical microscopy- phase contrast microscopy- Differential interference contrast microscopy – Fluorescence Microscopy- Scanning probe microscopy (STM, AFM) – Scanning new field optical microscopy – X-Ray Diffraction methods - Rotating crystal- Powder method – Debye- Scherrer camera- Structure factor calculations-EBSD & ED.					
Module: 2	SPECTROSCOPIC METHODS				9 Hours
Principles and Instrumentation for UV-Vis-IR, FTIR Spectroscopy, Raman Spectroscopy, NMR, XPS, AES and SIMS-proton induced X-Ray Emission spectroscopy (PIME) – Rutherford Back Scattering (RBS) analysis – application.					
Module: 3	ELECTRON MICROSCOPY AND OPTICAL CHARACTERISATION				9 Hours
SEM, EDAX, EPMA, TEM, STEM working principle and Instrumentation- sample preparation- data collection, processing and analysis- Photoluminescence-light-matter interaction- instrumentation- Electroluminescence-instrumentation-Applications.					
Module: 4	THERMAL ANALYSIS				9 Hours
Introduction- Thermogravimetric analysis (TDA)- instrumentation- determination of weight loss and decomposition products- differential thermal analysis (DTA) – cooling curves – differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermomechanical parameters- Chromatography- Liquid & Gas Chromatography.					
Module: 5	ELECTRICAL, MECHANICAL & MAGNETIC ANALYSIS				9 Hours
Two probe and four probe methods-van der Paw method- Hall probe and measurement scattering mechanism- C-V characteristics- Schottky barrier capacitance- impurity concentration- Mechanical and Magnetic Analysis: Vickers Hardness test - Vibrating Sample Magnetometer- Working principle of VSM- Instrumentation.					
Total Lectures					45 Hours
Reference Books					
1.	Sam Zhang and Lin Li., “Materials Characterization Techniques”, Taylor and Francis,2008, ISBN- 9780429143908				
2.	Yang Leng., “Materials Characterization: Introduction to Microscopic and Spectroscopic Methods”, Wiley 2013, ISBN- 9783527670772				
3.	Mitra p k., “Characterization of materials”, 2013, ISBN- 9788120348561				

4.	Duncan W Bruce., “Multi Length-Scale Characterization: Inorganic Materials Series”, 2014, ISBN-9781119953197	
5.	Khangaonkar P R, “An Introduction to Material Characterization”, 1st Edition Cengage Publication, 2008, ISBN-9788187972808	
Recommended by Board of Studies		05.05.2023
Approved by Academic Council		03 June 2023

Course Code	NANO ELECTRONICS	L	T	P	C
20PH3023		3	0	0	3
Course Objectives:					
Enable the student to: 1. Demonstrate the fabrication of Metal Oxide Field effect transistors. 2. Classify short-channel transistors based on their applications. 3. Design Complementary Metal Oxide Semiconductor devices.					
Course Outcomes:					
The student will be able to: 1. Compare different transistors based on the operation. 2. Differentiate short-channel transistors and their applications. 3. Analyze the properties of split gate transistor structures. 4. Evaluate characteristics of CMOS transistors for different circuits. 5. Construct Tunneling devices for high-frequency applications. 6. Design Nanoscale transistors for multiple applications.					
Module: 1	MOSFET CONFIGURATIONS				9 Hours
Introduction to MOSFET, Enhancement and depletion MOSFET, output and transfer current-voltage characteristics, limits in scaling, vertical and horizontal system integration, short channel MOS transistor.					
Module: 2	MOSFET CHARACTERISTICS				9 Hours
Drain Induced Barrier Lowering, I-V characteristics analysis of short channel field effect transistor, various split gate transistor- Planar, Double gate, tri gate and Gate all around transistor, Advanced Nanoscale transistor.					
Module: 3	CMOS TECHNOLOGY				9 Hours
Principles of CMOS technology, inverter CMOS, I-V characteristics and Nano CMOS design, Tunneling element technology, Quantum cellular automate – wire, inverter, logic gate and Majority gate design of QCA.					
Module: 4	NANOSCALE TRANSISTERS				9 Hours
Tunneling Diode, I-V characteristics, Resonant Tunneling Diode, I-V analysis, circuit design of RTD, Principles of Single Electron Transistor (SET), Architecture, circuit design of SET, comparison between FET and SET circuit design.					

Module: 5	HIGH ENERGY DEVICES	9 Hours
Vertical MOSFETs, Principles of High Electron Mobility Transistor- design and applications, Molecular electron devices, Nanotubes based sensors and Field Effect Transistor, Ferroelectric random access memory and its circuit design, Softcomputing.		
Total Lectures		45 Hours
Reference Books:		
1.	Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Strosio, "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications", Cambridge University Press, 2011.	
2.	Supriyo Datta, "Lessons from Nanoelectronics: A New Perspective on Transport", World Scientific, 2012.	
3.	W. R. Fahrner, "Nanotechnology and Nan electronics: Materials, Devices, Measurement Techniques" Springer Verlag Berlin Heidelberg, 2005.	
4.	J.P. Colinge, "FinFETs and other Multi-Gate Transistor Integrated Circuits and Systems", Springer, 2008.	
5.	Jaap Hoekstra, "Introduction to Nanoelectronic Single-Electron Circuit Design", Pan Stanford Publishing, 2010.	
Recommended by Board of Studies		5.5.2023
Approved by Academic Council		03 June 2023

Course Code	RENEWABLE AND SUSTAINABLE ENERGY SOURCES	L	T	P	C
23PH3024		3	0	0	3
Course Objectives:					
Enable the student to:					
1. Estimate on the requirement of renewable energy sources.					
2. Exploitre modern technologies in the field of renewable energy.					
3. Apply the advanced materials for energy generation in solar cells.					
Course Outcomes:					
The student will be able to:					
1. Understand the available renewable energy resources.					
2. Interpret the significance of wind and hydro energy system.					
3. Analyze the technologies available for conversion of biomass to energy.					
4. Recognize the phenomena behind the function and conversion efficiency of Si-photovoltaic cells.					
5. Estimate the currently commercialized technologies in the field of solar energy.					
6. Design the renewable energy conversion systems.					
Module: 1	BASIC CONCEPTS OF ENERGY SOURCES				9 Hours
Available Energy Sources – Classification of Energy Sources – Commercial and Non-commercial Energy Sources – Fossil Fuels and Climate Change issues – Renewable Energy Resources – Scientific Principles of Renewable Energy - Advantages and Limitations of Renewable Energy sources.					
Module: 2	WIND AND HYDROPOWER ENERGY SYSTEMS				9 Hours
Aerodynamics – Wind Energy Conversion – Basic Components of Wind Energy Conversion System - Wind Energy Collectors – Wind Energy Storage – Applications of Wind Energy - The Water Cycle – Hydroelectric power plants.					
Module: 3	ENERGY FROM BIO-MASS				9 Hours

Photosynthesis Process – Bio Fuels – Bio mass Resources – Bio-mass Conversion Technologies – Wet processes and Dry Processes – Classification of Bio-gas plants – Bio-gas from plant Wastes – Materials Used for Bio-gas generation – Utilization of Bio-gas - Methods for obtaining energy from Biomass.		
Module: 4	TRADITIONAL SOLAR PHOTOVOLTAIC	9 Hours
Electromagnetic spectrum - Photovoltaic effect – Materials for photovoltaic devices – Fabrication of Si-solar cells- Operation of single cell – Generation, recombination and carrier transport in solar cells - PV modules – Applications of photovoltaic.		
Module: 5	NEW GENERATION SOLAR CELLS	9 Hours
Thin film based solar cells: CZTSSe solar cells theory and fabrication – CdTe cells – CIGS cells – Quantum dot solar cells - Dye sensitized solar cells - Multi band solar cells- Organic solar cells – Perovskite solar cells – Tandem solar cells.		
Total Lectures		45 Hours
Text Books		
1.	Sridhar Alla , Suman Kalyan Adari, “Beginning Anomaly Detection with Python”, A Press Media LLC,2019, ISBN – 9781484251768.	
2.	R. O. Duda, P.E.Hart, and D.G.Stork, “Pattern Classification”, 2nd edition, Springer, 2007, ISBN – 0471-05669-3.	
Reference Books		
1.	Muhammad Kamran, Muhammad Rayyan Fazal “Renewable Energy Conversion Systems”, Elsevier Science, 2021, ISBN- 9780128235980.	
2.	Gopal Nath Tiwari, Rajeev Kumar Mishra, “Advanced Renewable Energy Sources”, Royal Society of Chemistry, 2015, ISBN- 9781782625780.	
3.	H.P. Garg, J. Prakash “Solar Energy: Fundamental and Applications”, Tata McGraw Hill Education 2000. ISBN- 9780074636312.	
4.	K.L. Chopra, S.R Das, “Thin film solar cells”, Springer 2014, ISBN-9781489904201.	
5.	Ana Belén Cristóbal López “Next Generation of Photovoltaics” Springer 2012, ISBN – 9783642233685.	
Recommended by Board of Studies		05.05.2023
Approved by Academic Council		03 June 2023

Course Code	LASERS AND FIBER OPTICS	L	T	P	C
23PH3025		3	0	0	3
Course Objectives:					
Enable the student to: 1. Apply knowledge of fiber optics and laser instrumentation. 2. Demonstrate the optical fibers and their properties. 3. Illustrate the fundamental knowledge about the industrial and medical applications of optical fibers.					
Course Outcomes:					
The student will be able to: 1. Explain the basic concepts of optical fibers and their properties. 2. Analyze different types of fiber optics and their characteristics. 3. Employ skills to demonstrate and classify different types of fiber optic sensors. 4. Understand the techniques and results of laser instruments for surgery 5. Evaluate the recent progress in industrial applications of lasers. 6. Compare and analyze the principles and characteristics of holography and photography.					
Module: 1	OPTICAL FIBRES AND THEIR PROPERTIES				9 Hours
Construction of optical fiber cable: Guiding mechanism in optical fiber and Basic component of optical fiber communication, –Principles of light propagation through a fibre: Total internal reflection, Acceptance angle (θ_a), Numerical aperture and Skew mode, –Different types of fibres and their properties: Single and multimode fibers and Step index and graded index fibers,– fibre characteristics: Mechanical characteristics					

and Transmission characteristics, – Absorption losses – Scattering losses – Dispersion – Connectors and splicers –Fibre termination – Optical sources: Light Emitting Diode (LED), – Optical detectors: PIN Diode.		
Module: 2	INDUSTRIAL APPLICATION OF OPTICAL FIBRES	9 Hours
Fibre optic sensors: Types of fiber optics sensor, Intrinsic sensor- Temperature/ Pressure sensor, Extrinsic sensors, Phase Modulated Fibre Optic Sensor and Displacement sensor (Extrinsic Sensor) – Fibre optic instrumentation system: Measurement of attenuation (by cut back method), Optical domain reflectometers, Fiber Scattering loss Measurement, Fiber Absorption Measurement, Fiber dispersion measurements, End reflection method and Near field scanning techniques – Different types of modulators: Electro-optic modulator (EOM) –Interferometric method of measurement of length – Moire fringes – Measurement of pressure, temperature, current, voltage, liquid level and strain.		
Module: 3	LASER FUNDAMENTALS	9 Hours
Fundamental characteristics of lasers – Level Lasers: Two-Level Laser, Three Level Laser, Quasi Three and four level lasers – Properties of laser: Monochromaticity, Coherence, Divergence and Directionality and Brightness –Laser modes – Resonator configuration – Q-switching and mode locking – Cavity damping – Types of lasers; – Gas lasers, solid lasers, liquid lasers and semiconductor lasers.		
Module: 4	INDUSTRIAL APPLICATION OF LASERS	9 Hours
Laser for measurement of distance, Laser for measurement of length, Laser for measurement of velocity, Laser for measurement of acceleration, Laser for measurement of current, voltage and Laser for measurement of Atmospheric Effect: Types of LIDAR, Construction And Working, and LIDAR Applications – Material processing: Laser instrumentation for material processing, Powder Feeder, Laser Heating, Laser Welding, Laser Melting, Conduction Limited Melting and Key Hole Melting – Laser trimming of material: Process Of Laser Trimming, Types Of Trim, Construction And Working Advantages – Material Removal and vaporization: Process Of Material Removal.		
Module: 5	HOLOGRAM AND MEDICAL APPLICATIONS	9 Hours
Holography: Basic Principle, Holography vs. photography, Principle Of Hologram Recording, Condition For Recording A Hologram, Reconstructing and viewing the holographic image– Holography for non-destructive testing – Holographic components – Medical applications of lasers, laser-Tissue Interactions Photochemical reactions, Thermalisation, collisional relaxation, Types of Interactions and Selecting an Interaction Mechanism – Laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery		
Total Lectures		45 Hours
Reference Books		
1.	Robert J Hoss, “Fiber Optics”, Pearson Technology Group; 2nd edition,2008, ISBN- 978-0133212419.	
2.	Eric Udd, William B., and Spillman, Jr., “Fiber Optic Sensors: An Introduction for Engineers and Scientists “, John Wiley & Sons, 2011, ISBN- 978-1-118-01410-3	
3.	John F. Ready, “Industrial Applications of Lasers”, Elsevier, 2008, ISBN- 9780080508603	
4.	Ginu Rajan., “Optical Fiber Sensors: Advanced Techniques and Applications” , CRC Press; 1st edition ,2020, ISBN- 978-0367656058.	
5.	G Agrawal, “Nonlinear Fibre Optics”, 6tt Edition, Elsevier, 2019. ISBN- 9780128170434.	
Recommended by Board of Studies		05.05.2023
Approved by Academic Council		03 June 2023

Course Code	SPACE PHYSICS	L	T	P	C
23PH3026		3	0	0	3
Course Objectives:					
Enable the student to:					
1. Classify the electromagnetic waves and their methods of detection in the space environment.					

2. Evaluate information about telescopes and optical systems used in space probes. 3. Design astronomical spectroscopic instruments over the entire electromagnetic spectrum.		
Course Outcomes:		
The student will be able to: 1. Compare and contrast the principles of electromagnetic wave detection. 2. Articulate the working principles of telescopes and optical systems used in satellites and space probes. 3. Apply the concepts of spectroscopy to space-based astronomical spectroscopy. 4. Analyze the methods of detection and the instrumentation behind radio waves and far infrared. 5. Evaluate the working principles of near-infrared to most energetic gamma rays and high energy cosmic ray particles. 6. Create novel instrumentation methods to detect and analyze electromagnetic waves and high-energy particles.		
Module: 1	ELECTROMAGNETIC RADIATION DETECTION	9 Hours
Introduction – Mathematical Description of Electromagnetic (EM) Waves – Plane EM Waves – Energy in EM Waves – Interaction of EM Waves with Charged Particles – Astrophysical Radiation Mechanisms – Blackbody Radiation and the Planck Function – Free-Free Radiation – Quantum Transitions – Interaction of EM Radiation with Matter – The Effects of Earth’s Atmosphere.		
Module: 2	TELESCOPES AND OPTICAL SYSTEMS	9 Hours
Introduction – Telescope Configurations – Telescope Mounting Methods – Telescope Optics – Optical Aberrations – Diffraction – Fourier Optics – Spatial Interferometry – Key Concepts in Astronomical Measurements – Transduction – The Decibel Scale – Responsivity – Background Radiation – Sensitivity and Noise in EM Detection – An Ideal Photon Detector.		
Module: 3	ASTRONOMICAL SPECTROSCOPY	9 Hours
Introduction – Spectrometer Types – Prism Spectrometers – Grating Spectrometers – The Grating Equation and Grating Dispersion – Grating Response to a Monochromatic Source – Spectral Resolving Power – Fabry-Perot (FP) Spectrometers – Fourier Transform Spectrometers – Advantages and Disadvantages of Different Spectrometers – Grating Spectrometer Instruments.		
Module: 4	RADIO DETECTION AND FAR INFRARED INSTRUMENTATION	9 Hours
Introduction – Antennas – Radio Receivers – Mixers and Amplifiers – Local Oscillators – IF Spectrometers – Radio Observations – Radio Interferometry – Case Studies – Far Infrared – Direct Detection Instruments – Bolometric Detectors – Kinetic Inductance Detectors – Photoconductive Detectors – Case Studies.		
Module: 5	INFRARED TO GAMMA RAY DETECTION	9 Hours
Introduction – Infrared Detectors – Optical and UV Detectors – Adaptive Optics – Case Studies – X-Ray CCDs and Fano Noise – The Proportional Counter – X-Ray Spectroscopy – The X-Ray Calorimeter – Scintillation Detectors – Semiconductor Detectors – X-Ray and Gamma Ray Imaging – High Energy Cosmic Ray Detection – Neutrino Detection – Case Studies.		
Total Lectures		45 Hours
Reference Books		
1.	Peter A.R. Ade, Matthew J. Griffin, and Carole E. Tucker, Physical Principles of Astronomical Instrumentation, New York: CRC Press, 2021, ISBN – 978-1439871898.	
2.	David N. Burrows, The WSPC Handbook of Astronomical Instrumentation, New York: World Scientific Publishing Co. Pvt. Ltd., 2021, ISBN – 978-9814644310.	

3.	Christoph U. Keller, Ramon Navarro, and Bernard R. Brandl, Field Guide to Astronomical Instrumentation, London: SPIE Press, 2015, ISBN – 978-1628411775.
4.	Thomas Eversberg, and Klaus Vollmann, Spectroscopic Instrumentation: Fundamentals and Guidelines for Astronomers, Berlin: Springer, 2015, ISBN – 978-3662511527.
5.	Astronomical Telescopes and Instrumentation, London: SPIE Press, 2010, ISBN – 978-0819482433.
Recommended by Board of Studies	05.05.2023
Approved by Academic Council	03 June 2023

Course Code	ATMOSPHERIC PHYSICS	L	T	P	C
23PH3027		3	0	0	3
Course Objectives:					
Enable the student to: Investigate the behaviour of the atmosphere and factors influencing heterogeneous systems. Assess information about equilibrium processes that affect the atmosphere. Develop an advanced understanding of atmospheric motions and waves.					
Course Outcomes:					
The student will be able to: Examine the composition and structure of the atmosphere and its various influencing factors. Correlate the physics of heterogeneous systems and the fundamental relations governing the same. Apply the principles of equilibrium and stability to understand the stratification of atmospheric layers. Analyze the absorption and emission behaviour of aerosols and clouds and their roles in climate change. Evaluate the kinematics of atmospheric motions and waves and their influence on the planetary boundary layer Create plausible solutions to curb global warming and climate change crises.					
Module: 1	INTRODUCTION TO ATMOSPHERE				9 Hours
Introduction – Atmospheric Behaviour – Influencing Mechanisms – Composition and Structure – Radiative Equilibrium of the Planet – The Global Energy Budget – The General Circulation – Thermodynamics of Gas – The First Law – Heat Capacity – Adiabatic Processes – The Second Law and its Implications.					
Module: 2	HETEROGENEOUS SYSTEMS				9 Hours
Introduction – Chemical Equilibrium – Fundamental Relations – Degrees of Freedom – Thermodynamic Characteristics – Equilibrium Phase Transformations – Transformations of Moist Air – Implications for the Distribution of Water Vapor – State Variables – Thermodynamic Behaviour.					
Module: 3	HYDROSTATIC EQUILIBRIUM				9 Hours
Introduction – Effective Gravity – Geopotential Coordinates – Hydrostatic Balance – Stratification – Lagrangian Interpretation – Hydrostatic Stability – Reaction to Vertical Displacement – Stability Categories – Implications – Finite Displacements – Stabilizing and Destabilizing Influences – Turbulent Dispersion.					
Module: 4	ATMOSPHERIC RADIATION				9 Hours
Introduction – Shortwave and Longwave Radiation – Radiative Transfer – Absorption – Lambert’s Law – Emission – Planck’s Law – Absorption Characteristics of Gases – Thermal Equilibrium – Thermal Relaxation – Aerosols and Clouds – Morphology – Microphysics – Macroscopic Characteristics – Roles of Clouds and Aerosols in Climate Change – Carbon Net Zero.					
Module: 5	ATMOSPHERIC MOTIONS AND WAVES				9 Hours
Introduction – Kinematics of Fluid Motion – Reynold’s Transport Theorem – Conservation of Mass – Atmospheric Equations of Motions – Large Scale Motions – Geostrophic Equilibrium – Curvilinear Motion					

– Divergent Motion – The Planetary Boundary Layer – Turbulence – Structure – Influence of Stratification – Atmospheric Waves – Acoustic Waves – Buoyancy Waves – The Lamb Waves – Rossby Waves.	
Total Lectures	45 Hours
Reference Books	
1.	Bruce Mullan, Atmospheric Science: Chemistry and Physics, New York: Callisto Reference, 2019, ISBN – 978-1641160445.
2.	Mary D’Souza, Atmospheric Physics, New York: Callisto Reference, 2017, ISBN – 978-1632398543.
3.	Gerard R. North and Kwang-Yul Kim, Wiley Series in Atmospheric Physics and Remote Sensing: Energy Balance Climate Models, New Delhi: Wiley VCH Verlag, 2017, ISBN – 978-
4.	Claudio Tomasi, Sandro Fuzzi and Alexander Kokhanovsky (Eds.), Wiley Series in Atmospheric Physics and Remote Sensing: Atmospheric Aerosols, New Delhi: Wiley VCH Verlag, 2017, ISBN – 978-3527411320.
5.	Murry A Salby, Introduction to Atmospheric Physics, New York: Academic Press, 1996, ISBN – 978-0126151602.
Recommended by Board of Studies	05.05.2023
Approved by Academic Council	03 June 2023

Course Code	FORENSIC PHYSICS	L	T	P	C
23PH3028		3	0	0	0
Course Objectives:					
Enable the student to:					
1. Describe the basics of physics in forensic science.					
2. Analyse the evidences for forensic investigation					
3. Apply different techniques in forensic physics to examine the evidence.					
Course Outcomes:					
The student will be able to:					
1. Analyse the significance of physical and trace evidences.					
2. Report on the causes and investigations done on vehicular accidents.					
3. Examine the production of sound and voice.					
4. Investigate the crime scene based on forensic photography.					
5. Interpret the various methods of photographing a crime scene.					
6. Apply the instrumental techniques for crime investigation.					
Module: 1		GENERAL FORENSIC SCIENCE			9 Hours
Introduction to Forensic science, Law and legal systems, Necessity and relevance of forensic science in criminal investigation, Types and significance and classification of physical and trace evidences, Various stages of physical evidence analysis- Investigation, Documentation, Collection, Analysis.					
Module: 2		AUTOMOBILE ACCIDENTS - CAUSES AND INVESTIGATION			9 Hours
Vehicular accidents-Introduction, Information sources: eye witnesses, Tire and other mark, Pedestrian impacts and vehicle speed, vehicle condition, vehicle damage, curved scuffmarks, Time and distance, reaction time, Vehicular Accident Photography					
Module: 3		SPEAKER IDENTIFICATION, TOOL MARKS, FINGERPRINTS			9 Hours
Voice Production, Speaker identification and authentication, Voice analysis, Definition, Tool marks and their characteristics, types of tool marks, matching of tool marks, Fundamentals of fingerprinting, Fingerprint patterns.					

Module: 4	FORENSIC PHOTOGRAPHY	9 Hours
Basic principles of photography, Photographic lenses, filters and artificial lights, Digital Photography, Ultraviolet and infrared photography, Special Photographic techniques used in forensic applications.		
Module: 5	PRACTICAL APPLICATIONS OF PHYSICS IN FORENSICS	9 Hours
An overview and significance of the instrumental techniques, Applications of forensic physics, Computer Forensics- -Definition, various types of computer crimes, collection, handling and preservation of digital evidences.		
Total Lectures		45 Hours
Reference Books		
1.	Forensic Science In Criminal Investigation And Trials 6Th Edition 2020, ISBN-13-978-9388548786	
2.	Encyclopedia of Forensic Sciences,3rd Edition - November 1, 2022, ISBN: 9780128236789	
3.	An Introduction to Forensic Science in Criminal Investigation,2022, ISBN: 978-8189128272	
4.	<u>Practical Cyber Forensics: An Incident-Based Approach to Forensic Investigations,2019, ISBN-13: 978-1484244593</u>	
5.	Renata Holubova, Jiří Straus, Jana Slezáková, “Forensic and Physics”, 2022, ISBN: 9781527584075	
Recommended by Board of Studies		5-5-2023
Approved by Academic Council		03 June 2023

Course Code	DEFENCE PHYSICS	L	T	P	C
23PH3029		3	0	0	3
Course Objectives:					
Enable the student to: 1. Distinguish between the various warfare platforms and systems. 2. Experiment on the military capabilities and naval combat systems. 3. Justify the physics concepts behind the mechanism of missile launching and radar technology.					
Course Outcomes:					
The student will be able to: 1. Estimate about the weapon systems and various warfare platforms. 2. Classify the different self defence and protective systems available. 3. Discriminate on the military vehicle used for combat. 4. Illustrate the navigation mechanics of marine combat systems. 5. Apply the physics laws towards the launching of rockets and missiles. 6. Analyze the design, working and tracking methods of radar.					
Module: 1	SYSTEMS AND WARFARE PLATFORMS				9 Hours
Types of platforms: land, sea, air - Weapon systems: guns, ordnance, missiles, rockets, bombs - sub- munitions – projectiles - mines/ countermines – lasers - undersea weapons - air-launched weapons - anti-aircraft, anti-personnel- anti-ship, anti-submarine- Self defence and Protection systems: Armour, smoke, chaff, decoys.					
Module: 2	MILITARY COMBAT SYSTEMS				9 Hours
Introduction to Military Warfare systems - Military capabilities: air warfare, surface warfare, sub surface warfare, littoral warfare - Military vehicle fundamentals: tracked, wheeled, A, B and C vehicles.					
Module: 3	NAVAL COMBAT SYSTEMS				9 Hours
Fundamentals of inertial navigation- principles of inertial accelerometers – gyroscopes -Basic principles of power and propulsion of marine systems-Laws of thermodynamics - fluid mechanics.					
Module: 4	ROCKETS & MISSILES SCIENCE				9 Hours

Basics of Missile Physics- Introduction to Guided Missiles- Classification of missiles and rockets- Missile Aerodynamic Configurations- Coordinate Transformation -Transformation Matrices -Equations of Motion - Ballistic Missile Trajectory - Effect of Curvature of Earth -Rotation of Earth- Variation of Gravity on Missile Trajectory.		
Module: 5	RADAR TECHNOLOGIES	9 Hours
Introduction to Radar- Radar parameters/definitions- radar equations- Atmospheric propagation- Space Surveillance and Tracking Radar- Radar Designs- quiet radar- jamming techniques & strategies.		
Total Lectures		45 Hours
Reference Books		
1.	Yacov Bar-Shlomo, "An Introduction to Weapons Systems", Create Space Independent Publishing Platform, 2016, ISBN: 978-1540599513.	
2.	Tupper, E. C Fourth., "Introduction to Naval Architecture", Butterworth-Heinemann, 2013, ISBN: 978-0080982373.	
3.	Anthony Lawrence, "Modern Inertial Technology: Navigation, Guidance, and Control", Springer-Verlag New York Inc, 2001, ISBN: 978-0387985077.	
4.	Martin J Dougherty, "Modern Air-Launched Weapons" Amber Books Ltd; Illustrated edition, 2019, ISBN : 978-1782747086.	
5.	Fouad Sabry, "Cruise Missile", One Billion Knowledgeable, 2022, ASIN: B0BVDD6S5C.	
Recommended by Board of Studies		05.05.2023
Approved by Academic Council		03 June 2023

Course Code	INTRODUCTION TO IPR AND ENTREPRENEURSHIP	L	T	P	C
23PH3030		3	0	0	3
Course Objectives:					
Enable the student to: 1. Explore research information sources. 2. Document patenting and commercialization of products. 3. Appreciate the role of entrepreneurship in commercializing the products.					
Course Outcomes:					
The student will be able to: 1. Identify the scientific literature for selecting and working on research problems. 2. Explain the steps in patenting. 3. Acquire an entrepreneurial mindset. 4. Analyze the possibility and procedure of commercialization. 5. Choose the role models and utilize the mentor support system. 6. Criticize the different types of business organizations.					
Module: 1	LITERATURE AND INFORMATION SOURCES	9 Hours			
Primary information sources – papers, notes, communications, letters – language of literature– synopses and supplementary materials – patents – secondary information sources – titles, abstracts, reviews, general treatises, monographs, textbooks – searching literature – plagiarism – structure of articles.					
Module: 2	INTRODUCTION TO PATENTING	9 Hours			

Intellectual Property Dynamics - types of Intellectual Property - flow of IP rights - infringement of IP rights –copyrights – trademarks - trade secrets.		
Module: 3	INTRODUCTION TO ENTREPRENEURSHIP SKILLS	9 Hours
Concept of Entrepreneur, Entrepreneurship and Enterprise, Definition of Entrepreneurship, Objectives of Entrepreneurship Development, Phases of Entrepreneurship Development, Role of Entrepreneurship, The Entrepreneurial Mindset, Characteristics of Entrepreneurship, Traits of Entrepreneurship, Entrepreneurial discipline with 3Ps.		
Module: 4	CASE STUDIES	9 Hours
Creative and Design Thinking, the entrepreneurial decision process, skill gap analysis, and role models, mentors and support system, entrepreneurial success stories-case studies.		
Module: 5	TYPES OF BUSINESS ORGANIZATIONS	9 Hours
Introduction to various form of business organization (sole proprietorship, partnership, corporations, Limited Liability company), mission, vision and strategy formulation.		
Total Lectures		45 Hours
Reference Books		
1.	V. Lindberg, “Intellectual Property and Open Source: A Practical guide to Protecting code”, O'Reilly Media, Inc., 2008, ISBN: 9780596517960.	
2.	Lowe R & S Mariott, “Enterprise: Entrepreneurship & Innovation”, Burlington, Butterworth-Heinemann, Oxford, 2006, ISBN: 9780750669207.	
3.	Ramachandran, “Entrepreneurship Development”, Mc Graw Hill, 2008, ISBN :9780070248878.	
4.	Hougaard S., “The business idea- The Early Stages of Entrepreneurship”, Berlin, Springer, 2005, ISBN: 9783540269595.	
5.	Richard Stim, “Patent, Copyright & Trademark: An Intellectual Property Desk Reference”, Nolo publishers, 2022, ISBN: 9781413329834.	
Recommended by Board of Studies		05.05.2023
Approved by Academic Council		03 June 2023

Course Code	SOLID STATE BATTERIES	L	T	P	C
23PH3031		3	0	0	3
Course Objectives:					
Enable the student to:					
1. Describe the cutting-edge technologies in solid-state batteries					
2. Elucidate the working of energy storage devices and their applications					
3. Demonstrate the making of thin film solid-state lithium-ion batteries					
Course Outcomes:					
The student will be able to:					
1. Investigate the various battery parameters.					

2. Analyze the working principle of different types of lithium batteries. 3. Apply the knowledge of the thin film making process to make lithium micro-batteries. 4. Evaluate the battery performance through testing methods. 5. Assess the alternative battery technologies. 6. Design advanced energy devices.		
Module: 1	BATTERY FUNDAMENTALS	9 Hours
Invention, Early innovators, Global Battery Markets, Voltage, Capacity, C-rates, Watts and Volt-Amps, State of Health, Octagon Battery: Specific Energy, Specific Power, Price, Cycle Life, Safety, Operating range, Toxicity, Fast Charging, Battery building blocks: Anode, Cathode, Electrolyte, Current Collectors, Separators for different battery systems; Primary and secondary batteries in the market working of Lechlanche cell, working of alkaline batteries, applications of primary batteries.		
Module: 2	LITHIUM BATTERIES	9 Hours
Types of lithium primary batteries, working of lithium – Iodine battery, working of lithium – MnO ₂ primary battery, working of lithium metal primary battery and its dendrite formation, applications of lithium primary battery, Applications of lithium primary batteries, advantages and disadvantages of lithium primary batteries. Working of lithium ion secondary battery. Applications, advantages and disadvantages of lithium ion battery.		
Module: 3	MICROBATTERIES FABRICATION	9 Hours
Microbatteries- a solid state battery, Fundamentals on thin and thick films- flexible and non-flexible substrates; Methods of constructing microbatteries- Rf-sputtering and Pulsed Laser Deposition Techniques. Design and working of Glove Box- Fabrication of coin-power microbatteries. Crimping Machine-working; Types of cells in fabrication of lithium ion batteries- Coin cell types, prismatic, cylindrical and other types.		
Module: 4	TESTING OF COIN-POWER MICRO-BATTERIES	9 Hours
Characterization of material components: X-ray Diffraction, Scanning Electron Microscope, Fourier Transform Spectroscopy; X-ray Photoelectron Spectroscopy; Battery Characteristics: Open Circuit Voltage; Cyclic Voltammetry; Galvanostatic Charge-Discharge Studies; Electrochemical Impedance Spectroscopy studies.		
Module: 5	RECENT PROGRESS IN BATTERIES AND ALTERNATIVE ENERGY DEVICES	9 Hours
Recent materials for lithium ion battery; advantages and disadvantages of lithium ion battery; alternative technologies: Sodium, Potassium, Magnesium, Iron ion, Aluminium ion, Silver ion batteries and other alternative batteries, Supercapacitor, Fuel Cells. Design of lithium ion batteries for specific applications: Space craft, Land and marine applications – pros and cons.		
Total Lectures		45 Hours
Reference Books		
1.	Beta Writer, Heidelberg, “Lithium-Ion Batteries”, Springer Publishers, 2019, ISBN 978-3-030-16800	
2.	Mitsunobu Sato, “Lithium-ion Batteries: Thin Film for Energy Materials and Devices”, IntechOpen, 2020, ISBN: 978-1789854633	
3.	Kosala Gunawardane, Nihal Kularatna, “Energy Storage Devices for Renewable Energy-Based Systems: Rechargeable Batteries and Supercapacitors”, AP publishers, 2021, ISBN: 978-0128207789	
4.	Aiping Yu, Victor Chabot, JiuJun Zhang, “Electrochemical supercapacitors for energy storage and delivery: fundamentals and applications”, CRC press, 2017, ISBN 9781315216942	
5.	Ashok Kumar, Shyamal Kumar Das, “Energy Storage and Conversion: Materials and Devices”, 2017, Narosa Publishing House, 2017, ISBN- 978-8184875782	
Recommended by Board of Studies		5.5.2023
Approved by Academic Council		03 June 2023

Course Code	QUANTUM COMPUTING IN AI	L	T	P	C
23PH3032		3	0	0	3
Course Objectives:					
Enable the student to:					
1. Examine the scientific background of quantum computing. 2. Differentiate on various quantum circuits and quantum algorithms. 3. Illustrate the interplay between quantum theory and artificial intelligence.					
Course Outcomes:					
The student will be able to:					
1. Correlate on qubits, quantum superposition and entanglement. 2. Operate on Hilbert space, density matrices and tensors behind quantum computing. 3. Distinguish between various quantum circuits involved in the field of quantum computing. 4. Report on the relation between quantum and classical complexity. 5. Debate on the theory of quantum information, quantum error and correction. 6. Validate on the inter relation between quantum theory and artificial intelligence.					
Module: 1	FOUNDATION OF QUANTUM COMPUTING				9 Hours
From classical to quantum information-origin of quantum computing- formulation of quantum mechanics - qubits and multi-qubits states, - Bloch sphere representation- quantum superposition- quantum entanglement – Bell’s theorem.					
Module: 2	SCIENTIFIC BACKGROUND				9 Hours
Basis vectors and orthogonality - Hilbert spaces – density matrices - tensors – probability and measurements - unitary operators and projectors - quantum Fourier transform - Dirac notation - eigen values and eigen vectors.					
Module: 3	QUANTUM CIRCUITS AND ALGORITHMS				9 Hours
Quantum circuits: Qubit gates – types – design – superposition — quantum algorithms: classical computation on quantum computers – relationship between quantum and classical complexity classes- Deutsch’s algorithm - Jozsa and Grover algorithms – Shor factorization.					
Module: 4	QUANTUM INFORMATION AND ERROR CORRECTION				9 Hours
Introduction to quantum information – comparison- quantum noise and quantum operations - applications of quantum operations and limitations – error correction: theory of quantum error and correction - tolerant quantum computation - entropy and information – basic properties of entropy - Von Neumann.					
Module: 5	QUANTUM THEORY AND AI - INTERPLAY AND APPLICATIONS				9 Hours
Semantic analysis – recognition and discrimination of quantum states and operators - quantum neural and Bayesian networks – quantum genetic algorithm – quantum algorithms for machine learning — quantum search – quantum game theory.					
Total Lectures					45 Hours
Reference Books					
1.	Eleanor G. Rieffel and Wolfgang H. Polak, “Quantum Computing: A Gentle Introduction” (Scientific and Engineering Computation), The MIT Press, Illustrated edition (29 August 2014), ISBN: 978-0262526678.				
2.	Jack D. Hidary, "Quantum Computing: An Applied Approach", Springer; 1st ed. 2019 edition (20 September 2019), ISBN: 978-3030239213.				
3.	Nielsen, "Quantum Computation And Quantum Information", Cambridge University Press (5 April 2013), ISBN: 978-1107619197.				
4.	Chris Bernhardt, "Quantum Computing for Everyone", The MIT Press; Reprint edition (8 September 2020), ISBN: 978-0262539531.				

5.	Parag K. Lala, "Quantum Computing", McGraw Hill; First Edition (1 November 2020), ISBN: 978-9390385263.	
Recommended by Board of Studies		5.5.2023
Approved by Academic Council		03 June 2023

Course Code	RELATIVITY AND COSMOLOGY	L	T	P	C
23PH3033		3	0	0	3

Course Objectives:

Enable the student to:

1. Elucidate the concept of curvature of space-time and its implications.
2. Evaluate the experimental proofs of the general theory of relativity.
3. Construct a theoretical basis for the big bang theory and nucleosynthesis of heavy elements.

Course Outcomes:

The student will be able to:

1. Assess the classical view of space-time and its transformation under the general theory of relativity.
2. Generalize the concepts of Riemann space and the vector fields associated with the curvature of space-time.
3. Apply the principles of general relativity to match with experimental observations.
4. Analyze the applications of relativity to the singularities of space-time.
5. Evaluate the concepts of the Big Bang theory and stellar nucleosynthesis.
6. Create novel technologies by the application of General Relativity.

Module: 1	CURVATURE OF SPACE-TIME	9 Hours
Introduction – Space and Time: The Classical View – Metric Space – Homogeneity and Isotropy of Space – Planetary Motions – From Space and Time to Space-Time – A Metric Space-Time – Minkowski Space – Ordinary vs Hyperbolic Rotations – Lorentz Transformations – From Inertial to Non-Inertial Reference Frames – Geodesics in a General Space-Time.		
Module: 2	RIEMANNIAN SPACES	9 Hours
Introduction – Manifolds – Vector Fields – Tensors – The Riemann-Christoffel Curvature Tensor – Transport in Curved Space and Manifolds – From Non-Inertial Frames to Gravity – The Equivalence Principle – Switching off Gravity: The Free Fall – Creating Gravity: Non-Inertial Frames – Geodesic Deviation – Link Between Geometry and Dynamics.		
Module: 3	FROM CURVATURE TO OBSERVATIONS	9 Hours
Introduction – Observational Test of the Equivalence Principle – Inertial vs Gravitational Masses – Gravitational Time Dilation – Gravitational Redshift – Field Equations in the Vacuum – The Ricci Tensor – The Einstein Tensor – Hilbert's Action – Schwarzschild Space-Time – Solution for a Point Mass – Energy Conservation – The Radial In-fall – Stable Circular Orbits – The Classical Tests of General Relativity.		
Module: 4	FROM SINGULARITIES TO COSMOLOGICAL SCALES	9 Hours
Introduction – Schwarzschild Black Holes – Field Equations – Requirements – Conservation Laws for a Relativistic Fluid – The Energy-Momentum Tensor – An Isotropic Radiation Field – Field Equations Inside a Matter-Energy Distribution – Applications of Field Equations – The Inner Schwarzschild Space-Time – Spherical Relativistic Hydrodynamics.		
Module: 5	THEORETICAL COSMOLOGY	9 Hours
Introduction – An Isotropic and Homogeneous Matter Distribution – The FLRW Metric – The Friedman Equations – Cosmological Parameters – The De-Sitter Model – The Open and Closed Friedman Universe –		

The Einstein De-Sitter Space – The Cosmological Redshift – The Big-Bang Theory – The Cosmic Microwave Background – Primordial Nucleosynthesis.	
Total Lectures	45 Hours
Reference Books	
1.	Nicola Vittorio, An Overview of General Relativity and Space-Time, New York: CRC Press, 2022, ISBN – 978-0367692889.
2.	Leonard Susskind and Andre Cabannes, General Relativity: The Theoretical Minimum, New Delhi: Allen Lane, 2023, ISBN – 978-0241562581.
3.	James Malcolm Bird, Einstein's Theories of Relativity and Gravitation, New Delhi: Legare Street Press, 2022, ISBN – 978-1362000754.
4.	Robert Resnick, Introduction to Special Relativity: An Indian Adaptation, New Delhi: Wiley, 2021, ISBN – 978-9354244919.
5.	Farook Rahaman, The General Theory of Relativity: A Mathematical Approach, New Delhi: Cambridge University Press, 2021, ISBN – 978-1108837996.
Recommended by Board of Studies	05.05.2023
Approved by Academic Council	03 June 2023

Course Code	CRYSTAL GROWTH TECHNIQUES	L	T	P	C
23PH3034		3	0	0	3
Course Objectives:					
Enable the student to:					
1. Acquire knowledge of nucleation mechanism involved in advanced crystal growth techniques. 2. Distinguish crystal growth methods such as melt, solution, and vapor transport. 3. Apply the advanced crystal growth mechanisms in the CVD and PVD systems.					
Course Outcomes:					
The student will be able to:					
1. Classify the different techniques used for growing crystals. 2. Review physics and chemistry in the context of materials science & engineering. 3. Describe the different types of bonding in solids and understand the broad areas of crystal growth methods. 4. Describe and demonstrate diffraction and review the melt growth, solution and vapour growth of crystals. 5. Demonstrate the crystal growth using various melt techniques. 6. Analyze the crystal growing process using various vapour methods.					
Module: 1	FUNDAMENTALS OF CRYSTAL GROWTH	9 Hours			
Importance of crystal growth – classification of crystal growth methods -Theories of nucleation – – Gibbs Thomson equation for vapor solution and melt energy of formation of a nucleus –Adsorption at the growth surface – Nucleation – Homogeneous and Heterogeneous nucleation – Growth surface.					
Module: 2	GROWTH FROM LOW TEMPERATURE SOLUTIONS	9 Hours			
Solution – selection of solvents – solubility and super solubility – Saturation and super saturation – Meir’s solubility diagram – Metastable zone width – measurement and its enhancement – Growth by (i) restricted evaporation of solvent, (ii) slow cooling of solution and (iii) temperature gradient methods – Growth in Gel media, Electrocrystallization.					
Module: 3	GROWTH FROM FLUX AND HYDROTHERMAL GROWTH	9 Hours			

Flux Growth – principle – choice of flux – Growth kinetics – phase equilibrium and phase diagram – – solvent evaporation technique – slow cooling technique - transport in a temperature gradient technique – Accelerated crucible rotation technique – Top seeded solution Growth – Hydrothermal Growth.		
Module: 4	GROWTH FROM MELT	9 Hours
Basis of melt growth Bridgman – Stock barger method – pulling from the melt – Czochralski method (CZ) – cooled seed Kyropoulos method – zone refining – vertical, horizontal floatzone methods –Skull melting Process – Vernueil method – flame fusion, plasma and arc image methods.		
Module: 5	GROWTH FROM VAPOUR	9 Hours
Basic principle – physical vapour deposition (PVD) – Evaporation and Sublimation processes – sputtering – chemical vapour Deposition (CVD) – Advantages and disadvantages –chemical vapour transport – Fundamentals – Growth by chemical vapour transport (CVT) Reaction.		
Total Lectures		45 Hours
Reference Books		
1.	Crystal Growth For Beginners: Fundamentals Of Nucleation, Crystal Growth And Epitaxy (Third Edition)(2017), ISBN: 978-9813143425	
2.	Hand book of crystal growth, Elsevier. Edited by Peter Rudolph (2014) ISBN: 9780444633033	
3.	<u>Crystal Growth Concepts, Mechanisms and Applications, Jinjin Li, Jianwei Li and Yanhui Chu (Editors)Shanghai Jiao Tong University, Shanghai, P.R. China, (2017), ISBN: 978-1-53612-203-9.</u>	
4.	Handbook of Crystal Growth, GovindhanDhanaraj, KullaiahByrappa, Vishwanath Prasad, Michael Dudley, Springer Berlin, Heidelberg, (2010), ISBN: 978-3-540-74182-4	
5.	<u>Crystallization and Science of Crystals, NY Research Press, (2015), ISBN: 9781632381033.</u>	
Recommended by Board of Studies		05.05.2023
Approved by Academic Council		03 June 2023

Course Code	RADIATION PHYSICS	L	T	P	C
23PH3035		3	0	0	3
Course Objectives:					
Enable the student to:					
1. Interpret the physics principles of atomic and nuclear physics. 2. Demonstrate basic radiation detection mechanisms and various types of detectors. 3. Criticize the importance of counting statistics and other statistical tools in radiation measurements.					
Course Outcomes:					
The student will be able to:					
1. Assess the physics principles of atomic and nuclear physics. 2. Distinguish the interaction of different radiations with matter. 3. Apply the various absorption mechanisms of radiation and particles in environmental radiation detection. 4. Analyze the instrumentation principles of radiation detection mechanisms and types of detectors. 5. Evaluate the importance of counting statistics and other statistical tools in radiation measurements. 6. Create peaceful applications of radiation in the field of food, water, health, and energy.					
Module: 1	REVIEW OF PHYSICAL PRINCIPLES	9 Hours			
Mechanics – Units and Dimensions – Work and Energy – Relativity Effects – Electricity – Electrical Charge: The Stat Coulomb – Electric Potential: The Stat Volt – Electric Field – Energy Transfer – Elastic and Inelastic					

Collision –Electromagnetic Waves – Excitation and Ionization – Periodic Table of the Elements – The Wave Mechanics Atomic Model – The Nucleus – The Neutron and the Nuclear Force – Isotopes –The Atomic Mass Unit – Binding Energy – Nuclear Models – Nuclear Stability.							
Module: 2		RADIOACTIVITY AND INTERACTION OF RADIATION WITH MATTER		9 Hours			
Radioactivity and Decay Mechanism – Kinetics of Decay – The Units of Radioactivity – Series Decay – Alpha Rays – Range-Energy Relationship – Energy Transfer – Beta Rays – Range Energy Relationship – Mechanism of Energy Loss – Ionization and Excitation – Gamma Rays – Exponential Absorption – Absorption Mechanisms – Pair Production – Compton Scattering – Photoelectric Effects – Neutrons – Production Classification – Interaction.							
Module: 3		METHODS OF MEASURING RADIATION		9 Hours			
Gas Filled Detectors – Ionization Chamber – Proportional Counters – Geiger Muller Counter – Scintillation Detection Systems – Photomultipliers – Scintillators – Semiconductor Detectors – Principles of Operation – Charged Particle Detectors – Thermo Luminescent Detectors – Film Badge – OSLD – High Purity Germanium Detectors – Track Devices – Photographic Emulsion – Track Etch Dosimeters – Spark Counters and Spark Chambers – Miscellaneous Detectors.							
Module: 4		COUNTING STATISTICS AND CALIBRATION OF INSTRUMENTS		9 Hours			
Uncertainty in the Measuring Process – Various Types of Distribution – Error Propagation – Accuracy of Counting Measurements – Significance of Data from Statistical Viewpoint – Calibration and Standards – Source Calibration – Neutron Sources – X-ray Machines – Calibration of Detection Equipment.							
Module: 5		RADIATION IN THE ENVIRONMENT AND THEIR APPLICATIONS		9 Hours			
Types of Radiation Sources – Natural Radiation Sources – Artificial Sources of Radiation – Applications of Radiations – Medical Applications – Industrial Applications – Radiation in Food Processing Industry – Agricultural Applications – Isotope Hydrology – Miscellaneous Applications.							
Total Lectures				45 Hours			
Reference Books							
1.	Nicholas Tsoulfanidis and Sheldon Landsberger, Measurement and Detection of Radiation, New York: CRC Press, 2021, ISBN – 978-0367434014.						
2.	Ervin B. Podgorsak, Radiation Physics for Medical Physicists, New York: Springer, 2018, ISBN – 978-3319797816.						
3.	Kuppusamy Thayalan, Basic Radiological Physics, New Delhi: Jaypee Brothers Medical Publishers, 2017, ISBN – 978-9352700486.						
4.	Lucio Cerrito, Radiation and Detectors: Introduction to the Physics of Radiation and Detection Devices, Berlin: Springer Publications, 2017, ISBN – 978-3319531793.						
5.	Pier-Giorgio Rancoita and Claude Leroy, Principles of Radiation Interaction in Matter and Detection, London: World Scientific, 2015, ISBN – 978-9814603188.						
Recommended by Board of Studies		05.05.2023					
Approved by Academic Council		03 June 2023					
Course Code		BIOMATERIALS		L	T	P	C
23PH3036				4	0	0	4
Course Objectives:							

Enable the student to: 1. Establish knowledge on the aspects of introduction to biomaterials and implant materials 2. Correlate the concepts of polymeric and ceramic implant materials for the effective replacement of human bones and tissues. 3. Analyze the properties of smart materials and their applications in biocompatibility.		
Course Outcomes:		
The student will be able to: 1. Examine various kinds of bulk and nano biomaterials properties. 2. Explain the concepts of metallic implant materials and their properties in detail. 3. Summarize the fundamental ideas of polymeric implant materials in the human body and their effectiveness. 4. Categorize ceramic implant materials and their applications in biomedical areas. 5. Illustrate smart biomaterials and their importance in medical applications. 6. Apply the biocompatibility phenomena in human tissues and interpret their applications.		
Module: 1	INTRODUCTION TO BIOMATERIALS	12 Hours
Definition of biomaterials, requirements & classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface and Bulk of bio-materials, Surface properties of materials, physical properties of materials, mechanical properties, Nano Biomaterials, Nano Ceramics, Nano Polymers, Nano Silica, Hydroxyapatite, Carbon Based Nanomaterials, Surface modification, Textured and porous Materials.		
Module: 2	METALLIC IMPLANT MATERIALS	12 Hours
Types, Characteristics and Functions of Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with bio metal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium.		
Module: 3	POLYMERIC IMPLANTS MATERIALS	12 Hours
Natural polymers, Types, Polyurethanes, Polyethenes, Polyolefin's, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetyls. Soft Tissue and Hard Tissue replacement Viscoelastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity. Importance of molecular structure, hydrophilic and hydrophobic surface properties, Physiochemical characteristics of biopolymers. Biodegradable polymers for medical purposes, Biopolymers in controlled release systems. Synthetic polymeric membranes and their biological applications.		
Module: 4	CERAMIC IMPLANT MATERIALS	12 Hours
Definition of bio ceramics. Common types of bioceramics: Aluminum oxides, Glass ceramics, Carbons. Bio resorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement Polymers filled with osteogenic fillers (e.g. hydroxyapatite).		
Module: 5	SMART MATERIALS AND BIOCOMPATIBILITY	12 Hours
Smart materials for medical applications- tissue replacement implants-Sutures, Surgical tapes, Adhesive, Percutaneous and skin implants, Maxillo facial augmentation, Joint replacements. Biocompatibility & Toxicological screening of biomaterials: Definition of biocompatibility, blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (in situ implantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization,		

carcinogenicity, mutagenicity and special tests. Surface immobilized biomolecules, Cell-biomaterial interactions, immune response, In Vitro and In Vivo assessment of tissue compatibility.	
Total Lectures	60 Hours
Reference Books	
1.	Biomaterials Science: An Introduction to Materials in Medicine, By Buddy D. Ratner, et. al. Academic Press, San Diego, 2004. ISBN: 9780080470368
2.	Biomaterials, Sujata V. Bhat, Narosa Publishing House, 2002. ISBN:978-94-010-3850-8
3.	Biomaterials – Science and Engineering, J B Park, Plenum Press, 2013, ISBN: 978-1-4612-9710-9
Recommended by Board of Studies	05.05.2023
Approved by Academic Council	03 June 2023

Course Code	RADIATION TREATMENT AND PLANNING	L	T	P	C
23PH3037		4	0	0	4
Course Objectives:					
Enable the student to:					
1. Assess the knowledge of radiotherapy machines. 2. Analyze the interaction of photon beams on matter. 3. Design novel calibration methods used for daily quality assurance.					
Course Outcomes:					
The student will be able to:					
1. Examine the advanced information about radiotherapy machines. 2. Distinguish different types of interaction of photon beams with matter. 3. Apply various calibration methods to ensure better quality treatment using machines. 4. Analyze the various clinical treatment planning. 5. Evaluate the various radiation treatment modalities. 6. Create better treatment modalities using electron beam therapy and advanced radiotherapy treatment methods like Cyberknife.					
Module: 1	RADIOTHERAPY MACHINES	12 Hours			
X-rays and Gamma rays – Linear Accelerator – Components of Modern LINAC – Injection System - RF Power Generation System – Accelerating Wave Guide – Microwave Power Transmission – Auxiliary System – Electronic Beam Transport – LINAC Treatment Head – Production of Photon and Electron Beams from LINAC – Beam Collimation – Cobalt-60 versus LINAC – Radiation Therapy Simulators.					
Module: 2	PHYSICAL ASPECTS OF EXTERNAL PHOTON BEAMS	12 Hours			
Photon Beam Sources – Inverse Square Law – Penetration of Photon Beams into Phantom or Patient – Surface Dose – Build-up – Skin Sparing Effect – Percentage Depth Dose – Tissue air Ratio – Back Scattering Factor – Tissue Phantom Ratio – Tissue Maximum Ratio – Scatter Air Ratio – Total Scatter Factor – Isodose Distribution in Water Phantom – Isodose Charts and Factors Effecting – Correction of Irregular Counters – Missing Tissue Compensation – Correction of Tissue Inhomogeneity – Clarkson’s Method – Dose Calculation.					
Module: 3	CLINICAL TREATMENT PLANNING IN PHOTON BEAMS	12 Hours			
Treatment Planning – Volume Definition - ICRU 50, ICRU 62, ICRU 83 Concepts – GTV – CTV – ITV – PTV – OAR – Dose Specification – Patient Data Acquisition – Simulation – Conventional Simulation – Isodose Curves – Wedge Filters – Bolus – Compensating Filters – Field Separation – Quality Assurance of Treatment Planning System – IAEA TRS 430 Protocol – AAPM TG 53 and 106 Protocols.					

Module: 4	PHYSICAL ASPECTS OF ELECTRON BEAM THERAPY	12 Hours
Production of Electron Beams – Interaction of Electron with Matter – Range Concept – Percentage Depth Dose – Electron Energy Specification – Scattering Power – Rapid Dose Fall-off – Electron Shielding – Dose Prescription and Thumb Rule – Field Inhomogeneity – Dose Build-up – Photon Contamination – Back Scatter – Collimation – Virtual SSD – Oblique Incidence.		
Module: 5	ADVANCED RADIOTHERAPY TREATMENT METHODS	12 Hours
Treatment Planning System – Imaging in Radiotherapy – Image Fusion – CT Simulation – Basics of 3-Dimensional Conformal Therapy – Beams Eye View – Digitally Reconstructed Radiograph – 3-D Conformal Radiotherapy – Plan Evaluation Methods – Dose Volume Histograms – Treatment Evaluation – Introduction to Intensity Modulated Radiotherapy and Image Guided Radiotherapy – Concept – Imaging Modality – 2D image – kV Cone Beam CT – Image Registration – Plan Adaptation – QA Protocol and Procedures – Stereotactic Radiosurgery and Stereotactic Radiotherapy – Tomotherapy – Cyber Knife – Particle Beam Therapy.		
Total Lectures		60 Hours
Reference Books		
1.	Charles M. Washington, Dennis T. Leaver and Megan Trad, Washington & Leaver's Principles and Practice of Radiation Therapy, New York: Mosby Publications, 2020, ISBN – 978-0323596954.	
2.	Faiz M. Khan, John P. Gibbons and Paul W. Sperduto (Eds.), Khan's Treatment Planning in Radiation Oncology, New York: LWW Publishers, 2016, ISBN – 978-1975162016.	
3.	Faiz M. Khan and John P. Gibbons, Khan's The Physics of Radiation Therapy, New York: Lippincott Williams & Wilkins, 2014, ISBN – 978-1451182453.	
4.	E.B. Podgorsak (Ed.), Radiation Oncology Physics: A Handbook for Teachers and Students, Vienna: International Atomic Energy Agency, 2005, ISBN – 978-9201073044.	
5.	William R. Hendee, Geoffrey S. Ibbot and Eric G. Hendee, Radiation Therapy Physics (3 rd Edition), London: Wiley-Liss Publications, 2004, ISBN – 978-0471394938.	
Recommended by Board of Studies		05.05.2023
Approved by Academic Council		03 June 2023

Course Code	MEDICAL RADIATION DOSIMETRY	L	T	P	C
23PH3038		4	0	0	4
Course Objectives:					
Enable the student to:					
1. Expound the concepts of atoms and nuclei.					
2. Differentiate alpha, beta, and gamma rays.					
3. Evaluate the interaction of radiation with the surrounding matter.					
Course Outcomes:					
The student will be able to:					
1. Compare and contrast between an atom and a nucleus and other critical ideas related to them.					
2. Differentiate between the types of radiation emitted from nuclear sources.					
3. Apply the interaction of radiation with matter in novel peaceful applications.					
4. Analyze and understand the various units of radiation measurements.					
5. Evaluate the different types of radiation detection and measurement.					
6. Create novel dosimetry systems for measuring different types of nuclear radiation.					
Module: 1	BASIC RADIATION PHYSICS				12 Hours

Atoms and Nuclei – Fundamental Particles – Atomic and Nuclear Structure – Mass Defect and Binding Energy – Radiation – Classification of Radiation – Electromagnetic Spectrum – Radioactivity – Alpha, Beta and Gamma Rays – Methods of Decay – Isotopes – Radiation Sources.		
Module: 2	INTERACTION OF RADIATION WITH MATTER	12 Hours
Types of Indirectly Ionizing Radiation – Photon Beam Attenuation – Types of Photon Interactions – Types of Electron Interactions – Types on Neutron Interactions – Photo Electric Effect – Coherent Scattering – Compton Effect – Pair Production – Photo Nuclear Disintegration – Effect following Radiation Interaction.		
Module: 3	RADIATION QUANTITIES AND UNITS	12 Hours
Radiometric, Interaction, Protection and Dosimetric Quantities – Particle and Energy Fluence – Linear and Mass Attenuation Coefficient – Stopping Power – Linear Energy Transfer – Absorbed Dose – Kerma – Exposure – Activity – Equivalent Dose – Effective Dose – Electronic or Charged Particle Equilibrium – Bragg Gray Cavity Theory – Spencer-Attix Cavity – Burlin Cavity Theory – Bremsstrahlung Radiation – Bragg’s Curve.		
Module: 4	RADIATION DETECTION	12 Hours
Properties of Dosimeters – Methods of Radiation Detection – Ionization Chamber Dosimetry System – Proportional Counters – Geiger-Muller Counters – Semiconductor Detector – Solid and Liquid Scintillation Counters – Film Dosimetry – Thermo-luminescent Dosimetry – Calorimetry – Chemical Dosimetry.		
Module: 5	CALIBRATION OF PHOTON AND ELECTRON BEAMS	12 Hours
Calibration Chain – Ionization Chambers – Electro Meter and Power Supply – Phantoms – Chamber Signal Corrections for Influence Quantities – Calibration of Mega Voltage Photon Beams and Mega Voltage Electron Beams based on Standard National and International Protocols.		
Total Lectures		60 Hours
Reference Books		
1.	Ben Mijnheer, Clinical 3D Dosimetry in Modern Radiation Therapy, New York: CRC Press, 2019, ISBN – 978-0367870478.	
2.	Brian J. McParland, Medical Radiation Dosimetry: Theory of Charged Particle Collision Energy Loss, Berlin: Springer, 2016, ISBN – 978-1447170051.	
3.	Brian J. McParland, Nuclear Medicine Radiation Dosimetry: Advanced Theoretical Principles, Berlin: Springer Publications, 2010, ISBN – 978-1441996558.	
4.	Michael G. Stabin, Fundamentals of Nuclear Medicine Dosimetry, Berlin: Springer, 2008, ISBN – 978-0387745787.	
5.	Govinda K N Rajan, Advanced Medical Radiation Dosimetry, New Delhi: Prentice-Hall of India Pvt.Ltd, 2004, ISBN – 978-8120307063.	
Recommended by Board of Studies		05.05.2023
Approved by Academic Council		03 June 2023

APPLIED CHEMISTRY

LIST OF NEW COURSES

S. No	Course Code	Course Title	Credits L:T:P:C			
1	21CH1001	Basic Concepts of Chemistry	3	0	0	0
2	21CH2001	States of Matter	4	0	0	4
3	21CH2002	Physical Chemistry Lab-I	0	0	3	2
4	21CH2003	Atomic Structure and Nuclear Chemistry	4	0	0	4
5	21CH2004	Inorganic Chemistry Lab – I	0	0	3	2
6	21CH2005	Basic principles and Chemistry of Hydrocarbons	4	0	0	4
7	21CH2006	Organic Chemistry Lab –I	0	0	3	2
8	21CH2007	Chemical Bonding and Solid State	4	0	0	4
9	21CH2008	Inorganic Chemistry Lab – II	0	0	3	2
10	21CH2009	Organic Compounds Containing Oxygen, Sulfur and Halides	4	0	0	4
11	21CH2010	Organic Chemistry Lab –II	0	0	3	2
12	21CH2011	Analytical Chemistry – I	4	0	0	4
13	21CH2012	Analytical Chemistry Lab - I	0	0	3	2
14	21CH2013	Thermodynamics and Chemical Equilibrium	4	0	0	4
15	21CH2014	Physical Chemistry Lab-II	0	0	3	2
16	21CH2015	Main Group Chemistry and Inorganic Polymers	4	0	0	4
17	21CH2016	Inorganic Chemistry Lab - III	0	0	3	2
18	21CH2017	Chemistry of Amines, Nitriles and Heterocyclic compounds	4	0	0	4
19	21CH2018	Organic Chemistry Lab -III	0	0	3	2
20	21CH2019	Chemical Kinetics and Surface Chemistry	4	0	0	4
21	21CH2020	Physical Chemistry Lab-III	0	0	3	2
22	21CH2021	Transition metals and Coordination Chemistry	4	0	0	4
23	21CH2022	Inorganic Chemistry Lab - IV	0	0	3	2
24	21CH2023	Organic Chemistry Lab -IV	0	0	3	2
25	21CH2024	Electrochemistry and Quantum Chemistry	4	0	0	4
26	21CH2025	Physical Chemistry Lab-IV	0	0	3	2
27	21CH2026	Biomolecules and Natural Products	4	0	0	4
28	21CH2027	Analytical Chemistry – II	4	0	0	4
29	21CH2028	Analytical Chemistry Lab - II	0	0	3	2
30	21CH2029	Advanced Inorganic Chemistry	4	0	0	4
31	21CH2030	Inorganic Chemistry Lab - V	0	0	3	2
32	21CH2031	Advanced Electrochemistry and Computational Chemistry	4	0	0	4
33	21CH2032	Physical Chemistry Lab-V	0	0	3	2
34	21CH2033	Advanced Organic Chemistry	4	0	0	4
35	21CH2034	Organic Chemistry Lab -V	0	0	3	2
36	21CH2035	Analytical Chemistry – III	4	0	0	4
37	21CH2036	Analytical Chemistry Lab - III	0	0	3	2
38	21CH2037	Environmental Studies	2	0	0	2
39	21CH2038	Principles of General Chemistry	4	0	0	4
40	21CH2039	Principles of General Chemistry Laboratory	0	0	3	2
41	21CH2040	Basic Inorganic and Physical Chemistry	4	0	0	4
42	21CH2041	Basic Inorganic and Physical Chemistry Laboratory	0	0	3	2
43	21CH2042	Fundamentals of Organic Chemistry	4	0	0	4
44	21CH2043	Fundamentals of Organic Chemistry Laboratory	0	0	3	2
45	21CH2044	Inorganic Chemistry	3	0	0	3
46	21CH2045	Qualitative Analysis and Inorganic Preparation Lab	0	0	3	2
47	21CH2046	Principles of Organic Chemistry	3	0	0	3
48	21CH2047	Organic Preparation Laboratory	0	0	3	2
49	21CH2048	Physical Chemistry	3	0	0	3
50	21CH2049	Supramolecular Chemistry	3	0	0	3

51	21CH2050	Water Chemistry	2	0	0	2
52	21CH2051	Chemistry for Health	2	0	0	2
53	21CH2052	Fundamentals of Forensic Chemistry	2	0	0	2
54	21CH2053	Basic Supramolecular Chemistry	2	0	0	2
55	21CH2054	Waste to Energy	2	0	0	2
56	21CH2055	Chemistry of Biofuels	2	0	0	2
57	21CH2056	Porous Coordination Polymers and their Applications	2	0	0	2
58	21CH2057	Industrial Inorganic Chemistry	2	0	0	2
59	21CH2058	Applied Main Group Chemistry	2	0	0	2
60	21CH2059	Glass and Ceramic Chemistry	2	0	0	2
61	21CH2060	Essentials of Chemistry in Various Fields	2	0	0	2
62	21CH2061	Industrial Polymer Chemistry	2	0	0	2
63	21CH2062	Intellectual Property Rights	2	0	0	2
64	21CH2063	Basics of Medicinal Chemistry	2	0	0	2
65	21CH2064	Applications of Electrochemistry	2	0	0	2
66	21CH2065	Chemistry in Fire Science	3	0	0	3
67	21CH2066	Fire Chemistry laboratory	0	0	2	1
68	21CH2067	Environmental Science laboratory	0	0	2	1
69	21CH2068	Recent Trends in Forensic Science	3	0	0	3

21CH1001	Basic Concepts of Chemistry	L	T	P	C
		3	0	0	0

Course Objectives:

Enable the student to

1. understand the basics of atomic structure and chemical bonding
2. know the properties of solids, liquids and gases
3. learn the fundamentals of organic chemistry

Course Outcomes:

The student will be able to

1. understand the basic concepts of atomic structure
2. recognize the importance of various types of bonding
3. differentiate the various types of matter
4. know the thermodynamic concepts
5. classify the various types of organic compounds
6. understand the mechanism of organic reactions

Module 1: Introductory Chemistry and Atomic Structure (7 Hours)

General Introduction - Importance and scope of Chemistry- Laws of Chemical combination – Atomic and Molecular mass – Mole concept-Molar mass – Concentration – Atomic number and Mass number – Bohr’s theory – Wave nature – Electromagnetic spectrum – Introduction to quantum theory – Quantum number – Pauli Exclusion principle – Hund’s rule – Aufbau principle

Module 2: Periodic properties and Chemical Bonding (8 Hours)

Modern periodic table – Electronic configuration –s,p,d,f-block elements – Periodic properties — Atomic radius – Ionic radius – Ionization enthalpy – Electron gain enthalpy – Electronegativity – Chemical bonding – Ionic bonding – Covalent bonding – Polarity of bond – Dipole moment – VB theory -Types of overlapping and nature of covalent bonds – Molecular orbital theory – Bond order – Coordinate covalent bond – Introduction CFT – Intermolecular forces.

Module 3: States of Matter (7 Hours)

Gaseous state – Gas laws – Ideal gas equation – Kinetic theory of gases – Behavior of Real gas – Vander Waal’s equation – Liquid state – Boiling point – Surface tension – Viscosity – General characteristics of solids – Amorphous and Crystalline solids –Classification of solids – Molecular solids – Ionic solids – Metallic solids – Covalent networks – Unit cells – Types – Examples – Stoichiometric defects – Electrical properties – Semiconductor – Magnetic properties.

Module 4: Thermodynamics and Equilibrium (8 Hours)

Thermodynamic terms – Systems and Surroundings - Open system and closed system – Isolated system – State functions – Internal energy – Enthalpy – Extensive and intensive properties – Heat capacity – Spontaneity – Entropy – Gibbs free energy – Third law of thermodynamics – Equilibrium in physical processes – Equilibrium constant – Acids, Bases and Salts – Bronsted- Lowry acids and bases – Lewis acids and Bases – Ionic product of water – pH scale – Solubility product – Redox reactions – Oxidation and reduction – Oxidation number – Redox couple - Redox potential – Standard electrode potential.

Module 5: Basic Organic Chemistry (6 Hours)

Tetra valence of carbon – sigma and pi bonds – Classification of organic compounds – Open chain compounds - Cyclic compounds-Alicyclic and Aromatic compounds – Heterocyclic compounds – Functional groups – Homologous series – IUPAC nomenclature – Isomerism – Types -Basic concepts of stereochemistry.

Module 6: Organic reaction mechanism and Purification (9 Hours)

Organic reaction mechanism – Substrate – Intermediate – Product –Reagent - Nucleophile – Electrophile - Inductive effect – Resonance – Types of organic reactions and mechanisms – Substitution reactions – Addition reactions- Elimination reactions – Rearrangement reactions –Concerted and photochemical reactions - Purification of organic compounds – Types-Introduction to Chromatography.

Text Books:

1. Mahan, B.M and Meyers, R. J, “University Chemistry”, 4th Edition, Pearson Education India, 2009
2. B.R. Puri, L.R. Sharma and Madan S. Pathania, “Principles of Physical Chemistry”, Vishal Publishing Co., Jalandhar, 2008.
3. J. D. Lee, “Concise Inorganic Chemistry” Wiley India Pvt. Ltd, New Delhi, India, 5th edition, Reprint 2009
4. Arun Bahl and B.S. Bahl, “Advanced organic Chemistry”, S. Chand & company Ltd. New Delhi, 2010

21CH2001	States of Matter	L	T	P	C
		4	0	0	4

Course Objectives:

Enable the student to

1. know the principles of state of matters
2. understand the basics of ionic equilibrium & colligative properties
3. learn the concept of liquid crystals

Course Outcomes:

The student will be able to

1. Understand the concepts of gaseous state
2. Differentiate the properties of liquid state
3. recognize the importance of solid state of matter
4. know about the equilibrium
5. understand colligative properties
6. understand liquid crystals and their applications

Unit I Gaseous State (18 Hours)

Kinetic molecular model of a gas - postulates and derivation of the kinetic gas equation- collision frequency-collision diameter-mean free path and viscosity of gases, - relation between mean free path and coefficient of viscosity- calculation of σ from η - variation of viscosity with temperature and pressure- Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy- law of equipartition of energy, degrees of freedom and molecular basis of heat capacities- Behaviour of real gases: Deviations from ideal gas behaviour - compressibility factor - variation with pressure for different gases-Causes of deviation from ideal behaviour- Vander Waals equation of state - derivation - application in explaining real gas behaviour- Isotherms of real gases and their comparison with van der Waals isotherms-continuity of states-critical state-relation between critical constants- van der Waals constants-law of corresponding states.

Unit II Liquid state(10 Hours)

Qualitative treatment of the structure of the liquid state-Radial distribution function- physical properties of liquids - vapour pressure-surface tension and coefficient of viscosity-and their determination-Effect of addition of various solutes on surface tension and viscosity-Explanation of cleansing action of detergents-Temperature variation of viscosity of liquids and comparison with that of gases-Qualitative discussion of structure of water.

Unit III Solid state (8 Hours)

Nature of the solid state- law of constancy of interfacial angles-law of rational indices- Miller indices-elementary ideas of symmetry-symmetry elements and symmetry operations-qualitative idea of point and space groups-seven crystal systems and fourteen Bravais lattices- X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method- Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals.

Unit IV Ionic equilibria & Colligative properties(18 Hours)

Strong, moderate and weak electrolytes-degree of ionization-factors affecting degree of ionization- ionization constant and ionic product of water-Ionization of weak acids and bases, pH scale, common ion effect-dissociation constants of mono, di and triprotic acids (exact treatment)- Salt hydrolysis-calculation of hydrolysis constant-degree of hydrolysis and pH for different salts-Buffer solutions-derivation of Henderson equation and its applications-buffer capacity-buffer range-buffer action - biochemical processes in the human body-Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators-Multistage equilibria in polyelectrolyte systems-hydrolysis and hydrolysis constants-Dilute solutions-lowering of vapour pressure-Raoult's and Henry's Laws and their applications- Relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure]- molar masses of normal, dissociated and associated solutes in solution.

Unit V Liquid Crystals (6 Hours)

The vacancy theory - Vapour pressure - Surface tension & surface energy - Some effects of surface tension - Interfacial tension - Surface active agent - Liquid crystal- introduction - Vapour pressure – temperature - Classification of liquid crystal – smectic and nematic - Compounds exhibiting both smectic and nematic characters- Glasses and liquid crystals. Structure of liquids-qualitative description. Structural differences between solids, liquids and gases. Liquid crystals- Explanation, classification with examples. Application of liquid crystals in LCDs and thermal sensing.

References:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford University, Press (2014).
2. B.R. Puri, L.R. Sharma and Madan S. Pathania, "Principles of Physical Chemistry", Vishal Publishing Co., Jalandhar, 2008.
3. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
4. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
5. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
6. Engel, T. & Reid, P. Physical Chemistry 3rd Ed. Pearson (2013).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	-	2	-	-
CO2	3	2	-	1	1	-	2	-	-
CO3	3	1	-	1	-	-	2	-	2
CO4	3	2	-	2	-	-	3	-	1
CO5	3	2	-	2	-	-	3	-	2
CO6	3	2	-	1	-	-	2	-	1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2002	Physical Chemistry Lab-I	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn the principle of surface tension measurement
2. understand the principles of viscosity
3. practice precise and accurate analysis

Course Outcomes:

The student will be able to

1. understand surface tension of various mediums
2. learn methods of surface tension measurement
3. identify basics of viscosity measurement
4. prepare buffer solutions
5. estimate the given acid by instrumentation methods
6. enhance the analytical skill

LIST OF EXPERIMENTS

1. Determination of the surface tension by drop number method
2. Determination of the surface tension by drop weight method.
3. Determination of the surface tension of detergent solutions with concentration.
4. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
5. Study the variation of viscosity of sucrose solution with the concentration of solute.
6. Indexing of a given powder diffraction pattern of a cubic crystalline system.
7. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
8. Preparation of buffer solutions of different pH i. Sodium acetate-acetic acid
9. Preparation of buffer solutions of different pH ii. Ammonium chloride-ammonium hydroxide
10. Determination of dissociation constant of a weak acid.

(Any 10 experiments)

Text books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	-	1	3	-
CO2	3	3	2	1	2	-	1	3	-
CO3	2	3	2	1	1	-	1	3	-
CO4	2	3	2	1	1	-	1	3	-
CO5	2	3	2	1	1	-	1	3	-
CO6	2	3	2	1	2	-	1	3	-

'3'-High, '2'- Medium, '1'-Low, '- ' No correlation

21CH2003	Atomic Structure and Nuclear Chemistry	L	T	P	C
		4	0	0	4

Course Objectives:

Enable the student to

1. learn the basics of atomic structure
2. understand the periodicity of elements
3. learn the basics of nuclear and acid-base chemistry

Course outcomes:

The student will be enable to

1. learn the atomic structure of the elements
2. learn the periodic properties of the elements
3. describe the nature of nuclear chemistry
4. know about application of nuclear chemistry
5. understand the concepts of acid and bases
6. learn the HSAB principles

Unit I: Atomic Structure: (12 Hours)

Bohr's theory- its limitations - atomic spectrum of hydrogen atom -Wave mechanics- de Broglie equation - Heisenberg's Uncertainty Principle and its significance - Schrödinger's wave equation - significance of ψ and ψ^2 - Quantum numbers and their significance- Radial and angular wave functions for hydrogen atom- Shapes of s, p, d and f orbitals- probability diagrams- Pauli's Exclusion Principle- Hund's rule of maximum multiplicity- Aufbau's principle- Variation of orbital energy with atomic number.

Unit II: Periodic properties: (12 Hours)

Modern periodic table - s, p, d and f block elements-Periodic properties of the elements- Effective nuclear charge-shielding effect- Slater rules- Atomic radii Ionic radii - crystal radii- Covalent radii- Ionization energy- factors affecting ionization energy- Electron affinity- Electronegativity- electronegativity scales- Variation of electronegativity-Diagonal Relationship - Oxidation and reduction

Unit III: Nuclear Chemistry and Radioactivity (18 Hours)

Binding energy-Empirical mass equation- The nuclear models- nuclear spin parity & magnetic moments of odd mass numbers nuclei. Nuclear reaction - nuclear cross section, threshold energy of nuclear reaction- Coulomb scattering-potential barrier-formation of a compound nucleus-Alpha Beta and Gamma radiation- heavy ion induced nuclear reactions- photonuclear reactions. Nuclear fission- Liquid drop model - fission cross section - mass energy and charge distribution of fission products - symmetric and Asymmetric fission - decay chains and delayed neutrons. Nuclear fission as a source of energy - Nuclear chain reacting systems - critical size of a reaction- reactors - thermonuclear reactors - Uranium and Thorium resources in India and their extractions- Heavy water manufacturing Radiation Chemistry- applications of Nuclear Chemistry-Positron emission tomography- Boron Neutron Capture Therapy.

Unit IV: Acid and Bases: (10 Hours)

Arrhenius concept - Bronsted-Lowry concept- conjugate acids and bases- relative strengths of acids and bases-effects of substituent and solvent- differentiating and levelling solvents. Lewis acid-base concept - classification of Lewis acids and bases - Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept) - applications of HSAB process.

Unit V: Metallurgy (8 Hours)

Chief modes of occurrence of metals - Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent-Electrometallurgy - Hydrometallurgy. - Thermometallurgy - Process - Concentration - Methods - Isolation - Electrolytic Reduction -Methods of purification of metals- Electrolytic Kroll process - Parting process- van Arkel-de Boer process and Mond's process- Zone refining

Text books:

1. Lee J. D. "Concise Inorganic Chemistry" Wiley India Pvt. Ltd, New Delhi, India, 5th edition, Reprint 2009
2. Singh, D. N. 'Basic Concepts of Inorganic Chemistry" 2nd Edition, Dorling Kindersley (India) Pvt Ltd., 2019
3. Atkin, P. Shriver & Atkins."Inorganic Chemistry" 5th Edition, Oxford University Press, 2010
4. Friedlander, Kennedy Miller."Nuclear and Radio Chemistry" John Wiley & Sons India Pvt. Ltd., 1981

5	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2					3		
CO2	3								
CO3	2							3	
CO4		3							1
CO5				2					
CO6									

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2004	Inorganic Chemistry Lab-I	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn the principle of volumetric analysis
2. understand the principles of acid base and redox titrations
3. practice precise and accurate analysis of unknown compounds using volumetric principles

Course Outcomes:

The student will be able to

1. understand the basic concepts of molarity, molality and normality
2. learn principles of volumetric analysis
3. identify the types of volumetric analysis
4. prepare the solutions of different molarity and normality
5. estimate the given unknown compounds by acid base and redox titrations
6. enhance the analytical skills of titrimetric analysis

LIST OF EXPERIMENTS

1. Preparation of solutions of different Molarity/Normality of titrants
2. Titrimetric Analysis Calibration and use of apparatus
3. Acid-Base Titrations - 1
4. Acid-Base Titrations - 2
5. Acid-Base Titrations - 3
6. Estimation of carbonate and hydroxide present together in mixture.

7. Estimation of carbonate and bicarbonate present together in a mixture.
8. Oxidation-Reduction Titrimetry – 1
9. Oxidation-Reduction Titrimetry – 2
10. Estimation of oxalic acid and sodium oxalate in a given mixture.
11. Estimation of Fe(II) with $K_2Cr_2O_7$ using internal indicator.
12. Estimation of Fe(II) with $K_2Cr_2O_7$ using external indicator.
13. Estimation of free alkali present in different soaps/detergents

Text books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3						3		
CO2	2	1						3	
CO3	3	1					3	1	
CO4		3						2	
CO5		3	1					2	
CO6		3						3	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2005	Basic Principles and Chemistry of Hydrocarbons	L	T	P	C
		4	0	0	4

Course Objectives

Enable the student to

1. understand the basic concepts and their importance
2. know the chemistry of functional groups alkanes, alkenes and alkynes
3. highlight the importance of stereoisomerism and conformational analysis

Course Outcomes

Student will be able to:

1. understand and explain the different behaviour of organic compounds based on fundamental concepts
2. formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
3. explain the reactivity of saturated aliphatic compounds and their conformation
4. describe the reactivity and applications of unsaturated compounds through various reactions
5. correlate and describe the stereochemical properties of organic compounds and reactions
6. correlate the basic principles to explain the reactivity of functional groups

Unit I: Basics Principles of Organic Chemistry (12 Hours)

Classification - Nomenclature - Influence of hybridization on bond properties - Electronic Displacements and their applications - Inductive, Electromeric, Resonance and Mesomeric effects and Hyperconjugation - Dipole moment – Acidity, Basicity and pKa values - Ortho effect - Conjugate acids and bases - Electrophiles and Nucleophiles - Homolytic and heterolytic fissions with examples – Intermediates - Carbocations, Carbanions, Free radicals and Carbenes and their stability - Introduction to types of organic reactions and their mechanism, Addition, Elimination and Substitution reactions.

Unit II: Chemistry of alkanes (12 Hours)

Alkanes– preparation, properties and uses - Wurtz reaction - Wurtz Fittig reaction, Corey House synthesis – Physical properties - Isomerism and its effect on properties of molecule -chemical properties, Free radical Halogenation, relative reactivity v/s selectivity. Conformational analysis of alkanes, - Cycloalkanes - relative stability, Baeyer strain theory, Cyclohexane conformations with energy diagram, Axial and equatorial positions preparation, properties and uses.

Unit III:-Chemistry of alkenes and alkynes (14 Hours)

Carbon-Carbon pi Bonds -Structure and isomerism - General methods of preparation, -Elimination -. Saytzeff and Hofmann eliminations. Mechanism of E1, E2, E1_{CB}, Wittig reaction, Reduction - physical and chemical properties - Electrophilic Additions, mechanism -Markownikoff and Anti Markownikoff addition - syn and anti addition; addition of Hydrogen, Halogen, methylene - oxymercuration-demercuration, hydroboration oxidation - ozonolysis, hydroxylation, Diels Alder reaction, 1,2-and 1,4-addition reactions in conjugated dienes. Alkynes -Preparation -

Reactions of alkynes -electrophilic and nucleophilic additions, formation of carbonyl compounds, Alkylation of terminal alkynes.

Unit IV: – aromaticity and aromatic hydrocarbons (10 Hours)

Aromaticity – Huckel’s rule - aromatic, non-aromatic and anti-aromatic compounds – heterocycles –annulenes - cyclic carbocations/carbanions - Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft’s alkylation/acylation with their mechanism - Directing effects of the groups.-Aromatic nucleophilic substitution - Polynuclear Hydrocarbons -Reactions of naphthalene phenanthrene and anthracene

Unit V:-Stereochemistry (12 Hours)

Stereochemistry - Stereoisomerism: Optical Activity and Optical Isomerism, Asymmetry, Chirality, Enantiomers, Diastereomers. Specific rotation; Configuration and Projection Formulae: Newmann, Sawhorse, Fischer and their interconversion. Relative and absolute configuration: Erythro-threo -D/L and R/S designations. Geometrical isomerism: cis-trans, syn-anti and E/Z notations with CIP rules Chirality in molecules with one and two stereocentres – meso structures- Stereochemistry of Allenes and biphenyls - Atropisomerism - Racemic mixture and their resolution.

Text Books

1. R.T. Morrison & R.N. Boyd, Organic Chemistry, 6th Edition, Pearson Education Pvt Ltd., Singapore, 2003
2. Arun Bahl and B.S. Bahl Advanced organic Chemistry, S. Chand & company Ltd. New Delhi, 2010

Reference Books

1. P.S. Kalsi, Stereo Chemistry Conformation and Mechanism, New Age Publishing Ltd., New Delhi, 2002
2. I.L. Finar, Organic Chemistry, Pearson Education Pvt. Ltd., Vol. I & II, 5th Edition, Singapore, 1975
3. J. March. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 4th edn., Wiley Student Edition, John Wiley & Sons Asia Pvt. Ltd., 2005

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1		1		3		
CO2	2	2	1		1		3		
CO3	3	2	1		1		3		
CO4	3	2	1		1		3		
CO5	3	1	1		1		3		
CO6	3	1	1		1		3		

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

21CH2006	Organic Chemistry Lab-I	L	T	P	C
		0	0	3	2

Course Objectives

Enable the student to

1. identify the functional group of the organic molecule
2. carryout various types of organic reactions to analyze the organic compound
3. understand the principle of systematic organic qualitative analysis

Course Outcomes

Students will be able to

1. enhance the knowledge of systematic analysis of an organic compound
2. understand the mechanism of the various reactions.
3. recognize the importance of analyzing organic compounds
4. employ various types of organic reactions
5. apply the knowledge in analyzing real samples
6. prepare derivatives for the given organic compound

LIST OF EXPERIMENTS

The experiments involve the identification of the functional groups present in the organic molecule and confirmation by derivatization of the given compound. The functional groups may be carboxylic acid, phenol, halide, amine, ketone, aldehyde, ester, urea, etc.

1. Qualitative Organic analysis -1
2. Qualitative Organic analysis -2
3. Qualitative Organic analysis -3
4. Qualitative Organic analysis -4
5. Qualitative Organic analysis -5
6. Qualitative Organic analysis -6

7. Qualitative Organic analysis -7
8. Qualitative Organic analysis -8
9. Qualitative Organic analysis -9
10. Qualitative Organic analysis -10
11. Qualitative Organic analysis -11
12. Qualitative Organic analysis -12

Text Books:

1. A.I. Vogel – “Text book of practical organic chemistry”, 5th Ed. ELBS, London, 1989
2. B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
3. Daniel R. Palleros, “Experimental Organic Chemistry” John Wiley & Sons, Inc., New York, 2000
4. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, “Text book of Practical Organic Chemistry”, LBS, Singapore, 1994
5. S.M. Khopar, “Basic concepts of Analytical Chemistry”, John Wiley & Sons, 1984
6. Gnanaprasam N.S., Ramamurthy G, “Organic Chemistry Lab Manual”, revised edition, S. Viswanathan printers and publishers Pvt. Ltd., Chennai, Reprinted 2011

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	2		1	2		1	3	
CO2	2	2		1	2		1	3	
CO3	1	2		1	2		1	3	
CO4	1	2		1	2		1	3	
CO5	1	2		1	2		1	3	
CO6	1	2		1	2		1	3	

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

21CH2007	Chemical Bonding and Solid State				L	T	P	C
					4	0	0	4

Course Objectives:

Enable the student to

1. learn the basics of chemical bonding
2. understand the solid state chemistry
3. learn the basics of metallurgy

Course Outcomes:

The student will be able to

1. understand various types of bonding
2. know the importance of chemical bonding
3. describe the nature of weak forces
4. know about solid state chemistry
5. understand the concepts of x-ray diffraction
6. learn the concepts of metallurgy

Unit I: Ionic Bond (8 Hours)

Types of Bond - General characteristics- types of ions- size effects, radius ratio rule and its limitations- Packing of ions in crystals- Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy- Madelung constant- Born-Haber cycle and its application- Solvation energy- Covalent character in ionic compounds- polarizing power and polarizability. Fajan’s rules and consequences of polarization- Ionic character in covalent compounds- Bond moment and dipole moment.

Unit II: Covalent Bond (14 Hours)

Lewis structure- Valence Bond theory (Heitler-London approach)-Energetics of hybridization- equivalent and non-equivalent hybrid orbitals- Bent’s rule - Molecular orbital theory- Molecular orbital diagrams of diatomic and simple polyatomic molecules and their ions- (idea of s-p mixing and orbital interaction to be given)- Formal charge- Valence shell electron pair repulsion theory (VSEPR) - shapes of simple molecules and ions containing lone pairs and bond pairs of electrons - multiple bonding (σ and π bond approach) and bond lengths.

Unit III: Metallic Bond and weak interactions (10 Hours)

Metallic Bond- Electron gas model - Weak Chemical Forces- van der Waals forces- ion-dipole forces - dipole-dipole interactions - induced dipole interactions - Instantaneous dipole-induced dipole interactions. Repulsive forces -

Hydrogen bonding- theories of hydrogen bonding- valence bond treatment- Effects of chemical force on melting and boiling points- solubility energetics of dissolution process.

Unit IV: Solid state (16 Hours)

Nature of the solid state- law of constancy of interfacial angles- law of rational indices – Miller Indices - elementary ideas of symmetry - symmetry elements and symmetry operations - qualitative idea of point and space groups - seven crystal systems and fourteen Bravais lattices - X-ray diffraction - Bragg's law - a simple account of rotating crystal method and powder pattern method- Analysis of powder diffraction patterns of NaCl CsCl and KCl- Defects in crystals- Qualitative idea of valence bond and band theories - Semiconductors and insulators - defects in solids

Unit V: Nanomaterials (12 Hours)

Nanomaterials – Classification – zero- one - two dimensional nanostructures – Special nanomaterials - Top down and Bottom up Approaches - High energy Ball milling – CVD - sol-gel methods – synthesis of oxide nanoparticles - Preparation of gold and silver metallic nanoparticles - Self assembled monolayers –preparation and application – microfabrication - Carbon nanotubes and inorganic nanowires- Properties and Applications of Fullerenes - Applications of Nanotechnology

Text Books:

1. Lee J. D. "Concise Inorganic Chemistry" Wiley India Pvt. Ltd, New Delhi, India, 5th edition, Reprint 2009
2. Gary Miessler, Paul J. Fischer, Donald A. Tarr."Inorganic Chemistry"Pearson International Pvt. Ltd. 5th Edition, 2014

Reference books:

1. James E Huheey."Inorganic Chemistry: Principles of structure and reactivity" Harper international SI edition. 3rd edition, 1983
2. Anthony R. West."Solid State Chemistry and its Applications"John Wily & Sons, 2nd edition, 2014
3. Shriver and Atkins."Inorganic Chemistry"Oxford University Press, 4th edition, 2010

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3						3		
CO2	3								
CO3	3								
CO4	3								
CO5		2							1
CO6	3								1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2008	Inorganic Chemistry Lab - II	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn the principle of complexometric titration
2. understand the principles of precipitation titration
3. practice precise and accurate analysis in volumetric and gravimetric analysis

Course Outcomes:

The student will be able to

1. understand the basics of complexometric titrations
2. learn principles of precipitation titrations
3. estimate the given unknown compounds using complexometric and precipitation titrations
4. identify basic principles of gravimetric analysis
5. estimate the given unknown compound using gravimetric principles
6. enhance the analytical skill in gravimetric analysis

LIST OF EXPERIMENTS

1. Synthesis of nanomaterials – 1
2. Synthesis of nanomaterials – 1
3. Synthesis of nanomaterials – 1
4. Synthesis of nanomaterials – 1
5. Synthesis of nanomaterials – 1
6. Synthesis of nanomaterials – 1
7. Measurement of band gap in semiconductor

8. Measurement of band gap in semiconductor
 9. Measurement of band gap in semiconductor
 10. Measurement of band gap in semiconductor
 11. Measurement of band gap in semiconductor
 12. Measurement of band gap in semiconductor
 13. Analysis of material using EDAX
 14. Analysis of material using EDAX
 15. Analysis of material using PXRD
 16. Analysis of material using PXRD
- (Minimum 10 experiments should be conducted)

Text books:

1. Khosla, B. D., Garg, V. C. & Gulati, A. "Senior Practical Physical Chemistry" R. Chand & Co. New Delhi, 2011.
2. Garland, C. W., Nibler, J. W. & Shoemaker, D. P. "Experiments in Physical Chemistry" 8th Ed., McGraw-Hill: New York, 2003.
3. Halpern, A. M., & McBane, G. C. "Experimental Physical Chemistry" 3rd Ed., W. H. Freeman & Co. New York, 2003.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					3		
CO2		3					3		
CO3		3					2	3	
CO4	3	1						3	
CO5		3						3	
CO6		3						2	

'3'-High, '2'- Medium, '1'-Low, '-'- No correlation

21CH2009	Organic Compounds Containing Oxygen, Sulfur and Halogens	L	T	P	C
		4	0	0	4

Course Objectives

Enable the student to

1. understand the preparation, properties and applications of oxygen containing functional groups.
2. unravel the spectrum of organic chemistry and the extent of organic transformations.
3. propose plausible mechanisms for reactions involving functional groups containing oxygen

Course Outcomes

Students will be able to

1. understand the theoretical aspects of chemistry of compounds having oxygen containing functional groups
2. illustrate the importance of organic transformations and reagents
3. understand the various mechanistic pathway of different naming reactions
4. predict the general reactivity, chemical reactions, and possible synthesis of organic compounds
5. describe the importance of organohalides
6. elaborate the applications of the oxygen containing compounds

Unit I: Chemistry of Halogenated Hydrocarbons (12 Hours)

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1 , S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent – E1 and E2 elimination-Wurtz coupling Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution – S_NAr - Benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions - Organometallic compounds of Mg and Li – Their use in synthesis of organic compounds.

Unit II: - Alcohols, Phenols, Ethers and Epoxides (12 Hours)

Alcohols -preparation, properties and relative reactivity of 1°, 2°, 3° alcohols - Bouvaelt-Blanc Reduction –Reactivity of allyl and benzyl alcohol - Preparation and properties of glycols -Oxidation by periodic acid and lead tetraacetate - Preparation and properties of glycerols-Pinacol-Pinacolone rearrangement – Phenols, Preparation and properties; Acidity and factors effecting it - Ring substitution reactions, Reimer-Tiemann and Kolbe's-Schmidt Reactions, Fries and Claisen rearrangements with mechanism - Ethers and Epoxides: preparation and reactions with acids - Reactions of epoxides with alcohols - ammonia derivatives and $LiAlH_4$

Unit III: Carbonyl Compounds (15 Hours)

Carbonyl compounds: Structure, reactivity and preparation, Nucleophilic additions, Nucleophilic addition-elimination reactions - Mechanisms of Aldol, Mannich and Benzoin condensation - Knoevenagel condensation - Claisen-Schmidt - Perkin - Cannizzaro and Wittig reaction - Beckmann and Benzil-Benzilic acid rearrangements - haloform reaction and Baeyer Villiger oxidation - α -substitution reactions - oxidations and reductions (Clemmensen, Wolff-Kishner, LiAlH_4 , NaBH_4 , MPV, PDC and PCC) -Addition reactions of unsaturated carbonyl compounds: Michael addition. - Active methylene compounds: Keto-enol tautomerism - Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Unit IV: Carboxylic Acids and their Derivatives (15 Hours)

Carboxylic acid: Preparation, physical properties and reactions of monocarboxylic acids, dicarboxylic acids, hydroxy acids and unsaturated acids - succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids - Preparation and reactions of acid chlorides - anhydrides, esters and amides - Comparative study of nucleophilic substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, amides - Claisen condensation - Dieckmann and Reformatsky reactions, Hofmann bromamide degradation and Curtius rearrangement.

Unit V: Sulphur containing compounds (6 Hours)

Preparation and reactions of thiols, mercaptans, thioethers and sulphonic acids, pTSA uses.

Text Books

1. R.T. Morrison & R.N. Boyd, Organic Chemistry, 6th Edition, Pearson Education Pvt Ltd., Singapore, 2003
2. Arun Bahl and B.S. Bahl Advanced organic Chemistry, S. Chand & company Ltd. New Delhi, 2010

Reference books

1. Organic chemistry, 5th edition, John E. McMurry, 7th Edition, Asian Books Private Limited, 2012.
2. Organic chemistry, Janice Gorzynski Smith, 2nd Edition, Tata McGraw Hill Education Private Limited, 2008.
3. I.L. Finar, "Organic Chemistry, Volume 1: The Fundamental Principles", London Longmans, 1963
4. J. March. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 4th edn., Wiley Student Edition, John Wiley & Sons Asia Pvt. Ltd., 2005

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1			1		3	1	
CO2	3	1			1		3	1	
CO3	3	1			1		3	1	
CO4	3	1			1		3	1	
CO5	3	1			1		3	1	
CO6	3	1			1		3	1	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2010	Organic Chemistry Lab-II	L	T	P	C
		0	0	3	2

Course Objectives

Enable the student to

1. know various methods to quantify organic compounds
2. understand the concept of back titration and use in quantitative analysis
3. estimate several organic molecules

Course Outcomes

The student will be able to

1. perform the systematic quantitative analysis of an organic compound
2. apply the concept of back titration in analysis
3. estimate the quantity of an unknown compound in the given solution
4. apply various methods to quantitatively estimate organic compound
5. identify the best technique to estimate the given organic molecule
6. understand the principles in the estimation

LIST OF EXPERIMENTS

The experiment focuses on the various method of estimating the organic molecules including titration. The quantitative estimation of common organic molecules will be given

1. Quantitative Organic analysis -1
2. Quantitative Organic analysis -2
3. Quantitative Organic analysis -3

4. Quantitative Organic analysis -4
5. Quantitative Organic analysis -5
6. Quantitative Organic analysis -6
7. Quantitative Organic analysis -7
8. Quantitative Organic analysis -8
9. Quantitative Organic analysis -9
10. Quantitative Organic analysis -10
11. Quantitative Organic analysis -11
12. Quantitative Organic analysis -12

Reference Books

1. A.I. Vogel – “Text book of practical organic chemistry”, 5th Ed. ELBS, London, 1989
2. B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
3. Daniel R. Palleros, “Experimental Organic Chemistry” John Wiley & Sons, Inc., New York, 2000
4. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, “Text book of Practical Organic Chemistry”, LBS, Singapore, 1994
5. S.M. Khopar, “Basic concepts of Analytical Chemistry”, John Wiley & Sons, 1984
6. Gnanapragasam N.S., Ramamurthy G, “Organic Chemistry Lab Manual”, revised edition, S. Viswanathan printers and publishers Pvt. Ltd., Chennai, Reprinted 2011

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	3		1	1		2	3	1
CO2	1	3		1	1		2	3	1
CO3	1	3		1	1		2	3	1
CO4	1	3		1	1		2	3	1
CO5	1	3		1	1		2	3	1
CO6	1	3		1	1		2	3	1

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

21CH2011	Analytical Chemistry – I				L	T	P	C
					4	0	0	4

Course Objectives:

Enable the student to

1. Understand the statistical methods used in chemical analysis
2. Learn the principle and application of gravimetry analysis
3. Understand the principle and methods for soil and water chemical analysis

Course Outcomes:

The student will be able to

1. Learn the significance of analytical chemistry
2. Learn the statistical methods in chemical analysis
3. Perform the protocols of separation methods
4. Understand the methods involved in qualitative and quantitative analysis
5. Understand the methods involved in analysis of air, water and soil
6. Analyze the thermal stability of the molecules

Unit I: Statistical Methods in Chemical Analysis (13Hours)

Introduction to analytical chemistry, chemical analysis and stages of chemical analysis, classification of analytical methods, preparation of sample for analysis, classifying chemicals, calculations used in analytical chemistry and problems, important units of measurement, Errors in chemical analysis: Mean and median, Accuracy and precision, Types of errors, Determinant and indeterminate errors, systematic and random errors, Absolute error and Relative error. Accuracy and precision of measurements, Relative and standard deviation, distribution of random errors and normal error curve, Good laboratory practices

Unit II: Principles of Qualitative and Quantitative analysis (14 Hours)

Principles of Quantitative analysis, Steps in a quantitative analysis, Properties of gravimetric precipitates, precipitating reagents, Formation of gravimetric precipitates, Conditions for quantitative precipitations, Steps involved in quantitative precipitation. Titrimetric Analysis: Introduction, Principles, classification-acid-base, redox, precipitation and complexometric titrations, applications in various fields of science. Semi micro qualitative analysis: Qualitative

analysis of simple salt containing one anion and one cation. Qualitative analysis of a mixture containing two anions and two cations. Analysis of a mixture containing two cations and two anions.

Unit III: Separation Techniques(11 Hours)

Introduction and principle of chromatographic technique, Polarity, Solvent polarity, Elution Strength, Mobile Phase, Stationery Phase, Sample Preparations, Extractions, Isolations Analytical and Preparative techniques, Paper, TLC, Column, Flash Chromatography, Advantages and Disadvantages.

Unit IV: Solvent Extraction [12 Hours]

Theory, principle and classification, Nernst's distribution law, efficiency of the technique. Mechanism of extraction: chelate extraction, synergic extraction, extraction by solvation, ion- pair extraction. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.

Unit V: Purification Techniques [12 Hours]

Dessicant: Types of dessicant- Relative efficiencies of dessicant- Drying powder and temperature- Regeneration of dessicant- choice of dessicant-technique of drying: drying of solids- Distillation: Theory of distillation Technique, Sublimation, Crystallisation, Distillation, Fractional Distillation, Vacuum Distillation, Steam Distillation, Differential Extraction and Tests for purity, Melting point, boiling point, Refractive index and density.

Text Books:

1. Vogel's textbook of quantities chemical analysis', G. H. Affery J. Bassett, J .Mendham, R. C. Denney, 5th edition, John Wiley and Sons Inc.
2. 'Modern Methods of Chemical Analysis', R.L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, 2nd edition, John Wiley, New York
3. Skoog D. A, West D. M, Holler F. J & Crouch S. R, "Fundamentals of Analytical Chemistry", Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.
4. Chatwal G. R & Anand S. K, "Instrumental Methods of Chemical Analysis", Himalaya Publishing House, Mumbai, India, 5th Edition, Reprint 2011.
5. Kalsi P. S, "Spectroscopy of Organic Compounds", New Age International Publishers, New Delhi, 6th Edition, 2004.
6. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall.
7. Vogel, A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Prentice Hall.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					3		
CO2	3		2				3		
CO3	3			3			2		
CO4	2	1						2	
CO5	3				2		3		
CO6	1			1					2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2012	Analytical Chemistry Lab– I				L	T	P	C
					0	0	3	2

Course Objectives

Enable the student to

1. Develop various skills for separating organic compounds.
2. Know the various organic separation techniques available.
3. Impart awareness about reaction various characterization techniques.

Course Outcomes

Students will be able to

1. Understand the principle of polarity and chromatography
2. explain the principles of separation the organic compounds from mixture
3. Purify the prepared organic compound and check the purity of prepared compound.
4. Setup the apparatus for various separation techniques.
5. Recognize the suitable separation techniques for organic compounds
6. Employ various characterization techniques for organic molecules

LIST OF EXPERIMENTS

1. Thin layer chromatography-1

2. Thin layer chromatography -2
3. Column chromatography -1
4. Column chromatography -2
5. Paper chromatography -1
6. Paper Chromatography -2
7. Extraction of metal ions from aqueous solution - 1
8. Extraction of metal ions from aqueous solution - 2
9. Extraction of organic species from the aqueous and non-aqueous media -1
10. Extraction of organic species from the aqueous and non-aqueous media -2
11. Crystallization - 1
12. Crystallization - 2
13. Finding Melting point of a compound - 1
14. Finding Melting point of a compound - 2
15. Finding Boiling point of a compound – 1
16. Finding Boiling point of a compound - 2

Reference Books

1. A.I. Vogel – “Text book of practical organic chemistry”, 5th Ed. ELBS, London, 1989
2. B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
3. Daniel R. Palleros, “Experimental Organic Chemistry” John Wiley & Sons, Inc., New York, 2000
4. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, “Text book of Practical Organic Chemistry”, LBS, Singapore, 1994
5. S.M. Khopar, “Basic concepts of Analytical Chemistry

Reference Books

1. A.I. Vogel – “Text book of practical organic chemistry”, 5th Ed. ELBS, London, 1989
2. B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3						3		1
CO2		2					3		
CO3			2	2			3		
CO4				2	2		2	2	
CO5					1	1	2		1
CO6					1	1	2		1

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20CH2013	Thermodynamics and Chemical Equilibrium	L	T	P	C
		4	0	0	4

Course Objectives:

Enable the student to

1. Learn the basics of thermodynamics
2. Understand various laws of thermodynamics and their applications
3. Learn the basics of chemical equilibrium

Course Outcomes:

The student will be able to

1. Understand the influence of temperature on molecules
2. Relate various thermodynamic properties
3. Understand partial molar properties and absolute entropy
4. Understand various physical properties of solutions
5. Relate partial molar properties
6. Understand chemical equilibrium and applications

Unit I: First law of Thermodynamics (16 Hours)

Terminology of thermodynamics- First law of thermodynamics – Heat and work, internal energy, enthalpy and heat capacity of a system –Expansion of an ideal gas and changes in thermodynamic property - Limitation of first law of thermodynamics -Joule Thomson effect and Joule Thomson coefficient

Unit II Thermochemistry (8 Hours)

Specific Heat- Bomb Calorimeters- Enthalpy- Thermochemical Equation- Hess's Law- Spontaneous Process- Heat of Formation- Gibbs Free Energy- Heat of Fusion - Heat of Vaporization- Conservation of Energy

Unit III Second Law of Thermodynamics (12 Hours)

Second law of thermodynamics – Carnot cycle (four stroke engine) – Efficiency of heat engine, concept of entropy and its physical significances – Entropy change in phase transformations – Entropy changes of an ideal gas in different processes

Unit IV Partial molar properties and Third Law (12Hours)

Gibbs-Helmholtz equation – variation of Gibbs energy with temperature – Thermodynamics of open system - Partial molar properties – Chemical potential – Gibbs-Duhem equation – variation of chemical potential with temperature and pressure – Activity – Activity coefficient – Ideal solution – Real solution –Third law of thermodynamics – Nernst theorem –Determination of absolute entropy of solids, liquids and gases. Statistical Thermodynamics- MB, BE & FD statistics

Unit V: Chemical Equilibrium: (12 Hours)

Thermodynamic equilibrium-Degree of advancement of reaction-Chemical equilibria in ideal gases-Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient- Equilibrium constants and their quantitative dependence on temperature, pressure and concentration-Free energy of mixing and spontaneity-thermodynamic derivation of relations between the various equilibrium constants Kp, Kc and Kx-Le Chatelier principle.

Text Books:

1. Donald A. McQuarrie: Physical Chemistry: A Molecular Approach, 1997.
2. B. R. Puri, Madan S. Pathania : Principles of Physical Chemistry, 2020.
3. Peter Atkins, Julio de Paula, and James Keeler: Atkins' Physical Chemistry: International Eleventh Edition, 2018.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	-	-	2	-	3	-	1
CO2	3	1	1	2	2	-	3	1	-
CO3	3	2	1	-	3	-	3	1	-
CO4	3	1	1	-	3	-	3	-	-
CO5	3	2	1	1	2	-	3	1	-
CO6	3	2	2	1	2	-	3	1	-

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH2014	Physical Chemistry Lab-II	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. Learn the principle of enthalpy and heat capacity
2. understand the principles of heat capacity
3. practice precise and accurate analysis

Course Outcomes:

The student will be able to

1. use calorimeter to determine the heat capacity
2. Determine the heat capacity of neutralization reaction.
3. Determine the enthalpy of ionization of ethanoic acid
4. Determine the integral enthalpy of various solutions.
5. Estimate the enthalpy of hydration and solubility
6. enhance the analytical skill

LIST OF EXPERIMENTS

1. Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).
2. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Calculation of the enthalpy of ionization of ethanoic acid.

- Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
- Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
- Determination of enthalpy of hydration of copper sulphate.
- Study of the solubility of benzoic acid in water and determination of ΔH .
- Determination of water equivalent of calorimeter and the determination of heat of dilution of sulphuric acid.
- Determination of heat of neutralization of sodium hydroxide and hydrochloric acid
- Determination of heat of neutralization of sulphuric acid using Dewar's vacuum flask as the calorimeter.

Text books:

- Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	3	3	2	1	-	1	3	-
CO2	1	3	3	2	2	-	2	3	-
CO3	1	3	3	2	2	-	1	3	-
CO4	2	3	3	2	1	-	1	3	-
CO5	1	3	2	2	1	-	1	3	-
CO6	2	3	3	2		-	1	3	-

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2015	Main Group Chemistry and Inorganic Polymers	L	T	P	C
		4	0	0	4

Course Objectives:

- Learn the occurrence, properties and reactions of main group elements
- Understand the preparation and the properties of inorganic polymers
- Know about noble gases

Course outcomes:

The student will be enable to

- Learn the periodic properties of main group elements
- Explore the properties, reactions and compounds of s block elements
- Describe the properties, and reactions of p block elements
- Know about the important compounds of p block elements
- Understand the preparation, properties and structures of inorganic polymers
- Learn the properties, compounds and uses of noble gases

Unit I: S block elements (11 Hours)

Electronic configurations of group I (alkali metals) - group II (alkaline earth metals) elements- physical and chemical properties – uses - extraction - compounds of elements of group I elements- oxides – halides - carbonates and bicarbonates – hydrides - organometallic compounds - Some important compounds of group II elements- oxides – hydroxides – sulphates –hydrides - carbonates and bicarbonates – carbides - organometallic compounds - Role of Mg^{2+} , Ca^{2+} ions in biological systems

Unit II: P block elements (13 Hours)

Periodic properties of p-block elements- electronic configuration- Physical and chemical properties- metallic character - oxidizing and reducing properties - oxidation states - diagonal relationship -Group XIII – XIV – catenation- graphite-silica- compounds- hydrides- oxides- hydroxides – halides - metal carbonyls - carbides

Unit III: P block elements (12 Hours)

Group XV- XVI- XVII elements- occurrence- properties- compounds-hydrides – oxides- hydroxides – halides - Organometallic compounds - allotropes of phosphorus and sulphur – phosphazines - back bonding - inter pseudo halides and pseudo halogens –uses - fertilizers

Unit IV: Inorganic Polymers (12 Hours)

Inorganic polymers- preparation- general properties- glass transition temperature- Phosphorous based chain and network polymers- Sulphur based polymers- Boron based polymers- Silicon based polymers- Coordination polymers-

types- comparison with organic polymers- structural aspects- applications. Conducting polymers- Types, preparation properties- applications-soluble polymers (colloids and dispersions) -commercially available conducting polymers.

Unit V: Noble gases (12 Hours)

Occurrence- isolation of noble gases from the atmosphere - electronic configuration - physical properties- uses of noble gases- compounds of noble gases- hydrates- clathrates -Xenon (II) compounds- structure- Xe (IV) compounds- Fluorides of Kr and Ra

Reference books:

1. Lee J. D, "Concise Inorganic Chemistry", Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Huheey J. E, Keiter E. A & Keiter R. L. "Inorganic Chemistry – Principles of structure and reactivity" Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
3. Puri, B. R., Sharma, L. R., & Kalia, K. C. "Principles of Inorganic Chemistry" Shoban Lal Nagin & Co Educational Publishers, 33rd edition, Reprint 2020
4. Madan, W. H., Tuli, G. D., & Madan, R. D. "Selected Topics in Inorganic Chemistry" S. Chand & Company Ltd, Reprint 2009

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3						3		
CO2	3						3		
CO3	3						3		
CO4	3						3		
CO5				3			1		2
CO6				2			2		

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2016	Inorganic Chemistry Lab - III	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. Learn the principles of inorganic qualitative analysis
2. Understand the principles of inorganic qualitative analysis
3. Practice precise and accurate qualitative analysis of mixtures containing anions and cations

Course Outcomes:

The student will be able to

1. Understand the basic concepts of inorganic qualitative analysis
2. Learn the principles of inorganic qualitative analysis
3. Identify the basics of semi micro analysis
4. Prepare the reagents needed for semi micro analysis
5. Identify the cations and anions in the given mixture
6. Enhance the analytical skills of semi micro analysis

LIST OF EXPERIMENTS

1. Qualitative analysis of anions – 1
2. Qualitative analysis of anions – 2
3. Qualitative analysis of anions – 3
4. Qualitative analysis of anions – 4
5. Qualitative analysis of alkali metals by flame test
6. Estimation of available chlorine in bleaching powder iodometrically.
7. Quantitative analysis of Chloride – Gravimetry
8. Quantitative analysis of Sulphate– Gravimetry
9. Estimation of antimony in tartar-emetic iodimetrically
10. Estimation of arsenite in tartar-emetic iodimetrically
11. Preparation of Aluminium potassium sulphate $KAl(SO_4)_2 \cdot 12H_2O$ (Potash alum)
12. Preparation of Aluminium potassium sulphate Chrome alum.
13. Estimation of Calcium in limestone.

Text Books:

1. Svehla / Sivasankar, "Vogel's Qualitative Inorganic Analysis", 7th edition, Pearson Education India, 2012

2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	3					1	3	
CO2	1	3					1	3	
CO3	1	3					1	3	
CO4		3					1	3	
CO5		3						3	
CO6		3						3	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2017	Chemistry of Amines, Nitriles and Heterocyclic compounds	L	T	P	C
		4	0	0	4

Course Objectives

Enable the student to

1. learn the theoretical aspects of compounds having nitrogen containing functional groups
2. know the different mechanistic pathway of naming reactions
3. study the general properties, preparation and applications of five and six membered heterocyclic compounds.

Course Outcomes

Students will be able to

1. illustrate the chemistry of compounds having nitrogen containing functional groups
2. explain the physical and chemical properties of nitrogen functional groups
3. understand the various mechanistic pathways of different naming reactions
4. predict the carbon skeleton of amines and heterocyclic compounds
5. recognize the importance of nitrogen containing compounds
6. understand the applications of the nitrogen containing compounds and heterocycles through their reaction chemistry

Unit I:- Chemistry of Amines (14 Hours)

Amines: Introduction, classification, properties and general methods of preparation - Distinction between Primary, secondary and tertiary amines using Hinsberg's method and nitrous acid - Name reactions with mechanism: Gabriel Phthalimide synthesis -Hoffmann- Bromamide reaction - Carbylamine reaction - Mannich reaction, Hofmann-elimination reaction and Cope elimination - Diazonium salt and applications – condensation reaction.

Unit II:-Chemistry of Nitro compounds (10 Hours)

Nitro compounds (Aliphatic and Aromatic): Nomenclature, classification, properties, general methods of preparation and applications - Reactions with mechanisms - alkali, nitrous acid, Henry condensation, Hydrolysis, Reduction reactions for aromatic compounds (electrolytic, acidic, basic and neutral medium, Electrophilic substitution reactions - Halogenation, nitration and sulphonation - Nucleophilic substitution reactions on the ring.

Unit III:-Nitrile and isonitrile compounds (10 Hours)

Nitriles: Introduction, Nomenclature, classification, properties, preparation and applications. - Reactions with mechanism: Grignard reagent, hydrolysis - reaction with HX, NH₃, aqueous ROH - Reduction reactions (catalytic reduction and Stephen's reaction) - Condensation reactions - Thorpe Nitrile - Isonitriles: Introduction, Nomenclature, properties Preparation and applications - Carbylamine reaction.

Unit IV: Heterocyclic Compounds I (14 Hours)

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom - Synthesis, reactions and mechanism of substitution reactions of Furan, Pyrrole, Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis - Thiophene, Derivatives of furan: Furfural and furoic acid. Pyridine (Hantzsch synthesis), Pyrimidine - Fischer indole synthesis and Madelung synthesis.

Unit V: Heterocyclic compounds II (10 Hours)

Preparation and properties of quinoline and isoquinoline - Skraup synthesis -Friedlander's synthesis - Knorr quinoline synthesis - Doebner-Miller synthesis - Bischler-Napieralski reaction - Pictet-Spengler reaction - Pomeranz-Fritsch reaction

Text books

1. R.T. Morrison & R.N. Boyd, Organic Chemistry, 6th Edition, Pearson Education Pvt Ltd., Singapore, 2003.
2. Arun Bahl and B.S. Bahl Advanced organic Chemistry, S. Chand & company Ltd. New Delhi, 2010.
3. R.K. Bansal, "Heterocyclic Chemistry", Wiley Eastern, 1990

Reference Books

- Organic chemistry, Janice Gorzynski Smith, 2nd Edition, Tata McGraw Hill Education Private Limited, 2008.
- Organic chemistry, Leroy G. Wade, 8th Edition, Pearson Education Inc., 2019
- I.L. Finar, "Organic Chemistry, Volume 1: The Fundamental Principles", London Longmans, 1963
- Gurdeep R. Chatwal, "Reaction Mechanism and Reagents in Organic Chemistry", Himalaya Publishing House, New Delhi, 2007.
- Joule, J. A. and Mills K. Heterocyclic Chemistry, 05th Edition, Wiley, 2010.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1			1		3	1	
CO2	3	1			1		3	1	
CO3	3	1			1		3	1	
CO4	3	1			1		3	1	
CO5	3	1			1		3	1	
CO6	3	1			1		3	1	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2018	Organic Chemistry Lab-III	L	T	P	C
		0	0	3	2

Course Objectives

Enable the student to

- develop various skills for preparing organic compounds.
- know the various organic preparative techniques available.
- impart awareness about reaction conditions for various types of organic reactions.

Course Outcomes

Students will be able to

- prepare organic compounds in one step in the lab.
- purify and find the purity of the prepared compound.
- setup the apparatus for various preparative techniques.
- understand the mechanism of the various preparative synthetic steps.
- recognize the importance of distillation, refluxing and recrystallization techniques.
- employ various types of organic reaction

LIST OF EXPERIMENTS

The experiments involve the preparation of several organic molecules by one step or two step processes. The reactions used for the preparation will be aromatic electrophilic substitution, esterification, hydrolysis, oxidation, reduction, etc.

- Single stage organic synthesis 1
- Single stage organic synthesis 2
- Single stage organic synthesis 3
- Single stage organic synthesis 4
- Single stage organic synthesis 5
- Single stage organic synthesis 6
- Single stage organic synthesis 7
- Single stage organic synthesis 8
- Double stage organic synthesis 1
- Double stage organic synthesis 2
- Double stage organic synthesis 3
- Double stage organic synthesis 4
- Double stage organic synthesis 5
- Double stage organic synthesis 6

(Minimum 10 experiments to be conducted)

Reference Books

- A.I. Vogel – "Text book of practical organic chemistry", 5th Ed. ELBS, London, 1989
- B.B. Dey and M.V. Sitharaman, "Laboratory manual of Organic Chemistry" Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
- Daniel R. Palleros, "Experimental Organic Chemistry" John Wiley & Sons, Inc., New York, 2000

4. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, "Text book of Practical Organic Chemistry", LBS, Singapore, 1994
5. S.M. Khopar, "Basic concepts of Analytical Chemistry

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	3		1	2		1	3	
CO2	1	3		1	2		1	3	
CO3	1	3		1	2		1	3	
CO4	1	3		1	2		1	3	
CO5	1	3		1	2		1	3	
CO6	1	3		1	2		1	3	

'3'-High, '2'- Medium, '1'-Low, '- ' No correlation

20CH2019	Chemical Kinetics and Surface Chemistry	L	T	P	C
		4	0	0	4

Course Objectives:

Enable the student to

1. Learn the phase equilibrium of binary solutions
2. get thorough knowledge about catalysis
3. understand the basics of surface chemistry and photochemistry

Course Outcomes:

The student will be able to

1. Understand the concepts of phases
2. Distinguish the types and kinetics of fast reactions
3. know the kinetics of flow techniques
4. realize the theory of acid – base catalysis
5. learn applications of surface chemistry
6. recognize the importance of photosensitization of Chemiluminescence

Unit I Phase Equilibria (20 Hours)

Concept of phases-components and degrees of freedom-derivation of Gibbs Phase Rule for nonreactive and reactive systems- Clausius-Clapeyron equation and its applications to solid liquid, liquid-vapour and solid-vapour equilibria-phase diagram for one component systems- Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points-Three component systems-water-chloroform-acetic acid system, triangular plots-Binary solutions- Gibbs-Duhem-Margules equation- lever rule, partial miscibility of liquids-CST- miscible pairs-steam distillation-Nernst distribution law-its derivation and applications.

Unit II Chemical Kinetics 16 Hour

Order and molecularity of a reaction-rate laws in terms of the advancement of a reaction-differential and integrated form of rate expressions up to second order reactions-experimental methods of the determination of rate laws-kinetics of complex reactions (integrated rate expressions up to first order only)- (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.-Temperature dependence of reaction rates-Arrhenius equation-activation energy-Collision theory of reaction rates- Lindemann mechanism-qualitative treatment of the theory of absolute reaction rates

Unit III Catalysis 8 Hour

Types of catalyst- specificity and selectivity-mechanisms of catalyzed reactions at solid surfaces- effect of particle size and efficiency of nanoparticles as catalysts-Enzyme catalysis,-Michaelis-Menten mechanism- acid-base catalysis.

Unit IV: Surface chemistry (8)

Adsorption –Physical adsorption, chemisorption, - Applications – Factors influencing – Langmuir adsorption isotherm – types of adsorption isotherm – Gibbs adsorption isotherm –BET equation – Determination of surface area -Insoluble surface film on liquids

Unit V – Photochemistry 8 Hour

Absorption and emission of radiation – Theories – Spontaneous and induced emission –Laser – Franck Condon principle - Type 1 & 2 – Physical properties of electronic excited state – Emission – Resonance emission – Selection rule – Fluorescence – Phosphorescence – Delayed fluorescence: E-Type and P-type – Excimer and Exciplex complex formation – Photosensitization and Chemiluminescence – Experimental techniques – Actinometry – Chemical actinometry – Flash photolysis.

Reference Books:

1. Peter Atkins & Julio De Paula, Physical Chemistry 10th Ed., Oxford University Press, (2014).
2. Castellan, G. W. Physical Chemistry, 4th Ed., Narosa (2004).
3. McQuarrie, D. A. & Simon, J. D., Molecular Thermodynamics, Viva Books Pvt. Ltd.: New Delhi (2004).
4. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.
6. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
7. Zundhal, S.S. Chemistry concepts and applications Cengage India (2011).
8. Ball, D. W. Physical Chemistry Cengage India (2012).
9. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
10. Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill (2011).
11. Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	-	3	-	1
CO2	3	2	2	1	2	-	3	-	1
CO3	3	2	2	1	2	-	3	-	2
CO4	3	2	2	1	3	-	3	-	1
CO5	3	2	2	2	2	-	3	-	1
CO6	3	2	2	1	3	-	3	-	1

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20CH2020	Physical Chemistry Lab-III	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn the principle of phase diagram
2. understand the principles of kinetics
3. practice precise and accurate analysis

Course Outcomes:

The student will be able to

1. construct phase diagram
2. understand equilibrium reactions
3. study the kinetics of hydrolysis reactions
4. study the kinetics of saponification reactions
5. verify absorption isotherms
6. enhance the analytical skill

LIST OF EXPERIMENTS

1. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.
2. Construction of the phase diagram: Simple eutectic
3. Construction of the phase diagram: congruently melting systems.
4. Distribution of acetic/ benzoic acid between water and cyclohexane.
5. Study the equilibrium of $I_2(aq) + I^- \rightarrow I_3^-(aq)$
6. Study the equilibrium of $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$
7. Study the kinetics of Iodide-persulphate reaction
8. Study the kinetics of Acid hydrolysis of methyl acetate with hydrochloric acid.
9. Study the kinetics of Saponification of ethyl acetate.
10. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.
11. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Text books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).

3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	3	2	1	1	-	1	3	-
CO2	3	3	2	1	2	-	2	3	-
CO3	2	3	2	1	2	-	2	3	-
CO4	2	3	1	1	1	-	2	3	-
CO5	2	3	1	1	1	-	1	3	-
CO6	3	3	2	1	2	-	1	3	-

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

Course Objectives:

21CH2021	Transition Metals and Coordination Chemistry	L	T	P	C
		4	0	0	4

Enable the student to

1. learn the properties of transition metals and f-block elements
2. understand the various theories of coordination chemistry.
3. know about the isomerism and stability of metal complexes

Course Outcomes:

Students will be able to

1. know the properties of transition metal compounds.
2. understand the chemistry of metal complexes
3. recognize the importance of f-block elements.
4. have complete understanding of formation of coordination complexes
5. know the various types of isomerism in coordination chemistry
6. understand the factors affecting the stability of metal complexes

Unit I Transition Metals (10 Hours)

Introduction – Metallic Character – Variable oxidation state – stability of the oxidation states - Complexes – Size of atoms and ions – Density – Melting and boiling points – Reactivity of metals – ionization energies – Colour – Polarization – Incompletely filled d or f shell – Magnetic properties – Measurement of magnetic moments – An example – Catalytic properties – Nonstoichiometry – Abundance

Unit II Transition metal compounds (12 Hours)

Hydrides, oxides, mixed oxides, hydroxide, sulphates and halides of Lanthanum- Vanadium, Titanium- chromium- Molybdenum- Tungsten- Manganese- Iron- Osmium- Cobalt- Nickel- Palladium- Platinum- Copper- Gold- Zinc

Unit III Coordination compounds (16 Hours)

Ligands – Classification - Double salts and Coordination compounds – Bonding theories – Werner's theory – Sidgwick Theory - VB Theory – Advantages and Defects - Crystal Field Theory – Shapes of d orbitals – Assumptions - Crystal Field Stabilization Energy - Factors Affecting $10Dq$ – Spectrochemical Series – Merits and limitations of Crystal field theory - MO Theory -Jahn Teller distortion – Electronic spectra – color – Magnetic properties - Isomerism — Ionization isomerism – Hydrate isomerism – Linkage isomerism – Coordination isomerism – Coordination position Isomerism –Geometric isomerism– optical isomerism – Stability – Relationship between stepwise and overall stability constant- Factors affecting stability constants

Unit IV Reactions in coordination complexes (12 Hours)

Thermodynamic and Kinetic Stability - Labile and Inert Complexes - Substitution in Octahedral Complexes – Rate constants for water exchange reactions - S_N1 , S_N2 Mechanism - Reactions of Coordinated Ligands - Substitution in square Planar Complexes – Trans Effect – Series - Applications of Trans Effect - Electron transfer reactions - Types - Outer sphere electron transfer reaction - Marcus Theory –Innersphere Reactions Properties of excited states - Basic Photochemical Processes –Photoredox reactions – Applications

Unit V Inner Transition Elements (10 Hours)

Lanthanides and actinides Introduction –Electronic structure – Oxidation states – Ionic Radii - Lanthanide contraction – Consequences - Colour and spectra - Magnetic Properties - Abundance – Extraction and uses - Extraction, Properties and Uses of Thorium and Uranium

Reference Books:

1. Lee J. D. "Concise Inorganic Chemistry" Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Shriver, Atkins. "Inorganic Chemistry" Oxford University Press, New Delhi, India, 4th edition., 2009.

- Huheey J. E., Keiter E. A. & Keiter R. L. "Inorganic Chemistry – Principles of structure and reactivity" Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
- Madan, W. H., Tuli, G. D. & Madan, R. D. "Selected Topics in Inorganic Chemistry" S. Chand & Company Ltd, Reprint 2009.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3						3	1	
CO2	3						3	1	
CO3	3						3	1	
CO4	1	3					3	1	
CO5	3						3		
CO6	3						3		

'3'-High, '2'- Medium, '1'-Low, '- 'No correlation

21CH2022	Inorganic Chemistry Lab - IV	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

- learn the principle of complexometric titration
- understand the principles of precipitation titration
- practice precise and accurate analysis in volumetric and gravimetric analysis

Course Outcomes:

The student will be able to

- understand the basics of complexometric titrations
- learn principles of precipitation titrations
- estimate the given unknown compounds using complexometric and precipitation titrations
- identify basic principles of gravimetric analysis
- estimate the given unknown compound using gravimetric principles
- enhance the analytical skill in gravimetric analysis

LIST OF EXPERIMENTS

- Complexometric titration I
- Complexometric titration II
- Complexometric titration III
- Precipitation titration I
- Precipitation titration II
- Semimicro qualitative analysis – 1
- Semimicro qualitative analysis – 2
- Semimicro qualitative analysis – 3
- Semimicro qualitative analysis – 4
- Semimicro qualitative analysis – 4
- Preparation of Manganese(III) phosphate, $\text{MnPO}_4 \cdot \text{H}_2\text{O}$
- Tetraamminecopper (II) sulphate, $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4 \cdot \text{H}_2\text{O}$
- Cis and trans $\text{K}[\text{Cr}(\text{C}_2\text{O}_4)_2 \cdot (\text{H}_2\text{O})_2]$ Potassium dioxalato diaquachromate (III)
- Tetraamminecarbonatocobalt (III) ion
- Potassium tris(oxalato)ferrate(III)

Text books:

- G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney "Vogel's Text Book of Quantitative Inorganic Analysis" 5th Edition, Longman Group UK Limited, 1989
- Marr & Rockett Practical Inorganic Chemistry. John Wiley & Sons 1972.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1		3						3	
CO2		3						3	
CO3		3						3	
CO4		3						2	
CO5		3						2	

CO6		3						2	

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

21CH2023	Organic Chemistry Lab-IV							L	T	P	C
								0	0	3	2

Course Objectives

Enable the student to

1. develop various skills for the extraction of natural products.
2. know the various analytical techniques to characterize the organic compounds.
3. impart awareness about reaction conditions for various types of organic reactions.

Course Outcomes

Students will be able to

1. analyze the properties of biomolecules in the lab.
2. purify and find the purity of the prepared compound.
3. setup the apparatus for various preparative techniques.
4. understand the mechanism of the various preparative synthetic steps.
5. recognize the importance of distillation, refluxing and recrystallization techniques.
6. employ various types of organic reaction

LIST OF EXPERIMENTS

1. Preparation of derivative of carbohydrate –
2. Analysis of Carbohydrate - 1
3. Analysis of Carbohydrate - 2
4. Characterization of carbohydrate
5. Extraction and analysis of natural products -1
6. Extraction and analysis of natural products - 2
7. Extraction and analysis of natural products - 3
8. Preparation of artificial sweetener
9. Analysis of Aminoacid – 1
10. Analysis of Aminoacid – 2
11. Extraction and analysis of oil
12. Preparation of biodiesel

Text Books:

1. A.I. Vogel – “Text book of practical organic chemistry”, 5th Ed. ELBS, London, 1989
2. B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
3. Daniel R. Palleros, “Experimental Organic Chemistry” John Wiley & Sons, Inc., New York, 2000
4. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, “Text book of Practical Organic Chemistry”, LBS, Singapore, 1994
5. S.M. Khopar, “Basic concepts of Analytical Chemistry”, John Wiley & Sons, 1984
6. Gnanapragasam N.S., Ramamurthy G, “Organic Chemistry Lab Manual”, revised edition, S. Viswanathan printers and publishers Pvt. Ltd., Chennai, Reprinted 2011
- 7.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	3		1	1		1	3	1
CO2	1	3		1	1		1	3	1
CO3	1	3		1	1		1	3	1
CO4	1	3		1	1		1	3	1
CO5	1	3		1	1		1	3	1
CO6	1	3		1	1		1	3	1

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20CH2024	Electrochemistry and Quantum Chemistry	L	T	P	C
		4	0	0	4

Course Objectives:

Enable the student to

1. understand the basics of electrolytic conductance
2. learn the fundamentals of electrochemistry, electro-kinetics and electrochemical cells
3. get thorough knowledge about quantum chemistry and group theory

Course Outcomes:

The student will be able to

1. understand the principles of electrolytic conductance
2. know the basics of electrochemistry and electrode kinetics
3. understand the operation principles of electrochemical cells and photovoltaic cells
4. know the basics of quantum mechanics
5. understand the uses of quantum chemistry of atoms and molecules
6. know about the concepts of group theory

Unit I : Electrolytic Conductance (16 Hours)

Electrolytic conductance – Variation of molar conductance with dilution – Ionic mobility – Faraday's laws -Hittorf's theoretical device – Determination of transport numbers – Kohlrausch's law – Calculation of molar ionic conductance – Relation between molar ionic conductance and ionic mobility – Variation of conductance with concentration – Determination of ionic mobility – Application of Kohlrausch's law – Diffusion and ionic mobility – Application of conductance measurements – Conductometric titrations – Precipitation titrations – Ostwald's dilution law – Arrhenius theory - Debye – Huckel theory of strong electrolytes – Activity coefficients of electrolytes – Debye-Huckel theory of mean activity coefficients of strong electrolytes – The Debye-Huckel Limiting Law (DHLL) – Determination of Ionization constant – pH and pOH – Buffer Solution Effect of Dilution, Conductance measurements, Applications of Conductance titrations, types of Conductance titrations, Advantages and disadvantages of Conductometric titrations

Unit II:: Electrochemical Cells-I (14 Hours)

EMF – Representation of cell - Galvanic cells – Weston standard cell - Half – reactions and reversible electrodes – Single electrode potential – calculation of single electrode potential - The Nernst equation – Classification of electrodes – Metal-metal ion electrodes – Amalgam Electrodes – Gas electrodes – Metal-insoluble salt electrodes – oxidation-reduction electrode – Reference electrodes - Electrochemical series – Electrochemical cells – Chemical cells - Concentration cells – Electrode and Electrolyte concentration cell – with and without transference - Liquid junction potential – Applications of EMF measurements – Determination of solubility product – Determination of pH - Potentiometric, acid-base, redox, precipitation titrations Potentiometry, Introduction, Instrumentation, Types of potentiometric Titrations, Variations in potentiometric titrations, Advantages of potentiometric Titrations.

Unit III:: Electrochemical Cells - II (8 Hours)

Polarization – Types of Polarization – concentration polarization and overvoltage – Measurement of overvoltage – Hydrogen overvoltage – Theories of overvoltage – Metal deposition and hydrogen overvoltage – Electroanalytical techniques – potentiometric – potentiostatic – Faradaic process – Mass transport – diffusion, convection, migration – Polarography – Tafel plot – Electrical double layer – Double layer capacitance – Introduction to Cyclic voltammetry - Applications

Unit IV:: Quantum Chemistry and Atomic Structure (14 Hours)

Introduction to quantum mechanics- Scrodinger equation- Free particle-particle in one dimensional box-Rigid rotor-Time independent Schrodinger equation - Significance of ψ and ψ^2 -Schrödinger equation for hydrogen atom-Radial and angular parts of the wavefunctions- Radial and angular nodes and their significance-Radial distribution functions - Significance of quantum numbers- nodal planes- -Electronic configurations of the atoms-Stability of half-filled and completely filled orbitals-concept of exchange energy-Relative energies of atomic orbitals-Anomalous electronic configurations.

Unit V:: Group Theory (8 Hours)

Molecular symmetry – symmetry elements and symmetry operations-successive operations, inverse operations - Cartesian coordinate system - relations among symmetry elements - Properties of a group – Abelian, non abelian and Isomorphic groups - Multiplication tables – classes, subgroups - Molecular point groups - Schoenflies symbols - Matrices of symmetry operations - Representations of a group-Reducible and irreducible, representations - Statement and proof of Great orthogonality theorem - Characters and construction of character table (C_{2v}, C_{3v}) – Explanation of a character table - Direct product groups

Text books:

1. B.R., Puri, L.R. Sharma and Madan S. Pathania, "Principles of Physical Chemistry", Shoban Lal Nagin Chand & Co., Jalandhar, 2000.
2. Kundu and S.K. Jain, "Physical Chemistry" S. Chand & Company Ltd., New Delhi, 1984.
3. John O'M. Bockris, Amulya K. N. Reddy, "Modern Electrochemistry Vol. I and II", Plenum Publishing, 1970.
4. Chandra, A.K. "Quantum Chemistry", McGraw Hill Education (India) Pvt. Ltd., New Delhi, 4th Edition, 2015
5. R L. Madan, "Physical Chemistry" McGraw –Hill Pvt. Ltd., New Delhi, 4th Edition,

Reference Books:

1. S. Glasstone and D.Lewis, "Elements of Physical Chemistry", 2nd Ed.,1982.
2. G.W. Castellan, "Physical Chemistry", Narosa publishing house, Chennai, 1989.
3. H. Snehe, "Comprehensive Physical Chemistry", PrgatiPrakashan, Meerut, 1987.
4. Hanna, M.W., "Quantum Mechanics in Chemistry", Addition Wisley, London, 3rd edition, 1981.
5. John C. Schug, "Introductory Quantum Chemistry", Holt, R & W Publisher, 1972

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	-	3	1	1
CO2	3	1	-	1	2	-	3	2	1
CO3	3	2	1	1	2	-	3	2	1
CO4	3	2	1	1	2	-	3	-	1
CO5	3	2	-	1	1	-	3	1	1
CO6	3	1	-	1	2	-	3	1	1

20CH2025	Physical Chemistry Lab-IV	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn the principle of electrochemistry experiments
2. understand the principles of conductometric and potentiometric titrations
3. practice precise and accurate analysis

Course Outcomes:

The student will be able to

1. understand the cell constant
2. estimate acid strength
3. estimate mixture of acids
4. perform potentiometric tirations
5. estimate the strengths dibasic acids
6. enhance the analytical skill

LIST OF EXPERIMENTS

1. Determination of cell constant
2. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
3. Conductometric titration of Strong acid vs. strong base
4. Conductometric titration of Weak acid vs. strong base
5. Conductometric titration of mixture of strong acid and weak acid vs. strong base
6. Conductometric titration of Strong acid vs. weak base
7. Potentiometric titration of Strong acid vs. strong base
8. Potentiometric titration of Weak acid vs. strong base
9. Potentiometric titration of Dibasic acid vs. strong base
10. Potentiometric titration of Potassium dichromate vs. Mohr's salt
11. Acid base titration using pH meter
12. Acid base titration using pH meter

Text books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	3	2	1	1	-	1	3	2
CO2	1	3	1	1	1	-	1	3	1
CO3	1	3	2	1	1	-	1	3	1
CO4	1	3	2	-	1	-	1	3	1
CO5	1	3	1	1	1	-	1	3	2
CO6	1	3	2	1	1	-	1	3	-

'3'-High, '2'- Medium, '1'-Low, '- ' No correlation

21CH2026	Biomolecules and Natural Products	L	T	P	C
		4	0	0	4

Course Objectives

Enable the student to

- learn the occurrence, properties and structural elucidation of carbohydrates and amino acids
- understand the structure, nomenclature and biological roles of nucleic acids and lipids
- know about the occurrence, synthesis and structural elucidation of alkaloids

Course Outcomes

Students will be able to

- know the classification and structural elucidation of carbohydrates
- recognize the classification and synthesis, reactions of amino acids and peptides
- understand the chemistry and mechanism of enzymatic reactions
- learn the structure and the biological importance of nucleic acids
- know the importance and reactions of lipids
- understand the importance and structural elucidation of alkaloids

Unit I:- Carbohydrates (10 Hours)

Occurrence, classification and their biological importance – Monosaccharides - Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose - Haworth projections and conformational structures - Interconversions of aldoses and ketoses - Killiani-Fischer synthesis and Ruff degradation -Disaccharides –Structure elucidation of maltose, lactose and sucrose. Polysaccharides –Elementary treatment of starch, cellulose and glycogen.

Unit II:- Amino Acids and Proteins (14 Hours)

Amino acids - classification - α -Amino Acids - Synthesis, ionic properties and reactions. Zwitterions - pKa values - isoelectric point and electrophoresis - determination of their primary structures-end group analysis - methods of peptide synthesis - Synthesis of peptides using N- protecting, O-protecting and C-activating groups - Solid-phase synthesis - primary, secondary and tertiary structures of proteins – Denaturation – Enzymes, Introduction, classification and characteristics of enzymes - Salient features of active site of enzymes - Mechanism of enzyme action, taking chymotrypsin as an example - factors affecting enzyme action - coenzymes and cofactors (NAD,FAD) - specificity of enzyme action including stereospecificity - enzyme inhibitors and their importance.

Unit III:- Nucleic acids (11 Hours)

Structure of components of nucleic acids - Bases, Sugars, Nucleosides and Nucleotides - Nomenclature of nucleosides and nucleotides - structure of polynucleotides, DNA and RNA - Biological roles of DNA and RNA - Concept of heredity - Genetic Code, Replication, Transcription and Translation.

Unit IV:- Lipids (10 Hours)

Introduction to oils and fats -common fatty acids present in oils and fats - Hydrogenation of fats and oils - Saponification value, acid value, iodine number - Reversion and rancidity.

Unit V:- Alkaloids and Terpenes (15 Hours)

Alkaloids - Introduction, Natural occurrence, Classification - Uses, general structural features - general methods for structure elucidation including Hoffmann's exhaustive methylation and Emde's method - Structure elucidation, synthesis and physiological action of Nicotine – Terpenes: Introduction, Occurrence, Uses, classification, isoprene

and special isoprene rule - general methods of structure elucidation including distinction between isopropylidene and isopropenyl group - Elucidation of structure and synthesis of Citral its industrial application.

Text Books

1. Finar. I. L, "Organic Chemistry", Volume 2, Doorling Kindersley (Indian), 6th Edition, 2008.
2. Gurdeep R. Chatwal, "Organic Chemistry of Natural Products", Himalaya Publishing Home, New Delhi, 5th & Enlarged Edition, 2008
3. Agarwal. O.P, "Chemistry of natural products, Vol.1 & 2", Goel publishing house, 36th edition, 2009

Reference Books

1. Lehninger, Principles of Biochemistry 5th edition, 2008 - Nelson, D. L. and M. M. Cox. (W. H. Freeman & Co.)
2. Organic Chemistry (5th Edn.) Robert. T. Morrison & N. Boyd. Hill edition.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1		1	1		3		1
CO2	3	1		1	1		3		1
CO3	3	1		1	1		3		1
CO4	3	1		1	1		3		1
CO5	3	1		1	1		3		1
CO6	3	1		1	1		3		1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2027	Analytical Chemistry – II				L	T	P	C
					4	0	0	4

Course Objectives:

Enable the student to

1. Learn the importance of electro-analytical methods
2. Elucidate the structure using modern analytical tools.
3. Learn the principle of spectroscopic methods

Course Outcomes:

The student will be able to

1. Understand the principle of spectroscopic methods
2. Elucidate the molecular structure using modern spectroscopic techniques
3. Understand the principle and application of Rotational and Vibrational Spectroscopy
4. Understand the principle and application of Electronic Spectroscopy
5. Understand the principle and application of Conductometry
6. Understand the principle and application of Potentiometry

Unit I: Introduction to Spectroscopic methods (10 hours)

Introduction, Definition of spectrum, origin of spectrum, classification of spectroscopy methods, properties of electromagnetic radiation, electromagnetic spectrum, different types of molecular energies, interaction of electromagnetic radiation with matter and problems.

Unit II: Rotational and Vibrational Spectroscopy (10 hours)

Principle, selection rules, instrumentation, sampling techniques and applications of Rotational, Infrared and Raman spectroscopy.

Unit III: Electronic Spectroscopy (12 hours)

Principles, instrumentation of UV-Vis Spectroscopy, analysis of UV spectra, Lambert-Beer's law, effect of solvent on λ_{max} , calculation λ_{max} of different organic compounds and calculation of stoichiometric ratios of metal-ligand complex (Job's method), Concept of chromophore and auxochrome, Bathochromic, hypsochromic, hyperchromic and hypochromic shifts and applications. Fluorescence spectroscopy, introduction, instrumentation, solvent and environment effects, fluorescence quenching, Stokes Shift, quantum yield and applications, applications of UV for identification of simple molecules.

Unit IV: Basic NMR and EPR Spectroscopy (14 hours)

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules - Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.

Unit V: Organic Spectroscopy (15 hours)

Principle, selection rules, instrumentation, sampling techniques and applications of Infrared and Raman spectroscopy, IR absorption positions of O, N and S containing functional groups, Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis. Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds. Applications of IR, and NMR for identification of simple organic molecules.

Text Books:

1. Vogel's textbook of quantities chemical analysis', G. H. Affery J. Bassett, J .Mendham, R. C. Denney, 5th edition, John Wiley and Sons Inc.
2. Modern Methods of Chemical Analysis', R.L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, 2nd edition, John Wiley, New York
3. Skoog D. A, West D. M, Holler F. J & Crouch S. R, "Fundamentals of Analytical Chemistry", Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.
4. Chatwal G. R & Anand S. K, "Instrumental Methods of Chemical Analysis", Himalaya Publishing House, Mumbai, India, 5th Edition, Reprint 2011.
5. Kalsi P. S, "Spectroscopy of Organic Compounds", New Age International Publishers, New Delhi, 6th Edition, 2004.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	√	√			√	√	√	√	√
CO2		√	√				√		√
CO3		√		√			√		
CO4		√		√			√	√	√
CO5		√		√	√		√	√	
CO6		√		√	√		√	√	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2028	Analytical Chemistry Lab -II	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn the principles of electromagnetic spectrum and transition
2. understand the principles of various spectroscopic techniques
3. practice the analysis of spectra of organic compounds

Course Outcomes:

The student will be able to

1. understand the basics of electromagnetic spectrum
2. differentiate the various transitions
3. understand the importance of vibrational spectroscopy
4. identify the functional groups based on ir spectra
5. realize the importance of electronic spectroscopy
6. enhance the analysis of organic spectra

LIST OF EXPERIMENTS

1. Differentiating various spectral region and identification of given spectra
2. Analysis of IR spectra - 1
3. Analysis of IR spectra - 2
4. Analysis of IR spectra - 3
5. Analysis of Rotational spectra - 1
6. Analysis of Rotational spectra - 2
7. Analysis of NMR spectra - 1
8. Analysis of NMR spectra - 2
9. Analysis of NMR spectra - 3
10. Analysis of Electronic spectra - 1
11. Analysis of Electronic spectra - 2
12. Analysis of Electronic spectra - 3

13. Study the 200-500 nm absorbance spectra of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1} , kJ mol^{-1} , cm^{-1} , eV).
14. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $\text{K}_2\text{Cr}_2\text{O}_7$.
15. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.
16. . Verify Lambert-Beer's law and determine the concentration of $\text{CuSO}_4/\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ in a solution of unknown concentration

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3				3		3		
CO2	3		2				3		
CO3	3			1			3		
CO4	2	2	1	1			3		1
CO5	2			1	1		2		1
CO6	2	1		1	1		2	1	1

21CH2029	Advanced Inorganic Chemistry	L	T	P	C
		4	0	0	4

Course Objectives:

Enable the student to

1. Learn the basics of organometallic chemistry
2. Understand the various reactions of coordination chemistry
3. Know about bioinorganic chemistry of metal complexes

Course Outcomes:

Students will be able to

1. Know the importance of 18 electron rule
2. Understand the chemistry of organometallic complexes
3. Recognize the importance of organometallic catalysis
4. Have complete understanding of reactions in coordination complexes
5. know the various types of photochemical processes in coordination chemistry
6. Understand importance of bioinorganic chemistry

Unit I: Organometallic Chemistry and catalysis (18 Hours)

18-electron rule- metal carbonyls, Metal alkyls, carbenes, carbynes and alkenes – Nitrosyls Metallocenes – Ferrocene – Preparation – Properties – Applications, Ligand Cone angle – Oxidative addition – Reductive elimination – Migration – Insertion – β -Hydride elimination -Homogeneous and heterogeneous catalysis -Wilkinson's catalyst – Ziegler – Natta Catalyst.

Unit II: Bioinorganic Chemistry (12 Hours)

Essentials and trace elements of life - basic reactions in the biological systems and the role of metal ions - Fe^{2+} Fe^{3+} Cu^{2+} and Zn^{2+} - Structure- function of hemoglobin and myoglobin and carbonic anhydrase.

Unit III Cement and concrete (8 Hours)

Cement- Composition- Classification- properties - manufacturing of Portland cement - blended cement - setting and hardening - special cements - Concrete- Reinforced concrete construction - decay of concrete

Unit IV: Composites (12 Hours)

Nano composites - classifications based on matrix materials and reinforcements – preparation- properties - structural characterizations and applications-Fibre- reinforced composites- environmental effects on composites - applications of composites -Bionano composites – Composition - super alloys thermoplastics – thermosets

Unit V: Chemistry of magnetic materials and Porous materials (10 Hours)

Magnetism- types- preparation- properties- Measurement of magnetic susceptibility- Soft and hard magnetic materials- Preparation- structure- electrical- magnetic- magneto- optical properties and applications- Hard magnetic materials- Properties and applications of hard ferrites-Porous materials- Types – preparation- properties- structural characterization and applications

Reference Books:

1. Lee J. D, "Concise Inorganic Chemistry" Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Shriver and Atkins, "Inorganic Chemistry" Oxford University Press, New Delhi, India, 4th edition, 2009.

- Huheey J. E., Keiter E. A. & Keiter R. L. "Inorganic Chemistry – Principles of structure and reactivity" Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
- Madan, W. H., Tuli, G. D., & Madan, R. D. "Selected Topics in Inorganic Chemistry" S. Chand & Company Ltd, Reprint 2009.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1		3					3		
CO2	2	3					3		
CO3	2	3	1	2			3		
CO4	2	3	1	1			2		1
CO5	2	3	1	1			2		1
CO6		3	1				2		1

21CH2030	Inorganic Chemistry Lab - V	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

- learn the different approaches of preparing nano materials
- understand the principles of preparation of nano materials
- practice the separation of metal ions

Course Outcomes:

The student will be able to

- understand the basics of preparing nano materials
- know the principles of preparing nano materials
- learn different methods of preparing nano materials
- identify basic conditions needed for the preparation of nano materials
- realize the importance of separation of metal ions using paper chromatographic techniques
- enhance the analytical skill for the separation of metal ions using paper chromatography

LIST OF EXPERIMENTS

- Preparation of Metal complex - I
- Preparation of Metal complex - II
- Preparation of Metal complex - III
- Estimation of Cu in brass.
- Estimation of Cr and Mn in Steel.
- Estimation of Fe in cement.
- Preparation of composites
- Preparation of composites
- Preparation of Metal organic framework
- Preparation of Metal organic framework
- Paper chromatographic separation of metal ions I
- Paper chromatographic separation of metal ions II
- Paper chromatographic separation of metal ions III
- Paper chromatographic separation of metal ions IV

Text books:

- Inorganic Synthesis, Vol. 1-10.
- G. H. Jeffery, J. Bassett, J. Mendham and R C. Denney "Vogel's Text Book of Quantitative Inorganic Analysis" 5th Edition, Longman Group UK Limited, 1989

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1		3						3	3
CO2		3						3	2
CO3		3						3	
CO4		3						2	
CO5		3						2	2

CO6		3						2	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH2031	Advanced Electrochemistry and Computational Chemistry							L	T	P	C
								4	0	0	4

Course Objectives:

Enable the student to

1. understand the importance of magnetic properties
2. learn the fundamentals of colloids and macromolecules
3. get thorough knowledge about computational chemistry

Course Outcomes:

The student will be able to

1. understand the basics of colloidal chemistry
2. understand the applications of electrochemistry
3. know the importance of electric and magnetic properties
4. know the various types of corrosion
5. understand the various types of macromolecules

Unit I:: Colloidal state (12)

Types of colloids – Lyophilic and Lyophobic colloids – Preparation – Dispersion and condensation methods – Purification of colloids – Properties of colloids – Tyndall effect – Brownian movement – Charge on colloidal particle – Electrical double layer – Coagulation – Electrophoresis – Determination of colloidal particles – Surfactants – Micelles – Critical micellar concentration – Emulsification – Applications of colloids

Unit II:: Advanced Electrochemistry (20 h)

Steaming potential – electro dialysis – the Dorn effect – electrical double layer – Structure of electrical double layer – Helmholtz model, Gouy-Chapman model and Stern model – Electrode kinetics - Derivation of Butler-Volmer Equation - over potential – decomposition potential - Corrosion – types – Dry corrosion – Wet corrosion – Galvanic series - Factors influencing corrosions – Prevention of corrosion – Galvanic, sacrificial and anodic protection-Batteries - Primary cell – Dry batteries – Alkaline battery – Ni-Cd battery – Mercury battery - Fuel cells – H₂-O₂ fuel cell - Secondary cell – Lead acid batteries – Graphene batteries -Photovoltaics –Electrochemical sensors – actuators

Unit3: Electric and Magnetic Properties (10 Hours)

Electric properties of molecules – Polarization of a molecule in an electric field – Clausius – Mosotti equation – The Debye equation – Dependence of polarizability on frequency – Bond moments – Dipole moments and molecular structure – Group moments – Magnetic properties of molecules – Molecular interpretation of diamagnetism and paramagnetism – Measurement of magnetic susceptibility – Ferromagnetism and antiferromagnetism-examples

Unit IV:: Macromolecules (8)

Classification of polymers – Molar masses of polymers – Determination of molar mass – Viscometry – Osmometry – Donnan membrane equilibrium –Ultracentrifugation – light scattering – Kinetics of addition and condensation polymerization - Polydispersity index.

Unit V:: Computational Chemistry (10 h)

Introduction- unfolding the Schrödinger equation- interpretation of the wavefunction and observables- LCAO-MO and FMO theories, Hückel and extended Hückel models – examples and calculating matrix elements for “simple real molecules- Hartree-Fock self-consistent method- Model chemistries using Gaussian software and its utility programs-basics of running quantum chemical calculations

References:

1. B.R., Puri, L.R. Sharma and Madan S. Pathania, “Principles of Physical Chemistry”, Shoban Lal Nagin Chand & Co., Jalandhar, 2000.
2. John O'M. Bockris, Amulya K. N. Reddy, “Modern Electrochemistry Vol. I and II”, Plenum Publishing, 1970.
3. S. Glasstone and D.Lewis, “Elements of Physical Chemistry”, 2nd Ed.,1982.
4. John C. Schug, “Introductory Quantum Chemistry”, Holt, R & W Publisher, 1972.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	-	3	-	-
CO2	3	-	2	-	-	-	3	-	-
CO3	3	-	-	3		-	2	-	-
CO4	2	1	-	-	-	-	-	2	-

CO5	3	-	-		2	-	3	-	-
CO6	1	-	-	1	-	-	-		2

20CH2032	Physical Chemistry Lab-V							L	T	P	C
								0	0	3	2

Course Objectives:

Enable the student to

1. learn the principle of electroplating
2. understand the corrosion behavior of a metal
3. know about battery characteristics

Course Outcomes:

The student will be able to

1. learn the principle of electroplating
2. know the basics of polarization
3. understand the inhibitor efficiency in corrosion studies
4. understand the discharge characteristics of secondary batteries
5. determine the molecular weight of polymers
6. analyze the colloidal sample

LIST OF EXPERIMENTS

1. Electroplating - Hull Cell Experiment -1
2. Electroplating - Hull Cell Experiment - 2
3. Electroplating - Harin Cell Experiment - 1
4. Electroplating - Harin Cell Experiment - 2
5. Corrosion studies – Weight loss method
6. Corrosion studies – OCP changes with time
7. Corrosion studies – Polarization
8. Corrosion studies – Inhibitor efficiency
9. Lead – acid battery – Discharge – C/4 rate (12 V, 2.5 Ah)
10. Lead – acid battery – Discharge – C/3 rate (12 V, 2.5 Ah)
11. Lead – acid battery – Discharge – C/4 rate (6 V, 2 Ah)
12. Lead – acid battery – Discharge – C/3 rate (6V, 2 Ah)
13. Determination of molecular weight of polymer
14. Electrophoresis

Text books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	3	3	1	1	-	2	3	-
CO2	2	3	2	1	2	-	2	3	-
CO3	2	3	1	1	2	-	1	3	1
CO4	1	3	1	1	2	-	2	3	1
CO5	2	3	1	1	2	-	1	3	-
CO6	1	3	2	1	1	-	2	3	1

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

21CH2033	Advanced Organic Chemistry							L	T	P	C
								4	0	0	4

Course Objectives

Enable the student to

1. learn the fundamentals of organic photochemistry and pericyclic reactions
2. understand the classification, preparation and uses of polymers and plastics

3. know the importance and chemistry of food, textiles and dyes

Course Outcomes

Students will be able to

1. recognize the fundamentals and laws of photochemistry and pericyclic reaction
2. understand the pathways of molecular rearrangements
3. learn the classification, synthesis and applications of polymers
4. know the preparation and applications of plastics
5. understand the chemistry and of nutrients, food colors and preservatives
6. recognize the classification, preparation and applications of dyes

Unit I:- Organic Photochemistry and pericyclic reactions (12 Hours)

Types of pericyclic reaction- Woodward Hoffmann - electrocyclic ring opening and ring closing, cycloaddition 2+2 and 4+2, ene reaction, sigmatropic reactions, chelotropic reaction- only examples – Diels Alder reaction- endo, region and stereoselectivity – FMO for Diels alder and electrocyclic ring closing- Electronic excitation –Photochemical reaction-photosensitizer, quenching, Norrish type I and II types- Paterno Buchi and Di-pi methane reaction

Unit II:- Molecular Rearrangements (10 Hours)

Rearrangements – via carbene and nitrene – Wolf rearrangement- Arndt - Eistert reaction – Curtius and Hoffmann rearrangement – Via carbocation – Wagner Meerwin – Favorski – Benzil-Benzilic acid – Dienone –Demjanov, Pinacol Pinacolone rearrangement -phenol rearrangement – Benzidine -Claisen, Cope, Fries rearrangement. Beckmann rearrangement

Unit III:- Polymers (14 Hours)

Introduction and classification Polymerisation reactions -Addition and condensation. Mechanism of cationic, anionic and free radical addition polymerization; Ziegler-Natta polymerisation of alkenes. Preparation and applications of plastics – thermosetting (phenol formaldehyde, Polyurethanes) and thermo softening (PVC, polythene); Fabrics – natural and synthetic (acrylic, polyamide, polyester). Rubbers – natural and synthetic, Buna-S, Chloroprene and Neoprene. Vulcanization - Polymer additives; Introduction to Biodegradable and conducting polymers with examples- Moulding constituents of plastics, moulding techniques- compression, extrusion and injection, blow moulding-Nylon 6,6 and nylon 6 preparation – Fibre reinforced plastics and application- carbon fibre –carbon reinforced plastics – Polymer blends and alloys, Engineering plastics, Polymers in medicine and surgery- silicone synthesis and application

Unit IV:- Pharmaceutical Compounds: Structure and Importance (10 Hours)

Classification, structure and therapeutic uses of antipyretics: Paracetamol with synthesis- Analgesics: Ibuprofen (with synthesis) - Antimalarials: Chloroquine with synthesis - An elementary treatment of Antibiotics and detailed study of chloramphenicol - Medicinal values

of curcumin and azadirachtin -, vitamin C and antacid : ranitidine – Sulpha drugs

Unit V:- Food Chemistry, textile and dyes (14 Hours)

Role and importance of Carbohydrates – Lipids – Proteins – Enzymes – Emulsions -Pigments - Food additives - permitted Food colours-their structure and synthesis – Flavours –fruit flavors -vanilla – caramel – mono sodium glutamate-fifth taste -Toxicity – Chemicals for preservation – sodium benzoate – Artificial sweetener- Aspartamate-structure –Saccharin- Thickening agent-emulsifiers –Gelling agent- china grass – Preservatives-benzoate and sorbate-anti-oxidant-TBHQ, BHA, BHT - vinegar- Vanaspathi- hydrogenated oil-, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing; Synthesis and applications of Azo dyes –Examples- Phthalein Dyes – Phenolphthalein; Natural dyes –Structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples

Text Books

1. Jain and Jain Engineering chemistry, 16th edition, Dhanpat Rai Publishing company (p) Ltd. New Delhi
2. Jagadamba Singh and Jaya Singh, “Photochemistry and Pericyclic Reactions”, New Age International Publishers, New Delhi, 3rd Revised Edition, Reprint, 2011
3. Finar. I. L, “Organic Chemistry”, Volume 2, Doorling Kindersley (Indian), 6th Edition, 2008.
4. Ashutosh Kar, “Medicinal Chemistry” New Age International Publishers, 5th Revised and Expanded edition, 2010.

Reference Books

1. Graham L. Patrick, “An introduction to Medicinal Chemistry”, Oxford university Press, 1995.
2. Richard B. Silverman, “The Organic Chemistry of Drug Design and Drug Action”, 2nd Edition, Academic Press, Reprinted, 2010.
3. Rama Rao Nandella, “Principles of Organic Medicinal Chemistry” New AgeInternational Publishers, New Delhi, Reprint, 2008.
4. Gareth Thomas “Fundamentals of Medicinal Chemistry”, London, Reprint, 2003.

- Coxon. J.M, and Halton. B, “Organic Photochemistry”, Cambridge University Press, London, 1st Paper back edition, 2011.
- Organic Chemistry (5th Edn.) Robert. T. Morrison & N. Boyd. Hill edition.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1		1	1		3		1
CO2	3	1		1	1		3		1
CO3	3	1		1	1		3		1
CO4	3	1		1	1		3		1
CO5	3	1		1	1		3		1
CO6	3	1		1	1		3		1

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

21CH2034	Organic Chemistry Lab- V	L	T	P	C
		0	0	3	2

Course Objectives

Enable the student to

- develop various skills for preparing industrially important organic compounds.
- know the various organic preparative techniques available.
- apply various reaction conditions for different types of organic reactions.

Course Outcomes

Students will be able to

- prepare industrially relevant organic compounds in the lab.
- analyze the purity of the prepared compound.
- setup the apparatus for various preparative techniques.
- understand the mechanism of the various preparative synthetic steps.
- recognize the importance of maintaining the reaction conditions
- employ various types of organic reaction

LIST OF EXPERIMENTS

- Preparation of organic dye - 1
- Preparation of organic dye - 1
- Analysis of food additive - 1
- Analysis of food additive - 2
- Preparation of Polymer -1
- Preparation of Polymer -2
- Preparation of active pharmaceutical ingredient - 1
- Preparation of active pharmaceutical ingredient -2
- Molecular rearrangement reaction -1
- Molecular rearrangement reaction -2
- Analysis of Polymer -1
- Analysis of Polymer -2

Text Books:

- A.I. Vogel – “Text book of practical organic chemistry”, 5th Ed. ELBS, London, 1989
- B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
- Daniel R. Palleros, “Experimental Organic Chemistry” John Wiley & Sons, Inc., New York, 2000
- B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, “Text book of Practical Organic Chemistry”, LBS, Singapore, 1994
- S.M. Khopar, “Basic concepts of Analytical Chemistry”, John Wiley & Sons, 1984
- Gnanapragasam N.S., Ramamurthy G, “Organic Chemistry Lab Manual”, revised edition, S. Viswanathan printers and publishers Pvt. Ltd., Chennai, Reprinted 2011

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	3		1	1		1	3	1
CO2	1	3		1	1		1	3	1

CO3	1	3		1	1		1	3	1
CO4	1	3		1	1		1	3	1
CO5	1	3		1	1		1	3	1
CO6	1	3		1	1		1	3	1

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

21CH2035	Analytical Chemistry – III	L	T	P	C
		4	0	0	4

Course Objectives:

Enable the student to

1. Learn the analysis method of air, soil and water
2. Learn the principle of mass spectroscopic techniques
3. Know the analysis methods related to food, cosmetics and drugs

Course Outcomes:

The student will be able to

1. Understand the principle and analytical methods of air, soil and water
2. Understand the principle and application of mass spectroscopy
3. Understand the analytical method for food analysis
4. Understand the analytical method for cosmetic analysis
5. Understand the analytical method for drug analysis
6. Understand the principle and application of various thermal methods

Unit I: Analysis of Air, Soil and Water(14 Hours)

Composition of atmospheric air, sampling of air, Determination of particulate matter, sulphur dioxide, nitrogen dioxide and carbon dioxide. Composition of soil, Organic and Inorganic constituents, analysis of soil, soil acidity, soil salinity and soil alkalinity, determination of soil pH, complexometric titrations, chelation, chelating agents, use of indicators, estimation of calcium and magnesium ions by complexometric titration. Water analysis, sources of water, hardness of water, temporary hardness, permanent hardness, units of hardness, estimation of hardness – EDTA method, water softening methods, lime – soda process, zeolite process, ion-exchange process, removal of microorganism, reverse osmosis, determination of dissolved oxygen, Chemical Oxygen Demand and Bio chemical Oxygen Demand

Unit II: Mass Spectroscopy (12 hours)

Introduction and principle, Sample Preparations, Ionization, Types of ionizations, Ionization sources, EI, ESI, Quadruples, Mass Analyzers, Mass-charge Ratio, APCI, MALDI, TOF, Tandem Mass, MS-MS, Mass Detector, Fragmentation Patterns.

Unit III: Food Analysis (12 hours)

Nutritional value of foods, food additives, artificial sweeteners, saccharin, cyclamate, aspartame, food flavours, esters, aldehydes and heterocyclic compounds, antioxidants, food colours, emulsifying agents, preservatives, taste enhancers, adulteration, Identification of adulterants, the analysis of detection and prevention of food adulteration, Analysis of preservatives and colouring matter.

Unit IV: Analysis of Cosmetics and Drugs

Definitions of Cosmetics, Major and minor constituents and their function, analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate, analysis of constituents of talcum powder, magnesium oxide, calcium oxide, zinc oxide and calcium carbonate by complexometric titration, definitions of drug, classification of drugs, FDA, analysis of some commonly used drugs, chemical and instrumental methods of drug analysis.

Unit V: Thermal Analysis (10 Hours)

Thermal Characterization techniques, Principle and applications of Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) Thermometric titration, Theory, Instrumentation, Factors affecting TG, DTA and DSC Curves – Applications.

Text Books:

1. Vogel's textbook of quantities chemical analysis', G. H. Affery J. Bassett, J .Mendham, R. C. Denney, 5th edition, John Wiley and Sons Inc.
2. Modern Methods of Chemical Analysis', R.L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, 2nd edition, John Wiley, New York
3. Chatwal G. R & Anand S. K, "Instrumental Methods of Chemical Analysis" Himalaya Publishing House, Mumbai, India, 5th Edition, Reprint 2011.

4. Kalsi P. S, "Spectroscopy of Organic Compounds", New Age International Publishers, New Delhi, 6th Edition, 2004.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3		3			3		
CO2	3	3		3			3		
CO3	3	2		2			2		
CO4	2	2	2					2	
CO5	2	2		3			3		
CO6	2	2							2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2036	Analytical Chemistry Lab– III	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. Learn the analytical method for water analysis
2. Learn the application of mass spectroscopic techniques
3. Know the analysis methods related to soil, cosmetics and drugs

Course Outcomes:

The student will be able to

1. Understand the principle and analytical methods of water
2. To learn the importance of pH determination
3. Understand the analytical method for food analysis
4. Understand the analytical method for cosmetic analysis
5. Understand the analytical method for drug analysis
6. Understand the analytical method for air analysis

LIST OF EXPERIMENTS

1. Estimation of Hardness of water
2. Estimation of Dissolved oxygen in watersample
3. Estimation of alkalinity in water sample
4. Determination of chemical oxygen demand (COD).
5. Determination of Biological oxygen demand (BOD).
6. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
7. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.
8. Analysis of soil - Determination of pH of soil.
9. Analysis of soil -Total soluble salt
10. Analysis of soil - Estimation of calcium, magnesium, phosphate, nitrate
11. Introduction to Air Sampling: Particulates in Urban Air
12. Determination of the Concentration of Carbon Dioxide in the Atmosphere
13. Analysis of Cosmetics
14. Estimation of free alkali present in different soaps/detergents
15. Analysis of Drugs
16. Mass Spectroscopy – 1
17. Mass Spectroscopy - 2

Text Books:

1. Vogel's textbook of quantities chemical analysis', G. H. Affery J. Bassett, J .Mendham, R. C. Denney, 5th edition, John Wiley and Sons Inc.
2. Modern Methods of Chemical Analysis', R.L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, 2nd edition, John Wiley, New York
3. Chatwal G. R & Anand S. K, "Instrumental Methods of Chemical Analysis" Himalaya Publishing House, Mumbai, India, 5th Edition, Reprint 2011.
4. Kalsi P. S, "Spectroscopy of Organic Compounds", New Age International Publishers, New Delhi, 6th Edition, 2004.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3

CO1	3	1					3		
CO2	3		2				3		
CO3	3			3			2		
CO4	2	1						2	
CO5	2				2		3		
CO6	2								2

21CH2037	Environmental Studies	L	T	P	C
		2	0	0	2

Course Objectives:

Enable the student to

1. acquire the knowledge of environmental studies, it's need & importance
2. know about pollution problem and green technology
3. create awareness about the major environmental issues for a sustainable development.

Course Outcome:

The student will be able to

1. Understand the natural environment and its relationships with human activities.
2. Characterize and analyze human impacts on the environment.
3. Acquire practical skills for solving pollution related problems
4. Design and evaluate strategies, Green technologies, and methods for sustainable development and for the remediation or restoration of degraded environments.
5. Integrate facts, concepts, and methods from multiple disciplines and apply to environmental and social problems.
6. Analyze the connectivity between the man made activities-Pollution-environmental issues-social problems-eco friendly solutions

Unit I: ENVIRONMENT AND NATURAL RESOURCES (8 Hours)

Environment - Definition, scope and importance , Renewable and Non-Renewable Resources – Natural resources– Forest resources: Use and over-exploitation, deforestation– Water resources: Use and over-utilization of surface and ground water, dams-benefits and problems – Energy resources: Growing energy needs, renewable and non-renewable energy sources, and use of alternate energy sources.– Land resources: Land as a resource, land degradation, soil erosion and desertification – Role of an individual in conservation of natural resources

Unit II: ECOSYSTEMS AND BIODIVERSITY (5 Hours)

Structure and function of an ecosystem — Energy flow in the ecosystem – Ecological succession – Food chains, food webs - Biodiversity –genetic, species and ecosystem diversity – Value of biodiversity– Threats to biodiversity– Endangered and endemic species of India –In-situ and Ex-situ conservation of biodiversity

Unit III: ENVIRONMENTAL POLLUTION (6 Hours)

Air pollution – Water pollution – Soil pollution – Noise pollution – Thermal pollution – Causes, effects and control measures– Nuclear hazards – Solid waste management – Role of an individual in prevention of pollution.

UNIT IV: SOCIAL ISSUES AND ENVIRONMENTAL LEGISLATION (6 hours)

From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting and watershed management –Environmental ethics: – Climate change, global warming, acid rain, ozone layer depletion,– Environment Production Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness

UNIT V: HUMAN POPULATION AND THE ENVIRONMENT (5 hours)

Population growth, Population explosion—Family Welfare Programme –Human rights – HIV/AIDS – Disaster management: Foods, earthquake, cyclone and landslides

Reference Books:

1. Deeksha Dave, "Environmental Studies", Cengage Learning India Pvt Ltd, New Delhi – 2011
2. Raman Shivakumar , "Introduction Environmental science and Engineering" ,Tata Mc Graw Hill, 2010.
3. BharuchaErach, "Text book on environmental studies" For Undergraduate Courses of all Branches of Higher Education, University Grants Commission, New Delhi, 2004.
4. Abnubha Kaushik, KaushikC.P., "Perspectives in Environmental Studies" New Age International Publishers, Third Edition, 2009.

5. Sharma B.K. "Environmental Chemistry" Comprehensive covering the UGC Syllabus, 11th Edition, Goel Publishing House, Meerut, Eleventh Edition, 2007.

21CH2038	Principles of General Chemistry	L	T	P	C
		4	0	0	4

Course Objectives:

Enable the student to

1. Learn the fundamental concepts in Chemistry
2. Understand the various types of chemical bonding
3. Know the importance of organic chemistry

Course Outcomes:

The student will be able to

1. Understand the basic concepts in Chemistry
2. Learn the trends in periodic properties
3. Summarize the various types of bonds
4. Know the importance of nuclear chemistry
5. Understand the basics of electrochemistry
6. Summarize the importance of Organic chemistry

Unit 1: Fundamental Concepts in Chemistry (14 Hours)

Atomic mass - Molecular mass - Mole concept - Molar volume - Oxidation and reduction - Oxidation number and valency - Equivalent mass. Methods of expressing concentration: Concept of Equilibrium: Acids and Bases - Arrhenius, Lowry-Bronsted and Lewis theories. Ionic product of water - pH and pOH, Strengths of acids and bases - Electrode potential - Electrochemical series - Buffer solution. Preparation of buffer solution having a known pH. Solvation, solubility, solubility product. The long form of periodic table. s, p, d, f block elements, - Effective nuclear charge, shielding or screening effect, variation of effective nuclear charge in periodic table - Atomic radii - Covalent radii - Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. - Electron gain enthalpy - Electronegativity - electronegativity scales. Variation of electronegativity - group electronegativity.

Unit III: Chemical bonding: (12 Hours) Ionic bond - Examples - Covalent bond: Lewis structure, Valence Bond theory, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules - Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons - Coordinate Bond - Metallic Bond - Semiconductors and insulators, defects in solids. - Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Hydrogen bonding

Unit III: Nuclear Chemistry and Radioactivity (10 Hours)

Nucleus - composition - Binding energy - Stability - Isotopes, Isobars and isotones - Radiation - characteristics of α , β and γ radiation - Nuclear reactions - Nuclear fission - Nuclear Fusion Applications of radioisotopes - Radioactive tracers

Unit IV: Electrochemistry: (10 Hours)

Redox reactions, electrode potential, Nernst Equation, Electrochemical series and significance, Electrochemical cell - EMF of an electrochemical cell - Potentiometric titration - Batteries - types - Dry batteries - Lead acid batteries - Hydrogen - fuel cells - hydrocarbons - polymer electrolyte fuel cells - Solar battery - photovoltaics - transducers - Electrochemical sensors - actuators

Unit V: Fundamentals of Organic Chemistry (14 Hours)

Classification, Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Homolytic and Heterolytic fission with suitable examples. Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes with their mechanism. Fischer Projection, Newmann and Sawhorse Projection formulae Geometrical isomerism, Optical Isomerism; Chirality/Asymmetry, Enantiomers; Distereoisomers, Meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

Text Books:

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991. • Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970 • Atkins, P.W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.

- Atkins, P.W & Paula, J.D. Physical Chemistry, 10th Ed., Oxford University Press (2014).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
- McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

21CH2039	Principles of General Chemistry Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

- learn the principle of volumetric titration and estimate the given unknown solution
- understand the principles of chemical analysis
- practice precise and accurate analysis

Course Outcomes:

The student will be able to

- prepare standard solutions of known concentration
- estimate different species in the unknown solution
- identify qualitatively the inorganic salt
- prepare inorganic metal complexes
- estimate the given acid by instrumentation methods
- enhance the analytical skill

LIST OF EXPERIMENTS

- Preparing standard solution
 - To determine the strength of oxalic acid solution by permanganometry.
 - Titration of strong acid vs strong base
 - Titration of strong base vs weak acid
 - Estimation of Fe^{3+} by spectrophotometer
 - To determine the strength of acid by pH meter - 1
 - To determine the strength of acid by pH meter - 2
 - To determine the strength of acid by conductometry - 1
 - To determine the strength of acid by conductometry - 2
 - Redox titration using Potentiometer
 - Finding melting point of an organic compound-1
 - Finding melting point of an organic compound - 2
- (Minimum 10 experiments to be conducted)

Text books:

- Svehla G., "Vogel's Textbook of Qualitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression 2008.
- J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas "Vogel's Quantitative Chemical Analysis", 6th edition, 7th Impression, Dorling Kindersley limited, New Delhi, India, 2008

21CH2040	Basic Inorganic and Physical Chemistry	L	T	P	C
		4	0	0	4

Course Objectives:

Enable the student to

- learn the fundamental concepts in chemistry and periodic properties
- understand the various types of chemical bonding
- know the importance of chemical equilibrium and electrochemistry

Course Outcomes:

The student will be able to

- understand the basic concepts in chemistry
- learn the trends in periodic properties
- summarize the various types of bonds
- know the importance of chemical equilibrium
- understand the basics of electrochemistry

6. summarize the applications of batteries

Unit I: Fundamental Concepts in Chemistry (12 Hours)

Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Oxidation number and valency - Equivalent mass. Methods of expressing concentration: Concept of Equilibrium: Acids and Bases - Arrhenius, Lowry-Bronsted and Lewis theories. Ionic product of water - pH and pOH, Strengths of acids and bases - Electrode potential – Electrochemical series - Buffer solution. Preparation of buffer solution having a known pH. Solvation, solubility, solubility product

Unit II: Periodicity(10 Hours)

The long form of periodic table. s, p, d, f block elements, - Effective nuclear charge, shielding or screening effect, variation of effective nuclear charge in periodic table - Atomic radii - Covalent radii - Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. - Electron gain enthalpy – Electronegativity -electronegativity scales. Variation of electronegativity - group electronegativity

Unit III: Chemical bonding (14 Hours)

Ionic bond; Covalent bond: Lewis structure, Valence Bond theory, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N₂, O₂, C₂, CO, NO, and their ions; HCl, BeF₂, CO₂, (idea of s-p mixing and orbital interaction to be given). Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons. Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids. Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment).

Unit IV: Chemical equilibrium:(12 Hours)

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p, K_c and K_x. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

Unit V: Electrochemistry: (12 Hours)

Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials. Redox reactions, electrode potential, Nernst Equation, Electrochemical series and significance, Electrochemical cell – EMF of an electrochemical cell – Potentiometric titration - Batteries – types - Dry batteries – Lead acid batteries- Hydrogen – fuel cells – hydrocarbons – polymer electrolyte fuel cells - Solar battery – photovoltaics - transducers -Electrochemical sensors

Text Books:

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970
3. Atkins, P.W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.

21CH2041	Basic Inorganic and Physical Chemistry Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn the principle of volumetric analysis
2. understand the principles of acid base and redox titrations
3. practice precise and accurate analysis of unknown compounds using volumetric principles

Course Outcomes:

The student will be able to

1. understand the basic concepts of molarity, molality and normality
2. learn principles of volumetric analysis
3. identify the types of volumetric analysis
4. prepare the solutions of different molarity and normality
5. estimate the given unknown compounds by acid base and redox titrations
6. enhance the analytical skills of titrimetric analysis

LIST OF EXPERIMENTS

1. Preparing standard solution

- To determine the strength of oxalic acid solution by permanganometry.
- Titration of acid vs base – 1
- Titration of acid vs base – 2
- To determine the strength of acid by pH meter - 1
- To determine the strength of acid by pH meter -2
- To determine the strength of acid by conductometry - 1
- To determine the strength of acid by conductometry - 2
- Redox titration using Potentiometer
- Determination of the surface tension
- Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
- Study the variation of viscosity of sucrose solution with the concentration of solute.
- Indexing of a given powder diffraction pattern of a cubic crystalline system.

(Minimum 10 experiments to be conducted)

Text books:

- Khosla, B. D., Garg, V. C. & Gulati, A. "Senior Practical Physical Chemistry" R. Chand & Co. New Delhi, 2011
- Garland, C. W., Nibler, J. W. & Shoemaker, D. P. "Experiments in Physical Chemistry" 8th Ed., McGraw-Hill: New York, 2003
- Halpern, A. M., & McBane, G. C. "Experimental Physical Chemistry" 3rd Ed., W. H. Freeman & Co. New York, 2003.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1									
CO2									
CO3									
CO4									
CO5									
CO6									

'3'-High, '2'- Medium, '1'-Low, '- ' No correlation

21CH2042	Fundamentals of Organic Chemistry	L	T	P	C
		4	0	0	4

Course Objectives:

Enable the student to

- know the importance of organic chemistry
- understand the chemistry of functional groups-
- know the importance of stereoisomerism and conformational analysis

Course Outcomes:

The student will be able to

- Summarize the importance of Organic chemistry
- Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Explain the reactivity of saturated aliphatic compounds and their conformation
- Describe the reactivity and applications of unsaturated compounds through various reactions
- Correlate and describe the stereochemical properties of organic compounds and reactions
- Correlate the basic principles to explain the reactivity of functional groups

Unit I: Fundamentals of Organic Chemistry: Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Unit II: Aliphatic Hydrocarbons :A. Carbon-Carbon sigma bonds Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity. B. Carbon-Carbon pi bonds: Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb

reactions. Saytzeff and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2- and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. 14 Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

Unit III: Aromatic Hydrocarbons: Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams. (24 Lectures) Aromatic Hydrocarbons Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

Unit IV: Functional Groups Organic Chemistry : Preparation, Properties and reactivity of Alkyl halides, Aryl halides. Preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Phenols- ring substitution reactions - Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and LiAlH₄ – Carbonyl : Structure, preparation and reactivity, unsaturated carbonyl reactivity - Active methylene compounds: Keto-enol tautomerism. Carboxylic Acids and their Derivatives: Preparation, properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids. Esters and amides; Comparative study of nucleophilic substitution at acyl group.

Unit V: Stereochemistry : Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis-trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

Reference Books:

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
4. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

21CH2043	Fundamentals of Organic Chemistry Laboratory	L	T	P	C
		0	0	3	2

Course Objectives

Enable the student to

1. identify the functional group of the organic molecule
2. understand the principle of systematic organic qualitative analysis
3. know different methods to quantify organic compounds

Course Outcomes

Students will be able to

1. Enhance the knowledge of systematic analysis of an organic compound
2. Recognize the importance of analysing a organic compound
3. Employ various organic reaction types
4. perform the systematic quantitative analysis of an organic compound
5. Estimate the quantity of unknown compound in the given solution
6. Understand the principles in the estimation

LIST OF EXPERIMENTS

The experiments involve the identification of the functional groups present in the organic molecule and confirmation by derivatization of the given compound. The experiments focus on the various method of estimating the organic molecules including titration. The quantitative estimation of common organic molecules will be given

1. Qualitative Organic analysis -1
2. Qualitative Organic analysis -2
3. Qualitative Organic analysis -3
4. Qualitative Organic analysis -4
5. Qualitative Organic analysis -5
6. Qualitative Organic analysis -6

7. Quantitative Organic analysis -1
8. Quantitative Organic analysis -2
9. Quantitative Organic analysis -3
10. Quantitative Organic analysis -4
11. Quantitative Organic analysis -5
12. Quantitative Organic analysis -6

(Any 10 Experiments)

Text Books:

1. A.I. Vogel – “Text book of practical organic chemistry”, 5th Ed. ELBS, London, 1989
2. B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
3. Daniel R. Palleros, “Experimental Organic Chemistry” John Wiley & Sons, Inc., New York, 2000
4. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, “Text book of Practical Organic Chemistry”, LBS, Singapore, 1994
5. S.M. Khopar, “Basic concepts of Analytical Chemistry”, John Wiley & Sons, 1984
6. Gnanapragasam N.S., Ramamurthy G, “Organic Chemistry Lab Manual”, revised edition, S. Viswanathan printers and publishers Pvt. Ltd., Chennai, Reprinted 2011

21CH2044	Inorganic Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn the basics of inorganic chemistry
2. know the importance of chemical bonding
3. understand the applications of transition metal compounds

Course outcomes:

The student will be enable to

1. learn the atomic structure of the elements
2. learn the periodic properties of the elements
3. describe the various types of chemical bonding
4. know the importance of weak interactions
5. understand the concepts of solid state
6. describe the properties of transition metal complexes

Unit I: Atomic Structure and Periodic Properties : (12 Hours)

Bohr's theory- its limitations - atomic spectrum of hydrogen atom -Wave mechanics- de Broglie equation - Heisenberg's Uncertainty Principle and its significance - Schrödinger's wave equation - significance of ψ and ψ^2 - Quantum numbers and their significance- Radial and angular wave functions for hydrogen atom- Shapes of s, p, d and f orbitals- probability diagrams- Pauli's Exclusion Principle- Hund's rule of maximum multiplicity- Aufbau's principle- Variation of orbital energy with atomic number. - Modern periodic table - s, p, d and f block elements- Periodic properties of the elements- Effective nuclear charge- shielding effect- Slater rules- Atomic radii Ionic radii - crystal radii- Covalent radii- Ionization energy- factors affecting ionization energy- Electron affinity- Electronegativity- electronegativity scales- Variation of electronegativity–Diagonal Relationship - Oxidation and reduction

Unit II: Acid and Bases: (7 Hours)

Arrhenius concept - Bronsted–Lowry concept- conjugate acids and bases- relative strengths of acids and bases-effects of substituent and solvent- differentiating and levelling solvents. Lewis acid-base concept - classification of Lewis acids and bases - Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept) - applications of HSAB process.

.Unit III: Chemical bonding (10 Hours)

Ionic bond; Covalent bond: Lewis structure, Valence Bond theory, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons. Coordinate Covalent bond - Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-

induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment).

Unit IV: Solid state (8 Hours)

Nature of the solid state- law of constancy of interfacial angles- law of rational indices - Miller

Indices - elementary ideas of symmetry - symmetry elements and symmetry operations - qualitative idea of point and space groups - seven crystal systems and fourteen Bravais lattices - X-ray diffraction - Bragg's law - a simple account of rotating crystal method and powder pattern method- Analysis of powder diffraction patterns of NaCl CsCl and KCl- Defects in crystals-

Unit V Transition Metals and their compounds

Introduction – Metallic Character – Variable oxidation state – stability of the oxidation states - Complexes – Size of atoms and ions – Density – Melting and boiling points – Reactivity of metals – ionization energies – Colour – Polarization – Incompletely filled d or f shell – Magnetic properties – Measurement of magnetic moments –Hydrides, oxides, mixed oxides, hydroxide, sulphates and halides of - Vanadium, Titanium-- Molybdenum- Tungsten- Manganese- Iron- - Cobalt

Text books:

1. Lee J. D. "Concise Inorganic Chemistry" Wiley India Pvt. Ltd, New Delhi, India, 5th edition, Reprint 2009
2. Singh, D. N. 'Basic Concepts of Inorganic Chemistry" 2nd Edition, Dorling Kindersley (India) Pvt Ltd., 2019
3. Atkins, P. Shriver & Atkins. "Inorganic Chemistry" 5th Edition, Oxford University Press, 2010

21CH2045	Qualitative Analysis and Inorganic Preparation Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. Learn the principles of inorganic qualitative analysis
2. Practice precise and accurate qualitative analysis of mixtures containing anions and cations
3. Prepare inorganic metal complexes

Course Outcomes:

The student will be able to

1. Understand the basic concepts of inorganic qualitative analysis
2. Learn the principles of inorganic qualitative analysis
3. Identify the basics of semi micro analysis
4. Prepare the reagents needed for semi micro analysis
5. Identify the cations and anions in the given mixture
6. Enhance the analytical skills of semi micro analysis

LIST OF EXPERIMENTS

Qualitative semimicro analysis of mixtures containing 1anions and 1common cations (or) 2 common cations. Emphasis should be given to the understanding of the chemistry of different reactions.

1. Semimicro qualitative analysis – 1
2. Semimicro qualitative analysis – 2
3. Semimicro qualitative analysis – 3
4. Semimicro qualitative analysis – 4
5. Semimicro qualitative analysis – 5
6. Semimicro qualitative analysis – 6
7. Preparation of Inorganic Complex – 1
8. Preparation of Inorganic Complex – 2
9. Preparation of Inorganic Complex – 3
10. Preparation of Inorganic Complex - 4
11. Preparation of Inorganic Complex – 5
12. Preparation of Inorganic Complex – 6

Reference Books:

1. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall.

21CH2046	Principles of Organic Chemistry	L	T	P	C
		3	0	0	3

Course Objectives

Enable the student to

1. Understand the basic concepts and their applications
2. establish the chemistry of functional groups- alkanes, alkenes, alkynes
3. highlight the importance of stereoisomerism and conformational analysis

Course Outcomes

Student will be able to:

1. Understand and explain the differential behaviour of organic compounds based on fundamental concepts learnt.
2. Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
3. Explain the reactivity of saturated aliphatic compounds and their conformation
4. Describe the reactivity and applications of unsaturated compounds through various reactions
5. Correlate and describe the stereochemical properties of organic compounds and reactions
6. Correlate the basic principles to explain the reactivity of functional groups

Unit I: Basics Principles of Organic Chemistry (8 Hours)

Classification - Nomenclature - Influence of hybridization on bond properties - Electronic Displacements and their applications - Inductive, Electromeric, Resonance and Mesomeric effects and Hyperconjugation - Dipole moment - Acidity, Basicity and pKa values - Ortho effect - Conjugate acids and bases

Unit II: Reactive Intermediates (9 Hours)

Electrophiles and Nucleophiles - Homolytic and heterolytic fissions with examples - Intermediates - Carbocations, Carbanions, Free radicals and Carbenes and their stability - Nitrenes - Introduction to types of organic reactions and their mechanism, Addition, Elimination and Substitution reactions.

Unit III: Stereochemistry (10 Hours)

Stereochemistry - Stereoisomerism: Optical Activity and Optical Isomerism, Asymmetry, Chirality, Enantiomers, Diastereomers. Specific rotation; Configuration and Projection Formulae: Newmann, Sawhorse, Fischer and their interconversion. Relative and absolute configuration: Erythro-threo -D/L and R/S designations. Geometrical isomerism: cis-trans, syn-anti and E/Z notations with CIP rules Chirality in molecules with one and two stereocentres - meso structures- Stereochemistry of Allenes and biphenyls - Atropisomerism - Racemic mixture and their resolution.

Unit IV: Chemistry of aliphatic compounds (10 Hours)

Alkanes- preparation, properties and uses -chemical properties, Free radical Halogenation,. Conformational analysis of alkanes -Alkenes - General methods of preparation, -Elimination -. Saytzeff and Hofmann eliminations - Electrophilic Additions-Markownikoff and Anti Markownikoff addition - hydroboration oxidation - ozonolysis, hydroxylation, Diels Alder reaction- Alkyl halides: Methods of preparation, nucleophilic substitution reactions - S_N1 , S_N2 and S_Ni mechanisms

Unit IV: Aromaticity (8 Hours)

Aromaticity - Huckel's rule - aromatic, non-aromatic and anti-aromatic compounds - heterocycles - annulenes - cyclic carbocations/carbanions - Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism - Directing effects of the groups.-Aromatic nucleophilic substitution - Polynuclear Hydrocarbons -Reactions of naphthalene phenanthrene and anthracene

Text Books

1. R.T. Morrison & R.N. Boyd, Organic Chemistry, 6th Edition, Pearson Education Pvt Ltd., Singapore, 2003
2. Arun Bahl and B.S. Bahl Advanced organic Chemistry, S. Chand & company Ltd. New Delhi, 2010

Reference Books

1. P.S. Kalsi, Stereo Chemistry Conformation and Mechanism, New Age Publishing Ltd., New Delhi, 2002
2. I.L. Finar, Organic Chemistry, Pearson Education Pvt. Ltd., Vol. I & II, 5th Edition, Singapore, 1975
3. J. March. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 4th edn., Wiley Student Edition, John Wiley & Sons Asia Pvt. Ltd., 2005

21CH2047	Organic Preparation Laboratory	L	T	P	C
		0	0	3	2

Course Objectives

Enable the student to

1. Develop various skills for preparing organic compounds.
2. Know the various organic preparative techniques available.
3. Impart awareness about reaction conditions for various types of organic reactions.

Course Outcomes

Students will be able to

1. Design and prepare organic compounds in one step in the lab.
2. Purify the prepared organic compound and check the purity of prepared compound.
3. Setup the apparatus for various preparative techniques.
4. Understand the mechanism of the various preparative synthetic steps.
5. Recognize the importance of distillation, refluxing and recrystallization techniques.
6. Characterize the prepared organic compounds with various techniques

LIST OF EXPERIMENTS

The experiments involves the preparation of several organic molecules The reactions used for the preparation will be aromatic electrophilic substitution, esterification, hydrolysis, oxidation, reduction, etc.

1. Preparation of organic compound - 1
2. Preparation of organic compound - 2
3. Preparation of organic compound - 3
4. Preparation of organic compound - 4
5. Preparation of organic compound - 5
6. Preparation of organic compound -6
7. Preparation of organic compound - 7
8. Preparation of organic compound - 8
9. Preparation of organic compound - 9
10. Preparation of organic compound - 10
11. Preparation of organic compound - 11
12. Preparation of organic compound – 12

(Any 10 Experiments)

Reference Books

1. A.I. Vogel – “Text book of practical organic chemistry”, 5th Ed. ELBS, London, 1989
2. B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
3. Daniel R. Palleros, “Experimental Organic Chemistry” John Wiley & Sons, Inc., New York, 2000
4. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, “Text book of Practical Organic Chemistry”, LBS, Singapore, 1994
5. S.M. Khopar, “Basic concepts of Analytical Chemistry

21CH2048	Physical Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. know the principles of state of matters
2. understand the basics of surface chemistry and colloids
3. learn the principles of electrochemistry and Corrosion

Course Outcomes:

The student will be able to

1. Understand the concepts of state of matter
2. Know the importance of liquid crystals
3. Understand the concepts of adsorption
4. recognize the importance of colloidal state
5. know about the basics of electrochemistry and electrochemical cells
6. understand the methods to prevent corrosion

Unit I: States of Matter - (12 Hours)

Solid State – Nature of the solid state- Miller indices- -seven crystal systems and fourteen Bravais lattices- X-ray diffraction, Bragg’s law – Structures of NaCl and CsCl -Defects in crystals – Liquid State - Physical properties of liquids - vapour pressure-surface tension and coefficient of viscosity-and their determination- Explanation of cleansing action of detergents-Gaseous state - postulates and derivation of the kinetic gas equation- collision frequency-collision diameter-mean free path and viscosity of gases, - heat capacities- Behaviour of real gases: Deviations from ideal gas

behaviour -Causes of deviation from ideal behaviour- Vander Waals equation of state -critical state-relation between critical constants- Comparison of properties of solids, liquids and gases.

Unit II: Liquid Crystals (6 Hours)

Classification of liquid crystal – classification with examples -smectic and nematic –Structure of Liquid Crystals – Chemical properties – Applications

Unit III: Surface Chemistry and Colloids (9 Hours)

Adsorption – Types – Adsorption of gases on solids – Applications - Langmuir and van der Waal's adsorption isotherm – Colloids – Types – preparation and properties – Stability of colloids - Surfactants – Micelles – Colloids and Forensic science – Application of Electrophoresis

Unit IV: Electrochemistry: (10 Hours)

Conductivity of electrolytes – Kohlrausch's law – Ostwald's dilution law – Conductometric titration – Redox Reactions – Electrode potential – Nernst Equation - Electrochemical series and significance, Electrochemical cell – EMF of an electrochemical cell – Potentiometric titration - Batteries – types - Dry batteries – Lead acid batteries- Hydrogen – fuel cells – hydrocarbons- Solar battery – photovoltaics - transducers -Electrochemical sensors

Unit V: Corrosion and Types (8 Hours)

Definition – Types - Consequences of corrosion - Dry Corrosion – types – mechanism – Wet corrosion – Mechanism - Galvanic series Factors influencing corrosion - Nature of metal –Nature of the environment - Corrosion control methods

References:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford University, Press (2014).
2. B.R. Puri, L.R. Sharma and Madan S. Pathania, "Principles of Physical Chemistry", Vishal Publishing Co., Jalandhar, 2008.
3. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
4. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
5. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
6. Engel, T. & Reid, P. Physical Chemistry 3rd Ed. Pearson (2013).
7. Jain and Jain Engineering chemistry, 16th edition, Dhanpat Rai Publishing company (p) Ltd. New Delhi

21CH2049	Supramolecular Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Learn the structural and functional basics of building blocks of supramolecular structures
2. Know driving forces of supramolecular structure formation
3. Classify the supramolecules based on structure and the chemistry behind host-guest assembly.

Course Outcomes:

Students will be able to

1. understand the selectivity in supramolecule formation
2. identify the various factors affecting the formation of supramolecules
3. understand the concepts of solution host-guest chemistry
4. design the various types of supramolecular architectures
5. recognize the importance of coordination polymers
6. apply the supramolecules in various fields

Unit I: Introduction To Supramolecular Chemistry(9 Hours)

Introduction to supramolecular chemistry – Selectivity – Lock and key principle and induced fit model – complementarity – Co-operativity and chelate effect – Pre-organization – Binding constants – Kinetic and thermodynamic selectivity – Supramolecular Interactions.

Unit II: Solution Host–Guest Chemistry(9 Hours)

Introduction: guests in solution – Macrocyclic vs. acyclic hosts – High-dilution synthesis – Template synthesis – Cation binding – Crown ethers - Heterocrowns and cryptands – Anion binding – Charged receptors – Neutral receptors – Lewis acid receptors – Neutral molecule binding – Calixarenes, cyclodextrins.

Unit III: Supramolecular Structures(9 Hours)

Ladders, polygons, and helices – Self-assembly using metal templates – Racks, ladders, and grids – Helicates – Molecular polygons – Rotaxanes and catenanes – applications – Borromean rings – Knots (structure and function of the above species).

Unit IV: Solid State Supramolecular Chemistry(9 Hours)

Introduction – Zeolites: structure – Zeolite composition – Zeolites and catalysis – Clathrates – Urea/thiourea clathrates – Clathrate hydrates (structure and function of the above species) –Uses.

Unit V: Self-Assembling Capsules (9 Hours)

Self-assembling capsules – Molecular containers – Metal directed capsules – Hydrogen bonded capsules – Concepts in crystal engineering – The Cambridge structural database - Metal-organic frameworks – applications.

Reference Books:

- Jonathan Steed, David Turner, Carl Wallace, Core concepts in Supramolecular Chemistry and nanochemistry, John Wiley & sons, 2007.
- Jean-Marie Lehn, Supramolecular Chemistry, RCS pubs., 2005
- Supramolecular chemistry –Fundamentals and applications advanced textbook, Katsuhiko Ariga · ToyokiKunitake, Springer-Verlag, 2000.
- Nano: The essentials, T. Pradeep, McGraw Hill Publishers, 2007.
- Nanochemistry, G.B. Sergeev, Elsevier, 2007.
- G. A. Ozin and A. C. Arsenault, “Nanochemistry: A chemical Approach to nanomaterials” RSC Publishing, 2005
- Zhong Cao G, “Nanostructures and Nanomaterials: Synthesis, Properties and Applications”, Imperial College Press, London, United Kingdom, 2004.
- Paul Engel, “Pain-free Biochemistry”, Wiley – Blackwell publishers, 2009.

21CH2050	Water Chemistry	L	T	P	C
		2	0	0	2

Course Objectives:

Enable the students to

- gain knowledge on the importance of water quality and
- acquire understanding on standards for water usage.
- have knowledge on water treatment processes

Course outcomes:

Student will be able to

- understand the roll and importance of drinking water to health
- to gain understanding on the control of water borne diseases.
- understand the need of purity of water to reduce the transmission of various diseases
- Judge the standards of water before supplying to a community.
- Apply the type of treatment required with respect to water quality.
- gain the knowledge on various treatment methods for getting drinking water

Unit I: Water and Human Body (6 Hours)

The Water in You: Water and the Human Body -vital nutrient to cell- role of water -regulating body temperature - water for mineral transportation–digestion- keep mucosal membrane moist- flushing waste- water from saliva-as lubricants in joints.

Unit II:: Water Chemistry (6 Hours)

Elements, radicals, and compounds –physical and chemical properties-Chemical water analysis Hydrogen ion concentration and pH-Alkalinity- Colloids and coagulation- Organic compounds Organic matter in wastewater-Laboratory chemical analyses.

Unit III: Determination of water quality parameters (6 Hours)

Chemistry of waste water – water pollution, pollutants in water, water quality requirement , potable water standards, wastewater effluent standards principles of determination of water quality parameters like pH, alkalinity, BOD, COD, hardness, lethal doses of pollutants – sulphides, chlorides, Ca, Mg, and analysis of minerals Fe, Mn, Ca, Mg in water

Unit IV: Water Quality and Pollution(6 Hours)

Quality of surface waters- Water quality in flowing waters -Water quality in stored waters Groundwater quality- Water quality standards- Microbiological quality of drinking water -Chemical quality of drinking water.

Unit V: Water Treatment for Drinking purpose (6 Hours)

Drinking water or Municipal water – Standard of potable water as per Indian Standard purification of water for domestic use – Removal of suspended impurities – Removal of microorganisms – Methodology in various commercial domestic Water Purifiers (

Text Books

- Engineering Chemistry by Jain and Jain, 16th Edition, Dhanpat Rai Publishing Company, New Delhi 2017.

- University Chemistry, B. M. Mahan, R. J. Meyers, 4th Edition, Pearson, 2009
- Waste Treatment and Disposal 2nd edition Paul T Williams, Wiley, 2005
- "Wastewater Treatment", Rao M.N., Datta A.K., (2008), 3rd edition, Oxford & IBH Publishing Co. New Delhi
- Viessman Jr, Hammer J. M, Perez, E.M, and Chadik, P. A, Water Supply and Pollution Control, PHI Learning, New Delhi, 2009
- Peavy, H.S., Rowe and Tchobonoglous, G., (1985), "Environmental Engineering", McGraw Hill

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	2	1	1	1
CO2	1	2		1	1	1	1	2	1
CO3	2	1	1		2	1	1	2	
CO4	2		2	1	2	2	1	2	1
CO5	1	3	1	2	1	2			
CO6	1	2		1		1	2	2	1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2051	Chemistry for Health	L	T	P	C
		2	0	0	2

Course Objectives:

Enable the students to

- understand about the chemistry connections to health.
- learn applications of chemistry concepts in day-to-day activities.
- develop a sense of responsibility towards the environment to safeguard.

Course Outcomes:

The student will be able to

- know the practical aspects of chemistry towards drugs and diseases.
- learn the chemistry concepts towards health.
- know chemistry for better health.
- gain knowledge in buying certified food products
- make right choice in choosing the right food.
- gain right perspective to guard their health

Unit I: Drugs and Diseases (6 Hours)

Clinical chemistry – antibiotics, antiseptics, antipyretics – definitions, examples (common drugs available in the market) – incurable diseases – causes for polio, diabetes, AIDS, cancer – signs and symptoms – vaccination – protein misfolding and disease – common drugs banned in India – effects of using banned drugs – effects of steroidal injections.

Unit II: Chemicals in Everyday Products (6 Hours)

Advantages and disadvantages of the following: monosodium glutamate (aginomotto) – lycopene (in tomato) – umami, the fifth taste and glutamate – caffeine and theobromine (in chocolates) – polyphenols (in tea) – docosahexanoic acid (in fish) – thiols (in onion) – polycyclic aromatic hydrocarbons (formed during cooking meat) – constituents of talcum powder and pulmonary fibrosis – ingredients of tooth paste – melatonin (in anti-ageing product) – microban (in toys) – alpha tocopherol (in body lotions) – aluminum chloride (in antiperspirants) – aspartame (in artificial sweetener) – chloral hydrate (in sedatives) – citric acid (in citrus fruits).

Unit III: Knowing Chemistry for Better Life (6 Hours)

Food adulteration – consumption of alcohol and its ill effects – PAH from oil – balanced diet – iodized salt – fluoride tooth paste – saturated and unsaturated fat - cholesterol (LDL and HDL) – ill health and fast food – organic food – crackers – ill effects of crackers – molecules of emotion (Adrenaline, Acetylcholine, Dopamine, Epinephrine, Norepinephrine, Serotonin, Melatonin, Oxytocin).

Unit IV: Chemistry of Food (6 Hours)

Food: source, functions of food – food groups – food guide – basic five food groups, usage of the food guide – food in relation to health – Objectives of cooking-Constituents of Carbohydrates, protein, lipids, minerals, vitamins – energy requirements of individuals – diet and its components – the protein requirements – biological value of proteins, supplementary value of proteins. Diseases associated with protein malnutrition. Nutritional value of carbohydrates. – Fibers in the diet, dietary sugars – nutritional aspects of lipids.

Unit V: Food preservation and processing (6 Hours)

Food deterioration, methods of preservation and processing. Quality control: Specifications and standards: PFA, FPO, FDA, drug license, WHO standards, ISI specifications, packing and label requirements, essential commodities act, consumer protection act. AGMARK, FPO. Flavouring agents – Anti oxidants – Emulsifiers- Acidulants and beverages. Soft drinks aerated water (ingredients and side effects).

Reference Books:

1. Karukstis K.K., and Hecke G.R.V., “Chemistry connections: the chemical basis of everyday phenomena” Elsevier Science and Technology books, 2nd edition, 2003.
2. Grace Ross Lewis, “1001 Chemicals in everyday products”, John Wiley and sons, 3rd edition, 2001.
3. www.listverse.com/2007/10/04/top-10-incurable-diseases/
4. www.bama.ua.edu/
5. www.foodproductdesign.com
6. www.angelfire.com/linux/chemistryofpaint/
7. www.ssrsi.org/sr1/weapon.explode.htm
8. Paul Engel, “Pain-free Biochemistry”, Wiley – Blackwell publishers, 2009.
9. Shakuntala Manay N. and ShadaksharaswamyM. FOODS: Facts and Principles. New age International Pvt. Ltd. Publishers, II ed. 2002.
10. Siva Sankar B., Food Processing and Preservation. Prentice – Hall of India Pvt. Ltd., New Delhi. 2002

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	1		2	1	1	2	1	1
CO2	2	2					2	1	
CO3	1	1	2	1	2	2	1	2	2
CO4	1		2	2	2		2	2	2
CO5			1	1	1	1	2		
CO6	2	2	1	1	2	1	2	2	1

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

21CH2052	Fundamentals of Forensic Chemistry				L	T	P	C
					2	0	0	2

Course Objectives:

Enable the students to:

1. Know about Forensic Science
2. Understand various concepts of Forensic Chemistry
3. Learn various legal aspects

Course Outcomes:

The student will be able to

1. Know about Forensic science
2. Learn about various Narcotic drugs and Psychotropic substances
3. Understand various explosive substances
4. Learn about fire and its causes
5. Learn various analytical procedures
6. Understand about Forensic analysis of beverages and food products

UNIT I- Introduction to Forensic science (6 Hours)

Definition, Scope, History and development of Forensic science - Need and Principle - Police and Forensic science laboratories / institutions in India, Organizational Structure of a Forensic Science Laboratory/Institution, Functions and responsibility of Forensic scientist -Introduction to forensic chemistry, Types of cases/exhibits received for analysis, Overview of forensic chemical analysis

UNIT II- Narcotic Drugs and Psychotropic Substances (6 Hours)

Introduction to Controlled Substances - Classification of controlled substances - Precursor chemicals, Narcotic raids and clandestine drug laboratories - NDPS Drugs, Classification of Drugs - Commonly abused drugs, Drug dependence and Drug Tolerance - Designer Drugs, Analysis of Drug of abuse by various chemical and instrumental methods

UNIT III: Explosives (6 Hours)

Introduction, classification and chemistry of explosives - Various types of IEDs and their reconstruction - Mechanism of explosion and their effects - Systematic examination of explosive and explosion residues (organic and inorganic) by chemical and instrumental techniques and interpretation of results - Explosives Act and Explosive Substance Act

UNITIV: Fire (6 Hours)

Introduction to Fires, Types of Fires, and Causes of fire, Patterns of fire - Thermodynamics of fire - Accelerants and incendiary devices, Forensic Analysis of Fire Debris by Instrumental methods - Forensic Analysis of petroleum products -Introduction to petroleum products and adulteration in petroleum products. Analysis of Petrol, Kerosene and Diesel as per BIS Specifications

UNIT V: Forensic Analysis of Beverages (6 Hours)

Introduction to Alcoholic and non-alcoholic beverages - Analysis of alcoholic beverages, country made liquor, illicit liquor and medicinal preparations - containing alcohol as constituents - Analysis of non-alcoholic beverages like tea, coffee - Adulterated Food Analysis- Analysis of samples taken under Food Adulteration Act

Reference Books:

1. Maudham Bassett et al; Voget's Textbook of Quantitative Chemical Analysis, 6th Ed. Longman, Essex
2. I. I. Finar: Organic Chemistry vol. II pearson Education (Singapore)
3. R. T. Morrison, R.N. Boyd; Organic Chemistry, 6th Ed. Prentice Hall, New Delhi
4. Brean S. Furniss Et al; A.I. Vogel Textbook Of Practical Organic Chemistry, Addison Wesley, Longman, Edinburgh
5. A. Burger; Medicinal Chemistry, Vol. II, Wiley Interscience, NY
6. D A Skoog, D.M. West, F.J. Holler; Analytical Chemistry – An Introduction, 7th Ed. Saunders, College Pub, Philadelphia, USA
7. Boudreau JE, Et al; Arson & Arson Investigation, Survey & Assessment National Institutes Of Law Enforcement, U.S. Dept Of Justice, U.S. Govt Printing Press
8. Detten J D; Kirk's Fire Investigation, 5th Ed. Prentice Hall, Eaglewood Cliffs, N. J.
9. Yinon Jitrit; Modern Methods & Application In Analysis Of Explosives, John Wiley & Sons, England
10. Working Procedure Manual – Chemistry, Explosives And Narcotics, BPR&D Pub

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1		1	1		3	2
CO2		1	2		1	1	1	2	2
CO3		2						1	2
CO4			2						2
CO5	1	2	1				1		
CO6	1							2	2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2053	Basic Supramolecular Chemistry	L	T	P	C
		2	0	0	2

Course Objectives:

Enable the student to

1. Learn the driving forces of supramolecular host guest interactions
2. Know the structural and functional basics of building blocks of supramolecular structures in solution state and solid state
3. Classify the supramolecules based on structure and the chemistry behind host-guest assembly.

Course Outcomes:

Students will be able to

1. understand the selectivity in supramolecule formation
2. identify the various factors affecting the formation of supramolecules
3. understand the concepts of solution host-guest chemistry
4. design the various types of supramolecular architectures
5. recognize the importance of coordination polymers
6. apply the supramolecules in various fields

Unit I: Introduction to Supramolecular Chemistry (6 Hours)

Introduction to supramolecular chemistry – Selectivity – Lock and key principle and induced fit model – complementarity – Co-operativity and chelate effect – Pre-organization – Supramolecular Interactions

Unit II: Solution Host–Guest Chemistry (6 Hours)

Introduction: guests in solution – Macrocyclic vs. acyclic hosts – High-dilution synthesis – Template synthesis – Cation binding – Crown ethers and cryptands – Anion binding – Charged receptors – Neutral receptors – Neutral molecule binding – Calixarenes and cyclodextrins

Unit III: Supramolecular Structures (6 Hours)

Ladders, polygons, and helices – Self-assembly using metal templates – Racks, ladders, and grids – Helicates – Molecular polygons – Rotaxanes, catenanes, Borromean rings and knots (structure and function of the above species) – Rotaxanes and catenanes as molecular devices.

Unit IV: Solid State Supramolecular Chemistry (6 Hours)

Introduction – Zeolites: structure – Zeolite composition – Zeolites and catalysis – Clathrates – Urea/thiourea clathrates – Clathrate hydrates (structure and function of the above species) – Uses.

Unit V: Self-Assembling Capsules (6 Hours)

Self-assembling capsules – Molecular containers – Metal directed capsules – Hydrogen bonded capsules – Concepts in crystal engineering – The Cambridge structural database - Crystal engineering with hydrogen bonds – Metal-organic frameworks and their guest properties

Reference Books:

- Jonathan Steed, David Turner, Carl Wallace, Core concepts in Supramolecular Chemistry and nanochemistry, John Wiley & sons, 2007.
- Jean-Marie Lehn, Supramolecular Chemistry, RCS pubs., 2005
- Supramolecular chemistry – Fundamentals and applications advanced textbook, Katsuhiko Ariga · Toyoki Kunitake, Springer-Verlag, 2000.
- Nano: The essentials, T. Pradeep, McGraw Hill Publishers, 2007.
- Nanochemistry, G.B. Sergeev, Elsevier, 2007.
- G. A. Ozin and A. C. Arsenault, “Nanochemistry: A chemical Approach to nanomaterials” RSC Publishing, 2005
- Zhong Cao G, “Nanostructures and Nanomaterials: Synthesis, Properties and Applications”, Imperial College Press, London, United Kingdom, 2004.
- Paul Engel, “Pain-free Biochemistry”, Wiley – Blackwell publishers, 2009.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2					3		
CO2	3	2					3		
CO3	3	1					2		
CO4	2			2			2		
CO5	1	2		1			1		
CO6			1	1	2	2			2

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

21CH2054	Waste to Energy	L	T	P	C
		2	0	0	2

Course Objectives:

To impart knowledge on

- Types of waste materials
- Conversion processes to convert waste to energy.
- Biomass, Biogas, Pyrolysis and Gasifier .

Course Outcomes:

The students will able to

- Understand the concept of waste to energy conversion, based on its properties
- Select the conditions for biomass pyrolysis and catalyst for chemical synthesis.
- Design a community biogas plant.
- Prepare charcoal and analyze its performance.
- Understand the current research scenario in waste to energy application
- Develop a small size biomass gasifier.

Unit I: Introduction to Energy from Waste: (6 Hours)

Classification of waste as fuel – Solid waste Management - Agro based, Forest residue, Industrial waste – Municipal solid waste – Conversion devices – Incinerators, gasifiers, digestors.

Unit II: Catalysis in waste conversion: (6 Hours)

Catalysts - Preparation of heterogeneous nano based catalyst – Properties – Application in the field of Energy.

Unit III: Biogas Production. (6 Hours)

Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Types of biogas Plants – Applications - Alcohol production from biomass.

Unit IV: Biomass Pyrolysis: (6 Hours)

Pyrolysis – pyrolysis process based on heating rate – Types, slow fast – Application - Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Unit V: Biomass Gasification: (6 Hours)

Types of gasification reaction – Types Gasifiers – Fixed bed system – Fluidized bed gasifiers - Downdraft and updraft gasifiers – Design, construction and operation – Application - Bench mark performance parameter.

References:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
5. Introduction to Biomass Energy Conversions, Sergio C. Capareda, CRC press, Taylor & Francis, 2014.
6. Non Conventional Energy Resources, G.D. Rai, 8th reprint, Khanna Publisher, 2013.
7. Biogas system: Principles and Application, K.M. Mital, 1st Edition, New Age International private Ltd., New Delhi, 2012.

	1	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2		2	1			1	2	2	
CO2	1	3	2	3	1	1	2	3	3	
CO3	2	2	2	1	2	1	1	3	2	
CO4	1	2	1		1	1	2	1	1	
CO5		1		1	1		1		2	
CO6	2	1	1	2	2			3	1	

21CH2055	Chemistry of Biofuels				L	T	P	C
					2	0	0	2

Course Objectives:

Enable the student to

To impart knowledge on

1. Types of Energy resources
2. Conversion processes of Biofuels from oil resource.
3. Biomass, Biodiesel, Transesterification, storage stability.

Course Outcomes:

The students will able to

1. understand basic concepts about biomass derived energy
2. Prepare biodiesel from various source
3. Select the conditions for biomass pyrolysis and catalyst for synthesis of Biofuel..
4. Understand the current research scenario in waste to energy application
5. Understand the characterization method for Biofuel
6. Design the storage tank for biofuel.

Unit I: Introduction to Energy crisis (6 Hours)

Energy Crisis – Types of energy sources – Status of Non renewable energy – Renewable energy source – Advantages – disadvantages. MNRE, India. Bio mass energy – waste to energy – environmental impacts of biofuel production; economics and life- cycle analysis of biofuel

Unit II: Biodiesel – Transesterification (6 Hours)

Types of transesterification reaction: Acid, Base and Enzyme method, Acid transesterification mechanism – base mechanism. Biofuel from plant seeds, waste cooking oil, Animal fat and algae -Oil methanol ratio – time and catalyst ratio – optimization parameters.

Unit III: Homogeneous and Heterogeneous catalyst (6 Hours)

Catalysts – Homogeneous and Heterogeneous - Preparation of heterogeneous nano based catalyst – preparation of catalyst from waste materials. Characterization methods XRD, SEM, FTIR and TEM - Properties – Application in the field of Energy

Unit IV: Biodiesel Characterization methods (6 Hours)

ASTM – biodiesel physical property – density, viscosity, Acid, iodine and peroxide value, Chemical properties – Chemical composition - FAME Analysis – Gas Chromatography – Principle – instrumentation – Evaluation of FAME samples.

Unit V: Biodiesel storage and oxidation stability (6 Hours)

Storage and oxidative stability of Biodiesel – ASTM standards – Antioxidants – synthetic and natural antioxidants – oxidative stability problems - Environmental Impact – Life Cycle Analysis Biofuel Economics, policies and future R&D.

References:

2. G. N. Tiwari and M. K. Ghosal,, Fundamentals of Renewable Energy Sources, Narosa Publishing House, , 2007
3. Kishore V V N, Renewable Energy Engineering and Technology, Principles and Practice, The Energy and Resources Institute (TERI) , 2009
4. C. M. Drapcho, N. P. Nhuan, T. Walker, Biofuel Engineering Process Technology, Mc Graw Hill 2008.
5. D. M. Mousdale, Biofuels, CRC Press 2008
6. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
7. Non Conventional Energy Resources, G.D. Rai, 8th reprint, Khanna Publisher, 2013.

8	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1		2	2		1	1		2
CO2	2	3	1	3	2		1	3	2
CO3	1	1		1	2	1	1	2	1
CO4		1		1	1		1		2
CO5	1	1			1	1	1		1
CO6	2	2	1	1			1	3	1

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

21CH2056	Porous Coordination Polymers and their Applications	L	T	P	C
		2	0	0	2

Course Objectives

To impart knowledge on

1. theoretical and practical knowledge (know-how) in the field of metal-organic framework materials.
2. preparation, basic characterization and assessment of MOFs
3. their potential use for environmental and energy applications.

Course Outcomes:

The students will able to

1. understand the necessary competences for the preparation organic linkers and implementation of MOF
2. predict the correct choice of characterization methods of the prepared materials,
3. determine the quantitative analysis of the measurements and interpretation of the results.
4. identify the correct MOF characterization and its functional groups
5. Apply knowledge to actual MOF applications in normal life
6. Demonstrate an understanding of the MOFs with other porous and non-porous materials

Unit I: Coordination polymers and Organic Coordination Networks (5 Hours)

Introduction of coordination polymers - discovery of coordination network - Secondary Building Units (SBUs): The Design Principles of MOFs Organic Coordination Network - Infinite Secondary Building Units-Organic linkers- different organic linker - Designing Linker Synthesis - ditropic, Tritopic - and Tetratopic Linkers.

Unit II: Metal-Organic Materials (MOMs) and Zeolite-like Metal-Organic Frameworks (ZMOFs) (7 Hours)

Introduction - metal-organic materials (MOMs) - Zeolite-Like Metal-Organic Frameworks (ZMOFs) – Background - Polytopic Pyridine-Like Ligands - Carboxylate-Based Ligands - Hetero-functional Ligands - Polytopic Multidentate Nitrogen-Donor Ligands - Supramolecular Building Blocks (SBBs).

Unit III: Synthesis of Metal-Organic Frameworks (5 Hours)

Scope mechanochemical construction of MOFs - advantages & limitations of mechanosynthesis - Neat Grinding - Direct Formation of Metal-Ligand Bonds - Mechanochemical Ligand Exchange - Coordination Polymers by Neat Grinding - MOF Synthesis via Sonication - Microwave Synthesis – hydrothermal – solvothermal -, electrochemical of Metal-Organic Frameworks and its basic characterization using powder X-ray - adsorption BET analysis.

Unit IV: Surface Pore Engineering of Porous Coordination Polymers (7 Hours)

Utilization of Metallo-Ligands (MLs) - Removal of Volatile Solvents and unwanted pollutants from as synthesized materials – purification - activation using different methods-heat drying - vacuum drying - vacuum drying with heat - room temperature drying - Pore Surface with Basic Functional Groups - increasing surface area and porosity using- solvent immersion - solvent exchange - solvent evaporation - single crystal-to-single transformation - hydrophobic pore surface - post-synthetic modification of surface.

Unit V: Applications of Metal-Organic Frameworks (6 Hours)

Designing MOF materials for suitable applications – functionalization - pollution removal - adsorption and desorption - Natural Gas Storage for Automobile Applications, - Ethylene Adsorption for Food Storage – catalysis - separation of oil/ water - and drug delivery.

Reference Books:

1. MacGillivray, L.R., Metal-organic frameworks: design and application, Hoboken : John Wiley & Sons, cop. 2010, ISBN 978-0-470-19556-7.
2. Furukawa, H., Cordova, K. E., O'Keeffe, M. & Yaghi, O. M. The chemistry and applications of metal-organic frameworks. Science 341, 1230444 (2013).
3. Helal, A., Al-Maythalony, B.A., Yamani, Z.H., Cordova, K.E., Yaghi, O.M., The chemistry of metal-organic frameworks for CO₂ capture, regeneration and conversion. Nature Reviews Materials 2, 17045 (2017).
4. Mazaj, M., Kaučič, V., ZabukovecLogar, N., Chemistry of metal-organic frameworks monitored by advanced X-ray diffraction and scattering techniques. Acta chimicaslovenica, 63, 440-458 (2016).
5. Stefan Kaskel, The Chemistry of Metal–Organic Frameworks, 2016, Wiley-VCH Verlag GmbH & Co. KGaA, Boschstr. 12, 69469 Weinheim, Germany ISBN: 978-3-527-33874-0.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	3				3		
CO2	3						3		
CO3	2						3		
CO4	1						3		
CO5	1						2		
CO6	1						2		

'3'-High, '2'- Medium, '1'-Low, '- ' No correlation

21CH2057	Industrial Inorganic Chemistry	L	T	P	C
		2	0	0	2

Course Objectives:

1. Learn the applications of industrial catalysis
2. Understand the applications of inorganic pigments, dyes and coatings
3. Learn the chemistry of alloys and fertilizers

Course outcomes:

The student will be enable to

1. Learn the fundamental concepts of catalysis
2. Know the various industrial catalytic reactions
3. Learn the preparation and properties of inorganic pigments
4. Describe the classification and applications of inorganic coatings and paints
5. Know about the chemistry of alloys
6. Understand the preparation and uses of inorganic fertilizers

Unit I: Industrial catalysis (7 Hours)

Fundamental aspects of catalysis –types - properties of catalysts, deactivation or regeneration of catalysts. Phase transfer catalysts, application of zeolites as catalysts. Catalysis -organic polymer chemistry - petroleum industry – oxidation catalyst- acid/base catalyst- photocatalyst–energy conversion- ammonia synthesis –catalytic asymmetric synthesis- catalysis in environmental control- Bio catalysis.

Unit II: Inorganic pigments (6 Hours)

Pigment- definition, extenders, dyes, pigment dyestuffs. Toners and lakes pigments. Inorganic pigments- examples, additive and subtractive colour mixing. Inorganic pigments- Sources, Preparation, properties and uses. Extender pigments like Calcium carbonate, hydrated aluminium oxide, aluminum silicates/ china clays, Magnesium silicate/ talc. White prime pigments, Black Pigments, Blue and Green Pigments.

Unit III: Inorganic coatings (6 Hours)

classification of surface coatings, Oil paint, Vehicle, modified oils, Fillers, Thinners, Enamels, emulsifying agents. Special paints- Heat retardant, Fire retardant, Eco-friendly paint, Plastic paints, Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing

Unit IV: Alloys (6 Hours)

Classification of alloys, ferrous and non-ferrous alloys, properties of alloys. Manufacture of Steel removal of silicon -decarbonization, demanganization, desulphurization dephosphorisation. Surface treatment- argon treatment, heat treatment, nitriding, carburizing. Composition and properties of different types of steels.

Unit V: Inorganic fertilizers (5 Hours)

Fertilizers- types, Manufacturing, properties and uses of Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

Reference Books:

1. Jens Hagen. "Industrial Catalysis: A practical approach" Wiley 2006
2. Lloyd, L. "Handbook of Industrial Catalysts" Springer 2011
3. Bartholomew, C. H. Farrauto, R. J. "Fundamentals of Industrial Catalytic Processes" Wiley 2005
4. Lubs H. A., Robert, E. "Chemistry of Synthetic Dyes and Pigments" Krieger Publishing Company, New York, 1977
5. Venkataraman, K. "Chemistry of Synthetic Dyes" – Vol III Academic Press, 1972
6. Jain, P. C., Jain, M. "Engineering Chemistry" Dhanpat Rai & Sons, Delhi. 2018
7. Gopalan, R., Venkappayya, D., Nagarajan, S. "Engineering Chemistry" Vikas Publications, New Delhi. 2013
8. Sharma, B. K. "Engineering Chemistry" Goel Publishing House, Meerut. 2011

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	2				3		
CO2	2	3	1				3		
CO3	3	2	3				3		
CO4	2						2		
CO5	3						1		
CO6	1						1		

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2058	Applied Main Group Chemistry	L	T	P	C
		2	0	0	2

Course Objectives

1. To make the student conversant with the applied main group chemistry
2. To encourage the students to understand the importance of main group chemistry in catalysis.
3. To impart knowledge about biological applications of main group chemistry.

Course outcomes

The Student will be able to

1. Learn synthetic methodologies involved in main group chemistry
2. Understand the effect of main group element on polymeric materials
3. Realize catalytic applications and cost reduction
4. Understand the importance of main group molecules in developing modern technologies
5. Analyse applications in toxicology and biology

Unit I: Synthesis and classification of main group compounds (7 hours)

Classifications, synthesis, characterisations and properties of Organoboranes, Organosilicons, Organophosphorous, Organoantimony, Organobismuth, Organogermanium, Organoarcentic, Organostannane, Organoselenium, Organotellurium compounds.

Unit II: Main group polymers (5 hours)

Synthesis, characterisation and properties of polysilanes-polygermanes-polystannenes- polyphosphazenes- polyphospholes-B, S, As (Arsole), Se and Te containing conjugated polymers.

Unit III: Catalytic applications (5 hours)

Frustrated Lewis Acid Pairs (FLP)-Low valance main group compounds-classifications-applications in small molecules activation-catalysis- Advantages.

Unit IV: Optoelectronic Applications (7 hours)

Solid state luminescence-theory- π conjugated molecules containing main group elements-applications in OLED, solar cell and forensic science.

Unit V: Medicinal chemistry applications (6 hours)

Chemical sensing-fluoride and cyanide-bio imaging (cancer cells and mitochondria)-photodynamic therapeutic applications-boron and antimony based anion transporters.

References:

1. Thomas Baumgartner and Frieder Jackle, Main Group Strategies towards Functional Hybrid Materials, First edition, John Wiley & Sons, 2018.
2. Ali Morsali, Lida Hashemi, Main Group Metal Coordination Polymers, John Wiley & Sons, 2017
3. Kin-Ya Akiba, Organo Main Group Chemistry, John Wiley & Sons, 2011
4. James E. Mark, Harry R. Allcock, Robert West, Inorganic Polymers, Oxford University Press, 2005
5. Ronald D. Archer, Inorganic and Organometallic polymers, John Wiley & Sons, 2001
6. A. G. Massey, Main Group Chemistry, 2nd Edition, John Wiley & Sons, 2000
7. Das, Kumar V.G, Main Group Elements and their Compounds, Springer-Verlag Berlin Heidelberg, 1999.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	-	2	-	1
CO2	3	2	2	1	1	-	3	-	1
CO3	3	2	2	2	1	-	3	-	1
CO4	3	2	1	2	1	-	2	-	1
CO5	3	2	2	1	1	-	3	-	1
CO6	3	2	1	1	1	-	3	-	1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

21CH2059	Glass and Ceramic Chemistry				L	T	P	C
					2	0	0	2

Course Objectives:

Enable the student to

1. learn the composition of ceramic glass and techniques to determine the glass fractures
2. understand the techniques to match glass fragments and various techniques in determining the composition of Glass
3. describe engineering ceramics and special glass

Course outcomes:

Student will be able to

1. understand the history, types of ceramics and glasses
2. acquire knowledge on engineering ceramics and glass fracture.
3. to compare the ceramics in medical and scientific field.
4. understand the history of glass and fracture
5. analyze various studies of glass by using spectroscopic techniques.
6. know the special glasses in various field.

Unit I Fundamentals of Ceramics

Ceramics: Brief introduction to types of ceramics. glazing of ceramics. Cement: Manufacture of Portland cement and the setting process, Different types of cements: quick setting cements, eco-friendly cement (slag cement), pozzolana cement.

Unit II Engineering Ceramics

Carbides : Boron carbide, Silicon carbide, Titanium carbide, Zirconium carbide, Hafnium carbide & Uranium carbide. Nitrides : Boron, Silicon & Aluminum nitrides. Silicides : Molybdenum disilicide. Borides. Sialon. Graphites. Cermet& Composites.

Unit III Ceramics in Medical and Scientific field.

Tissue attachment mechanism, Bio- active materials, nearly inert crystalline ceramics, porous ceramics, bioactive glass and glass ceramics, calcium phosphate ceramics, carbon base implant materials, ceramics for dental applications.

Unit IV: Glass history and fracture Types

Glass: Definition of glass, history of glass ,Basic concepts of glass structure, Batch materials and minor ingredients and their functions, Elementary concept of glass manufacturing process, Different types of glasses. Application of

glasses. Glass Fractures – Types (Compressive, Tensile, Shear) – Characteristic of Glass Fractures - Industrial (Tempered – Windshield Glass- Laminated) – Laboratory (Borosilicate – Soda- Lead)

Unit V: Special types of Glass in Medical Field

Application and properties of Bullet Proof glasses – Swap Test Glasses (Polymeric) – Glass ceramic – Glass fibre – Chromatic Glasses – Optical glass – Float glass (Gorilla Glass) – Case studies based on bullet proof glasses and Swap test glasses.

Reference Books

1. Kingery, W. D.; Bowen H. K.; Uhlmann, D. R. (1976), Introduction to Ceramics, Wiley Publishers, New Delhi.
2. Ceramics for Medical and Scientific products: Tissue attachment mechanism, Bio- active materials, nearly inert crystalline ceramics, porous ceramics, bioactive glass and glass ceramics, calcium phosphate ceramics, carbon base implant materials, ceramics for dental applications.
3. The Forensic Analysis of Glass Evidence: Past, Present, and Future, Brooke Weinger Kammrath, Andrew C. Koutrakos, Meghan E. McMahon, John A. Reffner, Wiley - VCH Verlag GmbH & Co. KGaA, 2016.
4. Forensic Examination of Glass and Paint: Analysis and Interpretation (Taylor & Francis Forensic Science Series) Edited by Brian Caddy 2012
5. The third edition of Forensic science – basics -Jay. A. Seigel, Karthy Mirokovits – Wiley Blackwell, third edition 2016, CRC press.
6. Forensic Interpretation of Glass Evidence- James Michale Curran – Tacha Natalie – John S. Buckleton, Taylor and Francis, 2014
7. Materials Analysis in Forensic Science, 1st Edition, Max M. Hock, 2016, Academic Press.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	2						3		
CO2	1	2						3		
CO3	1	2						3		
CO4	1	1						3		2
CO5	1	13								1
CO6										1

“3”– High; “2”– Medium ; “1”– Low; “-”– No correlation

21CH2060	Essentials of Chemistry in Various Fields	L	T	P	C
		2	0	0	2

Course Objectives:

Enable the student to

1. know the classification and process in Aromatherapy & Perfumery
2. understand the industrial process in soaps, powders and crackers.
3. know the procedures in clinical chemistry & software tools in chemistry.

Course Outcomes:

Student will be able to

1. acquire the basic knowledge about aromatherapy and perfumery.
2. know the preparation, properties of various soaps, washing powders and moth balls.
3. understand the concepts, types & properties of various explosives and fire safety procedures.
4. approach and understand in clinical laboratory techniques, Golden hour procedures and first aids.
5. know the chemistry software, tools to visualize the molecules.

Unit I Chemistry in Aromatherapy & Perfumery (6 Hours)

Basics of aromatherapy & its branches – Essential Oils in aromatherapy – types – Process and Application. Perfumery - Introduction – types – Solvent –types – extraction methods – Blending of aroma oils with carrier oils– Perfumery practice – types - Packing –Packaging – labelling – License – Buyers strategy – Production strategy - Market survey – Business opportunities in Essential oil, perfumery & Aromatherapy.

Unit II : Kitchen Chemistry (6 Hours)

Chemistry in action Soaps and detergents - Soaps – Introduction. Types of soaps – based on usage - Toilet soaps, washing soaps. Liquid soap. TFM and grades of soaps. Bathing bars. Cleansing action of soap. Detergents - Introduction. Types of detergents - anionic, cationic, non-ionic and amphoteric detergents -hair dye- nail polish-

whitener-moth balls – Washing powder ingredients – types – process – Applications nail polish- whitener-moth balls – Household bleach Environmental Acts. Business opportunities in kitchen Chemistry

Unit III: Explosive Chemistry (4 Hours)

Explosives chemistry: - Explosives – introduction – types - TNT, TNG, RDX, Gun cotton: name, structure and action. (No structure or chemical reactions needed)- Bomb types - Explosive Ordnance Factory - Fire crackers - Green Crackers - Fire safety procedures in industry, Pharmaceutical Industry– License Procedure- Environmental Acts.

Unit VI: Clinical Chemistry (8 Hours)

Unit - I Blood - Constituents of blood cells and plasma, plasma proteins, albumin and globular - lipoproteins, functions (Details not expected), Coagulation - 'Coagulation factors, blood sugar – Urinal Analysis – salt, stone, bilirubin test details – CLINICAL CHEMISTRY – approach methods - Injuries - Introduction –Golden hour trauma procedures - Accidental injuries –Injury Types – First Aid for different injuries - Procedures – Management – Case study. Drug Chemistry - Drugs –Introduction - Classification of drugs - Analgesics, Antipyretics, Antihistamines, Antacids, Antibiotics and Antifertility drugs with examples. Drug addiction and abuse. Prevention and treatment.

Unit V: Basics in Computer Chemistry (6 Hours)

Computer Lab based instruction on the use of computer and internet in learning. Use of educational softwares, information mining from internet and using INFLIBNET/NICNET, NPTEL and VIRTUAL LABS OF MHRD. Word processing and document preparation. Use of Spread sheets in Data handling and presentation. Introduction to chemical structure drawing, visualization of molecules using chemistry softwares.

Reference Books:

1. Scientific Soapmaking: The Chemistry of the Cold Process, March 2010, Kevin M. Dunn
2. Liquid Soapmaking: Tips, Techniques and Recipes for Creating All Manner of Liquid and Soft Soap Naturally!, Goldilock press., November 2014, Jackie Thomson.
3. The Complete Book of Essential Oils and Aromatherapy, Valerie Ann Worwood, New World library 1991.
4. The Power Of Essential Oils: Knowledge For Beginners To Start, Healing Yourself By Natural Healing: Essential Oils Reference Book Paperback – Import, 2 March 2021 by Miki Ranah.
5. The Chemistry of Explosives: RSC (RSC Paperbacks) Paperback – 8 July 2011 Jacqueline Akhavan.
6. First Aid Manual 7th Edition Paperback – 1 May 1997 by St John Ambulance, , St Andrew's Ambulance Association and the British Red Cross Society
7. Computer Software Applications in Chemistry, Peter C. Jurs John Wiley & Sons, 02-Feb-1996 - Science.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	3			2			2		3
CO2		2			2			2		3
CO3		2			2			2		3
CO4		2			2			2		3
CO5		2			2			2		3
CO6		1								1

“3”– High; “2”–Medium ; “1”– - Low ; “-”– No correlation

21CH2061	Industrial Polymer Chemistry	L	T	P	C
		2	0	0	2

Course Objectives:

Enable the student to

1. know the classification and mechanism of polymer formation
2. understand the characterization techniques used in polymer chemistry
3. know concepts of Industrial polymers.

Course Outcomes:

Student will be able to

1. acquire the basic knowledge about polymers.
2. know the Synthesis of various polymers, properties and choose the methods for characterizing the polymer.
3. understand the thermal and mechanical properties of industrial polymers.
4. develop various fabrication and molding techniques.
5. understand the vulcanization process and various polymer industries in India.

Module I:-Basics of Polymers(6 Hours)

Introduction - Brief history of macromolecular science, general characteristics of polymers in comparison with common organic compounds. Nomenclatures. Distinction between plastics, elastomers and fibers. Natural polymers-

cellulose. Types of polymers- thermoplastics and thermosetting, functionality concept. Concept of cross linked polymers. Types of polymerization- addition, condensation, ionic, co-ordination. Addition – polymerization – mechanism, initiation, propagation and termination processes.

Module II: Polymerization Methods (6 Hours)

Methods of polymerization-bulk, suspension, emulsion, solution necessity of copolymers and copolymerization, (a) phenol- formaldehyde resins (b) amino resins urea- formaldehyde and melamine-formaldehyde resins (c) polyurethanes (d) epoxy resins- grades of epoxy resins, curing process and its importance (e) poly carbonates.

Module III: Elastomers-I (6 Hours)

Polyisoprene, polybutadiene, neoprene. Detailed study of the following thermoplastic polymers with respect to synthesis, chemistry, properties and applications. Polyolefin, polyethylenes_HDPE, LDPE, polyvinyl chloride- industrial grades of PVC, Teflon, Polystyrene-homopolymers, copolymers such as SBR, ABS, SAN.

Module IV: Elastomers- II (6 Hours)

Vinyl polymers- polyvinyl acetate and its modifications like PVA, PVB and polyacetals. Polyamides - nylon -6, nylon-66 and other nylons. Poly ethers and poly esters, terephthalates. Cellulosic such as esters, ethers, acetates, butyrates, nitrate, CMC; regenerated cellulose.

Module V: Experimental Methods (6 Hours)

Molecular weight and molecular weight distribution – number , weight and viscosity average molecular weights of polymers, methods of determining molecular weight, Glassy state, glass transition temperature, TGA, factors affecting GTT, crystallinity in polymers. Polymer processing- compression moulding, casting, extrusion ,fibre spinning, injection moulding, thermoforming, vulcanization of elastomers, polymer industry in India.

References:

1. Blmeyer, “Textbook of polymer science”, John Wiley and Sons
2. D.D. Deshpande, “Physical chemistry of macromolecules”, Vishal publications, New Delhi, 1985
3. V.R. Gowariker, N.V. Viswanathan and J.Sreethan, “Polymer Science”, Wiley Eastern Ltd, 1986
4. V.R. Gowariker, N.V. Viswanathan, N.V.JayadevSreedhar, “Polymer Science”, I edition, New Age International Publishers Pvt. Ltd., New Delhi, 2008.
5. G.S. Misra, “Introductory Polymer chemistry”, New Age International Pvt. Ltd., 2008
6. Anil Kumar and Rakesh K. Gupta, “Fundamentals of polymer engineering” Tata McGraw Hill Publication Ltd., New Delhi, 2003 (revised and expanded edition)
7. R.J. Young, P.A. Lovell, “Introduction to polymers” Stanley Thomas Publishers, London, 2000
8. P. Bahadur, “Principles of polymer science”, Alpha Science International Ltd., 2nd Edition, 2005.
9. G. Odian, “Principles of Polymerisation”, IV Edition, Wiley Student Edition, New Delhi, 2007.
10. M.G. Arora, M. Singh and M.S. Yadav, “Polymer Chemistry” II revised Edition, Anmol Publications Pvt. Ltd., 2003.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	3			2			2		3
CO2		2			2			2		3
CO3		2			2			2		3
CO4		2			2			2		3
CO5		2			2			2		3
CO6		1								1

“3”– High; “2”– Medium ; “1”– Low ; “-”– No correlation

21CH2062	Intellectual Property Rights	L	T	P	C
		2	0	0	2

Course Objectives

Enable the student to

1. To give an idea about IPR, Patents, Design, Copyrights, Trademarks,
2. To learn the process for filling the patents
3. To understand the various enforcements of IPRs, Registration and its enforcement.

Course Outcomes

Student will be able to

1. learn the concepts of Intellectual Property
2. import knowledge on the Patent rights in the national and international level
3. experience the patent filling procedure

4. apply the concepts into the patentable rights
5. experience the digital and knowledge assets
6. realize the various enforcement of IPRs

UNIT I:Introduction (7 Hours)

Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO – TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT II:Registration of IPRs (6 Hours)

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

UNIT III:Agreements and Legislations (6 Hours)

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT IV:Digital Products and Law (6 Hours)

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

UNIT V:Enforcement of IPRs(5 Hours)

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

Text Books:

1. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012
2. S. V. Satakar, —Intellectual Property Rights and Copy Rights, EssEss Publications, New Delhi, 2002.

References

1. Deborah E. Bouchoux, —Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets, Cengage Learning, Third Edition, 2012.
2. PrabuddhaGanguli, Intellectual Property Rights: Unleashing the Knowledge Economy, McGraw Hill Education, 2011.
3. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3			2				2
CO2		2			2				2
CO3		2			2				2
CO4		2			2				2
CO5		2			2				2
CO6		1							2

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

21CH2063	Basics of Medicinal Chemistry	L	T	P	C
		2	0	0	2

Course Objectives

Enable the student to

1. Understand various types of drugs in the chemotherapy
2. Correlate the activity and structure of the drugs
3. highlight the synthetic methods of common drug molecules

Course outcomes

Student will be able to:

1. Explain the basic properties and their relation to biological action
2. Understand and explain the different behaviour of organic drug molecules.
3. Describe the role, activity and structure of anesthetics
4. Explain the activity of various hypnotics and sedatives
5. Correlate structure activity relationship of common drug molecules
6. Outline the synthetic methods of common drug molecules

Unit I: Physicochemical properties (6 Hours)

Physicochemical properties in relation to biological action - Ionization, Solubility, Partition Coefficient, Hydrogen bonding, Protein binding, Chelation, bioisosterism, Optical and Geometrical isomerism.

Unit II: Anaesthetics (6 Hours)

General anaesthetics - Classification, mechanism of action, synthesis of nitrous oxide, halothane, thiopental sodium and chloroform - Local anaesthetics - Classification, mechanism of action - SAR, synthesis of procaine hydrochloride, benzocaine, lignocaine hydrochloride

Unit III: Hypnotic and sedative (6 Hours)

Hypnotic and sedative - Classification, mechanism of action - SAR of barbituric acid derivatives and synthesis of barbitol - allobarbitol, hexobarbitol. SAR of benzodiazepines and synthesis of diazepam, alprazolam, zolpidem - Anti-convulsants - Classification, mechanism of action and synthesis of phenobarbital and phenytoin sodium.

Unit IV: Analgesics and antipyretics (6 Hours)

Analgesics and antipyretics - Classification - mechanism of action and SAR of morphine analogue, mechanism of action, mechanism of action and SAR of salicylic acid - aryl alkanoic acid derivatives - synthesis of aspirin and paracetamol - Anti-histamines - Classification, mechanism of action and SAR ethanolamine derivatives - synthesis of promethazine hydrochloride

Unit V: Diuretics and anti-hypertensives (6 Hours)

Diuretics - Classification - mechanism of action and SAR - Synthesis and uses of hydrochlorothiazide, acetazolamide. Hydroflumethiazide - ethacrynic acid - furosemide. Anti-hypertensives - Classification, mechanism of action, SAR. Synthesis of captopril, propranolol hydrochloride.

Text books

1. Lemke, T. L., Williams, D. A., Foye's Principles of Medicinal Chemistry 7th Edition Wolters Kluwer and Lippincott Williams & Wilkins, 2007
2. Beale, J. M., Block, J. H., Wilson and Gisvold's Textbook of organic medicinal and pharmaceutical chemistry, 12th edition, Wolters Kluwer and Lippincott Williams & Wilkins, 2011
3. Kar, A., Medicinal Chemistry, Revised third edition, New age International publishers, 2005
4. Sriram, D., Yogeeshwari, P. Medicinal Chemistry, second edition, Pearson India, 2009

1	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3			2			2	
CO2		2			2			2	
CO3		2			2			2	
CO4		2			2			2	
CO5		2			2			2	
CO6		1							

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH2064	Applications of Electrochemistry	L	T	P	C
		2	0	0	2

Course Objectives:

Enable the student to

1. learn about corrosion protection technology
2. understand the concepts of electrometallurgy and energy storage systems
3. learn the applications of photoelectrochemical cells and biomaterials

Course Outcomes:

The student will be able to

1. understand the corrosion prevention techniques
2. learn the applications of electrometallurgy
3. understand about different electrochemical energy storage systems
4. learn about solar cells and photoelectrochemical cells
5. summarize the importance of artificial organs
6. realize the importance of biomaterials and cell tissues

Unit I: Corrosion Protection Technology (6 Hours)

Theory of corrosion, action of corroding environment, mechanism of corrosion & detection of corrosion, fouling, pigments, binders & additives for corrosion prevention, recent developments in corrosion protection materials etc.

Unit II: Electrometallurgy (5 Hours)

Introduction to electrometallurgy – Metal extraction and refining – Electrorefining and electrowinning of metals – Fused salt electrolysis of aluminium and magnesium.

Unit III: Electrochemical Energy Storage systems (5 Hours)

Batteries - Flow Battery - Fuel Cell and Hydrogen Electrolyser – Flywheel - Super-Conducting magnetic energy storage system - Super Capacitor.

Unit IV: Solar Cells & Photoelectrochemical Cells (5 Hours)

Preparation of CdS/Cu₂S solar cells, amorphous Si solar cells, GaAs solar cells and their characteristics - Photo-electrochemical cells for conversion of light energy to electrical energy - PEC cells based on CdSe, Si and GaAs and their output characteristics.

Unit V: Biomaterials and Electrochemistry (5 Hours)

Biomaterials science – Artificial Organs - heart valve prosthesis – Artificial flip joints – Dental implants – Intraocular lenses – left Ventricular Assist Device – Vascular grafts – stents – Pacemakers – Biocompatibility – Drug Delivery Systems – Surface modification of bio implants – Electrochemical characterization in Artificial saliva – Interaction between bio materials and cell tissues.

Text Books:

1. V. S. Sastri, Edward Ghali, Mimoun Elboujdaini, “Corrosion Prevention and Protection: Practical Solutions”, John Wiley & Sons, Ltd., 2007.
2. Konstantin I. Popov, Stojan S. Djokić, Branimir N. Grgur, “Fundamental Aspects of Electrometallurgy”, Springer, 2002.
3. Vijay G. Singh, “Applied Electrochemistry”, Nova Science Publishers, 2010.
4. Nurdan Demirci Sankir, Mehmet Sankir, “Photoelectrochemical Solar Cells”, Wiley, 2019
5. R.K. Kotnala and N.P. Singh, “Essentials of solar cells”, Allied Publishers P.Ltd., New Delhi, 1986

Reference Books:

1. Ole Øystein Knudsen, Amy Forsgren, “Corrosion Control Through Organic Coatings”, CRC Press, 2017.
2. Raj Narayan, An Introduction to metallic corrosion and its prevention, Oxford & IBH, 1983.
3. A.F. Fahrenbruch and R.H. Bube, “Fundamentals of Solar Cells”, Academic Press, London, 1983.
4. Shay Fisher, “Biomaterials: From Theory to Applications”, NY Research Press, 2020.
5. Serge Cosnier, “Bioelectrochemistry: Design and Applications of Biomaterials”, De Gruyter; 1st edition (March 4, 2019).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	2	2	2	1	1	2	2	3
CO2	1	1	1	2	2	2	1	2	3
CO3	2	2	2	2	1	1	2	2	3
CO4	2	2	2	2	1	1	2	2	3
CO5	2	2	2	2	1	1	3	3	3
CO6	2	2	2	2	1	1	3	3	3

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

21CH2065	Chemistry in Fire Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn about fundamental chemistry of fire and combustion process
2. differentiate various types of fires and chemistry of fire extinguishers
3. understand the importance of fire retardant materials

Course Outcomes:

The student will be able to

1. explain the atomic properties and the chemical properties of fire.
2. learn the various terms involved in combustion process and fire chemistry
3. categorize the components of fire
4. understand the chemistry involved in fire detection process
5. demonstrate the knowledge of fire extinguishing materials
6. summarize the various types of fire-retardant materials

Unit I: Fire Chemistry Basics (8 Hours)

Periodic Table – Atom – Atomic size – Ionization – Periodic Properties – Types of Bonds

Unit II: Thermodynamics and Heat Transfer in Fire (10 Hours)

Fire – Definition - Melting Point – Boiling Point - Vapour Pressure – Vapour Density – Laws of Thermodynamics- Combustion – Ignition Temperature - Analysis of Flue gas - Types of Combustion with Examples – Complete Combustion – Incomplete Combustion – Rapid Combustion – Spontaneous Combustion – Explosion – Stages of Combustion -Heat of vaporization – Molar Heat capacity – Specific Heat Capacity – Molar heat of vaporization – Molar heat of Combustion – Joule -Thomson Effect

Unit III: Classification of fire and chemistry of fire extinguishers(10 Hours)

Requirement of fire – Fuel – Oxidant – Heat – Chain Reaction - Examples - Classes of fire – solid – Solid organic fuels -flammable liquid – flammable gases – combustible metals – electrical fires – Approaches to put out the fire – Starvation – Smothering – Cooling - Chemistry of extinguisher – Water –Foam – BCF – Dry Powders – Sodium bicarbonate- Monoammonium phosphate

Unit IV: Fire detection and prevention (9 Hours)

Detection of Fire – Principles and types – Heat – Light – Electromagnetic Spectrum – IR – Visible and UV light - Ionization Chamber - Smoke - Prevention of fire -Sprinklers - Non-combustible materials – Silicate materials – Gypsum plaster board –Fire retardant polymers - Foundations of Fire Fighting Tactics and Strategies

Unit V: Nanotechnology and Fire Safety (8 Hours)

Nanomaterials– Definition – Top down and Bottomup Approaches – Classification of nanomaterials – Examples – Sol-gel-process – steps – advantages – Use of nanotechnology in fire resistance – fire resistant nanocoatings - Starch based coatings – Hydrogels for fire resistant blankets – nanocomposite foams – Characterization of nanomaterials

Textbooks:

1. Jain and Jain, “Engineering Chemistry” 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017
2. James G. Quintiere, “Principles of Fire Behavior” Second Edition, CRC Press, 2016
3. Richard Gann and Raymond Friedman ‘Principles of Fire Behaviora Combustion”, Jones and Bartlett Publishers, Inc; 2016

References:

1. J.D. DeHaan, Kirk’s Fire Investigation, 3rd Edition, Prentice Hall, New Jersey, 1991
2. “Essentials of Fire Fighting”, 7th Edition by International Fire Service Training Association, published from FPP/IFSTA, 2019
3. “Nanotechnology: The future of fire safety” by Richard Olawoyin in *Safety Science*, Volume 110, Part A, December 2018, Pages 214-221

21CH2066	Fire Chemistry laboratory	L	T	P	C
		0	0	2	1

Course Objectives

Enable the students to

1. perform experiments based on fire chemistry
2. demonstrate qualitative analysis of metals
3. synthesize and characterize nanomaterials

Course Outcomes

The students will be able to

1. determine the boiling point and melting point of the samples
2. identify the metal ion by various tests
3. estimate the heat of combustion
4. analyze the characteristics of water
5. understand the importance of spectrophotometry
6. synthesize and characterize the nanomaterial

LIST OF EXPERIMENTS

1. Finding the Boiling point of a flammable liquid - 1
2. Finding the Boiling point of a flammable liquid – 2
3. Estimation of melting point of petroleum wax
4. Qualitative analysis of metals -1
5. Qualitative analysis of metals -2
6. Identification of metals by flame test

7. Determination of Heat of Combustion -1
8. Determination of Heat of Combustion – 2
9. Analysis of water -1
10. Analysis of water -2
11. Spectrophotometry Experiment
12. Synthesis of nanomaterials - 1
13. Synthesis of nanomaterials – 2
14. Estimation of sodium bicarbonate

(Minimum 10 Experiments to be conducted)

Text Books:

1. Elias A. J., “A Collection of Interesting General Chemistry Experiments”, Revised Edition, Universities Press, 2007
2. Khosla, B. D., Garg, V. C., and Gulati, A. R., “Senior Practical Physical Chemistry” Chand & Co.: New Delhi, 2011.
3. Garland, C. W.; Nibler, J. W. and Shoemaker, D. P., “Experiments in Physical Chemistry”, 8th Edition, McGraw-Hill, New York, 2003.
4. Halpern, A. M. and McBane G. C., “Experimental Physical Chemistry”, W.H. Freeman & Co. New York, 2003.
5. Jain and Jain “Engineering Chemistry” 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017

21CH2067	Environmental Science Laboratory	L	T	P	C
		0	0	2	1

Course Objectives

Enable the students to

1. perform experiments based on analysis of water
2. demonstrate the analysis of air sample
3. analyze the pollutants present in the environment

Course Outcomes

The students will be able to

1. determine the alkalinity and hardness of water samples
2. analyze the samples using instrumental methods
3. determine the partition coefficient
4. analyze the sample by fluorometry
5. perform the experiments based on kinetics
6. determine the concentration of pollutants in the atmosphere

LIST OF EXPERIMENTS

1. Estimation of alkalinity in water sample.
2. Estimation of total, permanent and temporary hardness by EDTA method in water sample.
3. Determination of dissolved oxygen in water sample.
4. Estimation of iron in water sample by spectrophotometry
5. Estimation of acid using pH measurements
6. The pH and Buffer Capacity of Environmental Waters
7. Conductivity of Various Waters (TDS)
8. Fluorometric Determination of Polycyclic Aromatic Hydrocarbons
9. Determination of the Octanol/Water Partition Coefficient for Organic Pollutants of Varying Hydrophobic/Hydrophilic Character
10. Kinetics of the Decomposition of Pollutants in the Environment with an Application to Plasticizers
11. Introduction to Air Sampling: Particulates in Urban Air
12. Determination of the Concentration of Carbon Dioxide in the Atmosphere

Text Books

1. Mendham J., Denney R. C., Barnes J. D., Thomas M. J. K., Vogel's Quantitative Chemical Analysis, Pearson Education limited, 6th Edition, 2000.
2. Elias, A. J., A Collection of Interesting General Chemistry Experiments, Revised Edition, Universities Press, 2007.

21CH2068	Recent Trends in Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the importance of forensic science
2. learn the various branches of forensic science
3. know the application of forensic science in various fields the fundamentals of organic chemistry

Course Outcomes:

The student will be able to

1. understand the basic concepts of forensic science
2. know the procedures involved in crime scene management
3. recognize the importance of finger print analysis and questioned documents
4. classify the various types of toxins and their analysis
5. know the importance of forensic serology
6. understand the significance of forensics for workplace investigation

Unit 1: Forensic Science and Crime Scene management (9 Hours)

Forensic science – Definition –History and scope- Branches of Forensic Science – Central and state forensic science laboratories in India - Directorate of Forensic Science and Mobile Crime Laboratories -Crime – Definition, types, causes and consequences - Broad concepts of criminal Justice system - Investigating the Crime Scene - Role of Investigator - Collection of Evidence - Evaluation of crime scene - Protection of crime scene - Photography and Videography of Crime scene - Searching Methods - Chain of Custody - Report writing and presentation in court of law - Case studies.

Unit 2: Fingerprints and Questioned documents (9 Hours)

Introduction- Formation of ridges - Fingerprint patterns - Fingerprint characters - Biometric Systems of identification and its relevance – Case studies - Definition of questioned documents - Types of questioned documents- Basic tools needed for forensic documents -Examination of Questioned Documents - Comparison of handwriting - Standards for comparison of handwriting- Comparison of photocopied documents - Examination of counterfeit Indian currency notes, passports, visas, credit cards and debit cards – Analytical techniques – Case studies.

Unit 3: Forensic Toxicology(9 Hours)

Toxicology – Introduction -Alcoholic Beverages-Definition of alcohol and illicit liquor - Alcoholic and non-alcoholic beverages and their composition - Absorption-distribution and elimination- Estimation of ethyl alcohol in blood and urine – Legal aspects of drinking and driving -Alcohol and work place –Types of drugs - Narcotics, stimulants, depressants and hallucinogens- General characteristics- Drug addicts and crimes -Classification of poisons-,Physico-chemical characteristics -Snake venom - Carbon monoxide poisoning -Techniques used in toxicology.

Unit 4: Forensic Biology and Serology (9 Hours)

Common body fluids - Composition and functions of blood - Collection and preservation of blood - Distinction between human and non-human blood - Antigens and antibodies - Composition, functions and forensic significance of saliva, sweat, milk, semen and urine - Tests for their identifications.

Unit 5: Industrial Forensics and Cybercrimes(9 Hours)

Industrial Products - Physical and chemical examination of adulterated and non-adulterated oils and fats - Analysis of chemical fertilizers and consumer items - Types of cement and their composition - Analysis of cement mortar, cement concrete and stones -Paint and Varnishes: Nature, composition and forensic examination-Forensic examination of electrical appliances/installations - Cybercrimes - Definition - Types of computer crimes – Case studies.

References:

1. Jay A Siegel, Pekka J Saukko, Geoffery Knupfer, “Encyclopedia of Forensic Science”, Volume 1-3: Academic Press, 2nd Edition, 2013.
2. Richard Saferstein, “Criminalistics: An Introduction to Forensic Science”, Pearson Education International, 12th Edition, 2017.
3. Stuart H. James and Jon J. Nord, “Forensic Science: An Introduction to Scientific and Investigative Techniques”, CRC Press, 4th Edition, 2014.
4. M. Houck, J. Siegel, “Fundamentals of Forensic Science”, Academic Press, 3rd Edition, 2015.
5. K. Mirakovits, G. Londino-Smolar, “The Basics of Investigating Forensic Science”, CRC Press, 2015.

**DEPARTMENT OF
APPLIED CHEMISTRY**

LIST OF NEW COURSES (2020)

S. No	Course Code	Course Title	Credits			
			L	T	P	C
1	19CH3003	Internet of Chemical Things	3	0	0	3
2	19CH3004	Energy Conservation Technology	3	0	0	3
3	19CH3005	Waste Treatment Technology	3	0	0	3
4	19CH3006	Pharmaceutical Technology	3	0	0	3
5	19CH3007	Battery Technology	3	0	0	3
6	19CH3008	Corrosion Engineering	3	0	0	3
7	20CH1001	Essentials of Chemistry for Aerospace Engineers	3	0	0	3
8	20CH1002	Applied Chemistry for Electrical and Computer Engineering	2	0	2	3
9	20CH1003	Applied Chemistry for Food Processing Technology	2	0	0	2
10	20CH1004	Applied Chemistry Laboratory for Food Processing Technology	0	0	3	1.5
11	20CH1005	Principles of Environmental Chemistry	3	0	0	3
12	20CH1006	Public Health Service Laboratory	0	0	2	1
13	20CH2001	Complementary Chemistry	3	0	0	3
14	20CH2002	Physical Chemistry Laboratory	0	0	3	2
15	20CH2003	Inorganic Chemistry for Forensic Science	3	0	0	3
16	20CH2004	Inorganic Chemistry Laboratory	0	0	3	2
17	20CH2005	Analytical Chemistry for Forensic Science	3	0	0	3
18	20CH2006	Organic Chemistry for Forensic Science	3	0	0	3
19	20CH2007	Instrumentation Techniques for Forensic Science	3	0	0	3
20	20CH2008	Analytical Chemistry Laboratory	0	0	3	2
21	20CH2009	Forensic Chemistry	3	0	0	3
22	20CH2010	Forensic Toxicology	3	0	0	3
23	20CH2011	Forensic Toxicology Laboratory	0	0	3	2
24	20CH2012	Crime Investigation Techniques	3	0	0	3
25	20CH2013	Nanochemistry for Forensic Science	3	0	0	3
26	20FS2001	Fundamentals of Forensic Science	3	0	0	3
27	20FS2002	Crime and Society	3	0	0	3
28	20FS2003	Forensic Physics	3	0	0	3
29	20FS2004	Fundamentals of Forensic Science Laboratory	0	0	3	2
30	20FS2005	Indian Constitution, Fundamental Laws and Procedure	4	0	0	4
31	20FS2006	Forensic Dermatoglyphics	3	0	0	3
32	20FS2007	Forensic Science Laboratory	0	0	3	2
33	20FS2008	Forensic Science and Criminal Justice System	3	0	0	3
34	20FS2009	Forensic Physics Laboratory	0	0	3	2
35	20FS2010	Cyber Forensics Laboratory	0	0	3	2
36	20FS2011	Questioned Documents	3	0	0	3
37	20FS2012	Questioned Documents Laboratory	0	0	3	2
38	20FS2013	Forensic Dermatoglyphics Laboratory	0	0	3	2
39	20FS2014	Forensic Biology and Serology -I	3	0	0	3
40	20FS2015	Forensic Biology and Serology Laboratory	0	0	3	2
41	20FS2016	Forensic Ballistics	3	0	0	3
42	20FS2017	Forensic Ballistics Laboratory	0	0	3	2
43	20FS2018	Moot Court for Forensic Science	0	0	3	2
44	20FS2019	Cyber Crimes and Cyber Forensics	3	0	0	3
45	20FS2020	Fundamentals of Forensic Psychology	3	0	0	3
46	20FS2021	Crime Scene Investigation	3	0	0	3
47	20FS2022	DNA Typing	3	0	0	3

48	20FS2023	Forensic Medicine	3	0	0	3
49	20FS2024	Forensic Anthropology and Odontology	3	0	0	3
50	20FS2025	Accident Investigation	3	0	0	3
51	20FS2026	Forensic Biology And Serology -II	3	0	0	3
52	20FS2027	Modern Techniques In Explosives and Bomb Detection	3	0	0	3
53	20FS2028	Foundation Course on Computer Fundamentals and Office	3	0	0	3
54	20CH3001	Chemical Kinetics and Chemical Thermodynamics	3	0	0	3
55	20CH3002	Theories of Chemical Bonding	3	0	0	3
56	20CH3003	Organic Reaction Mechanism and Stereochemistry	3	0	0	3
57	20CH3004	Statistical Thermodynamics and Quantum Chemistry	3	0	0	3
58	20CH3005	Coordination Chemistry of Transition Elements	3	0	0	3
59	20CH3006	Principles of Molecular Spectroscopy	3	0	0	3
60	20CH3007	Synthetic Reagents and Methodology	3	0	0	3
61	20CH3008	Group Theory and Applied Physical Chemistry	3	0	0	3
62	20CH3009	Organometallic and Bioinorganic Chemistry	3	0	0	3
63	20CH3010	Pericyclic Reactions and Biomolecules	3	0	0	3
64	20CH3011	Qualitative and Quantitative Organic Analysis Lab	0	0	6	4
65	20CH3012	Qualitative Analysis and Inorganic Preparation Lab	0	0	6	4
66	20CH3013	Physical Chemistry Lab	0	0	6	4
67	20CH3014	Inorganic Quantitative Analysis lab	0	0	3	2
68	20CH3015	Modern Instrumental Analysis Lab	0	0	3	2
69	20CH3016	Synthetic Organic Chemistry Lab	0	0	3	2
70	20CH3017	Instrumental Methods of Chemical Analysis	3	0	0	3
71	20CH3018	Chemistry of non-Transition elements	3	0	0	3
72	20CH3019	Nuclear Chemistry and Solid State Chemistry	3	0	0	3
73	20CH3020	Organic Spectroscopy	3	0	0	3
74	20CH3021	Supramolecular Chemistry and Green Chemistry	3	0	0	3
75	20CH3022	Applied Electrochemistry	3	0	0	3
76	20CH3023	Research Methodology and IPR	3	0	0	3
77	20CH3024	Applied Polymer Chemistry	3	0	0	3
78	20CH3025	Laboratory Chemistry for the daily life	0	0	3	2
79	20CH3026	Forensic Chemistry	3	0	0	3
80	20CH3027	Advanced Photo and Electrocatalysis	3	0	0	3
81	20CH3028	Medicinal Chemistry	3	0	0	3
82	20CH3029	Photophysical Chemistry	3	0	0	3
83	20CH3030	Bioanalytical Chemistry and Biosensors	3	0	0	3
84	20CH3031	Nanomaterials Synthesis and Characterization	3	0	0	3
85	20CH3032	Stereoselective synthesis	3	0	0	3
86	20CH3033	Chemistry of Biofuels	3	0	0	3
87	20CH3034	Glass Forensic Science	3	0	0	3
88	20CH3035	Applied Chemical Crystallography	3	0	0	3
89	20CH3036	Chemistry of Carbenes	3	0	0	3
90	20CH3037	Metal-Organic Framework Materials	3	0	0	3
91	20CH3038	Advanced Main Group Chemistry	3	0	0	3
92	20CH3039	Chromatography	3	0	0	3
93	20CH3040	Water Treatment Technologies	3	0	0	3
94	20CH3041	Bioorganometallic Chemistry	3	0	0	3
95	20CH3042	Supramolecular Chemistry	3	0	0	3
96	20CH3043	Analytical Chemistry	3	0	0	3
97	20CH3044	Essentials of Forensic Chemistry	3	0	0	3
98	20CH3045	Forensic Tools and Techniques	3	0	0	3
99	20CH3046	Instrumental Methods of Analysis - I	3	0	0	3

100	20CH3047	Advanced Forensic Toxicology and Pharmacology	3	0	0	3
101	20CH3048	Instrumental methods of analysis - II	3	0	0	3
102	20CH3049	Forensic Chemistry Lab	0	0	3	2
103	20CH3050	Forensic Tools and Techniques Lab	0	0	3	2
104	20CH3051	Forensic Toxicology Lab	0	0	3	2
105	20CH3052	Instrumental Analysis Lab	0	0	3	2
106	20CH3053	Modern Instrumental Analysis Lab	0	0	3	2
107	20CH3054	Biochemistry and Biochemical Applications	3	0	0	3
108	20CH3055	Standards, Quality Management, Laboratory Management and Safety	3	0	0	3
109	20CH3056	IPR, Ethics and Research Methodology	3	0	0	3
110	20CH3057	Forensic Analysis of Drugs	3	0	0	3
111	20CH3058	Advanced Pharmaceutical Toxicology	3	0	0	3
112	20CH3059	Analytical Forensic Toxicology	3	0	0	3
113	20CH3060	Electrochemical Devices for Electric Vehicles	3	0	0	3
114	20CH3061	Entrepreneurship and Business Plan	2	0	0	2
115	20FS3001	Forensic Science and Criminal Justice System	3	0	0	3
116	20FS3002	Forensic Physics and Advanced Ballistics	3	0	0	3
117	20FS3003	Forensic Biology	3	0	0	3
118	20FS3004	Advanced Questioned Documents	3	0	0	3
119	20FS3005	Finger Prints and other Impressions	3	0	0	3
120	20FS3006	Crime Scene Management Lab	0	0	3	2
121	20FS3007	Forensic Physics and Ballistics Lab	0	0	3	2
122	20FS3008	Questioned Documents and Finger Print Analysis Lab	0	0	3	2
123	20FS3009	Cyber Crime	3	0	0	3
124	20FS3010	Forensic Psychology	3	0	0	3
125	20FS3011	Forensic Serology and Molecular Genetics	3	0	0	3
126	20FS3012	Forensic Phonetics, Voice Analysis and Speaker Recognition	3	0	0	3
127	20FS3013	Microscopy in Forensic Science	3	0	0	3
128	20FS3014	Biological Instrumental Methods	3	0	0	3
129	20FS3015	Statistics and Forensic Applications	2	0	0	2
130	20FS3016	Molecular Biology & Immunology	3	0	0	3
131	20FS3017	Medical Jurisprudence	3	0	0	3
132	20FS3018	Human Anatomy, Physiology and Forensic Medicine	3	0	0	3

Course Outcomes for the approved course 19CH1007- Applied Chemistry Lab

The student will be able to

1. Understand the kinetics of a chemical reaction
2. Analyze the water quality
3. Apply the electrochemistry principles.
4. Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials
5. Synthesize a small drug molecule
6. Analyze a salt sample

19CH3003	INTERNET OF CHEMICAL THINGS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide knowledge on chemical resource management
2. To impart knowledge on use of internet in molecular processes
3. To make the student understand about the challenges in IoCT

Course Outcome:

1. To know the use of computer programs in chemistry
2. To understand the importance of internet in chemistry
3. To utilize the information technology and library resources
4. To learn the IoCT concepts in molecular processes
5. To apply the knowledge of IoCT in analytical techniques
6. To know the problems of implementing IoCT

Module 1: Computers and Chemistry (9 hrs)

Introduction to Computers and Computing - Memory Devices - Secondary Storage - Computer Languages - Number Systems and Some Related Numerical Problems - Operating System - Principles Of Programming - Algorithms and Flow-Charts - Use of Computer Programmes - Operation of PC - Data Processing - Running of Standard Programs and Packages such as MS WORD - MS EXCEL - Emphasis on Calculations and Chart Formations. X-Y Plot

Module 2: Internet and Chemistry (10 hrs)

Application of Internet in Chemistry - Search Engines - Information Technology and Library Resources: The Internet and World Wide Web. Web resources - E-Consortium - UGC infonet - E-books - Internet Discussion Groups and Communities - Blogs - Search engines - Scirus - Google Scholar - ChemIndustry - Wiki- Databases - ChemSpider - Science Direct - SciFinder - Scopus

Module 3: Interconnection and Networking of Chemical Machines (10 hrs)

Internet of Chemical Things - Interconnection and Networking of Chemical Machines - Computing Devices and all Chemical Services Delivered through the Infrastructure of the Internet - Flow Chemistry – Use of Small Low Powered Computer Systems – Inexpensive Robotic and Computer Applications

Module 4: Use of IoCT in Molecular Processes (10 hrs)

Use of IoCT in Solvent Choice - Rate of Product Formation - Environmental Impact and Reagent Expense – Increased Data Collection – New Reactivity Schemes – Use of IoCT in Molecular Processes – IR Spectroscopy – Mass Spectroscopy - Remote Operation - Monitoring of Long-Term (Bio)Chemical Reactions – Microbial Fermentation Monitoring - Experimental Conditions

Module 5: Challenges in IoCT (6 hrs)

Safety of Experimenters - Challenges in IoCT- Size – Energy Consumption – Processing Power

Text Books:

1. C. J. Cramer, “Essentials of Computational Chemistry” 2nd ed., Wiley International, 2005
2. C. Hugh, “ Using Artificial Intelligence in Chemistry and Biology: A Practical Guide”, CRC Press, 2008
3. S. V. Ley, D. E. Fitzpatrick, R. J. Ingham and N. Nikbin, “The Internet of Chemical Things”, Beilstein Magazine, 2015, Issue 1, (doi: 0.3762/bmag.2). and references therein
4. S.-H. Chiu and P. L. Urban, “ Biosens. Bioelectron.”, 2015, 64, 260- 268 . and references therein

References:

1. J. R. Dean, A. M. Jones, D. Holmes, R. Reed, J. Weyers and A Jones, “Practical Skills in Chemistry” Pearson Education Ltd., 2002
2. G.R.D. Prabhua, H. A. Witeka and P. L. Urban, “Telechemistry: Following Chemical Reactions via Cloud Using the Particle Photon Wi-Fi Module”, Reaction Chemistry & Engineering, 2019, 4, 1616-1622, Royal Society of Chemistry (doi: 10.1039/C9RE00043G) and references therein
3. D. A. Skoog, F. J. Holler and S. R. Crouch, “ Principles of Instrumental Analysis” 7th Edition - Cengage International, Boston, 2017.

19CH3004	ENERGY CONSERVATION TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart knowledge on thermal and electrical utilities for evaluating energy saving potential
2. To impart knowledge on energy management and environmental impact
3. To facilitate the application of energy conservation techniques in process industries

Course Outcome:

1. To evaluate the performance of thermal utilities like furnace, boilers and steam distribution systems to improve efficiency

2. To evaluate the performance of electrical utilities like pumps, fans blowers to improve efficiency
3. To carryout performance assessment and suggest methods to improve the overall efficiency for different energy intensive industries
4. To develop procedures for conducting energy audit indifferent utilities in accordance with national and international energy regulation
5. To assess the energy generated/consumed at various industries
6. To carryout the energy and environmental impact analysis

Module 1: Energy Efficiency in Thermal Utilities (9 hrs)

Steam Engineering in Thermal and Cogeneration Plants -Steam Traps and Various Energy Conservation Measures; Boilers-Losses and Efficiency Calculation Methods, Controls. Furnaces-Heat Balance in Furnaces, Furnace Efficiency Calculations, Energy Conservation Opportunities in Furnaces, Insulation and Refractories.

Module 2: Energy Efficiency in Electrical Utilities (9 hrs)

Electrical System - Motor - Harmonics - Diesel Generator - Centrifugal Pumps - Fans And Blowers - Air Compressor - Lighting System –Energy Consumption and Energy Saving Potentials - Design Considerations.

Module 3: Energy and Environmental Impact Analysis (9 hrs)

Energy - Environment & Climate - Impact of Emission on Environment & Climate - Sources of emission - Types of Emissions from various Sectors Like Industry -Power - Human Activities - Agricultural Activities - Emission Estimation Methodologies

Module 4: Energy Management (10 hrs)

Scope of Energy Audit - Types of Energy Audit - Detailed Energy Audit Methodology - Role of Energy Managers in Industries; Energy Management System (Enms): ISO Standards - Implementing Energy Efficiency Measures - Detailed Project Report - Energy Monitoring and Targeting - Identification of Energy Conservation Measures / Technologies - Economic and Cost Benefit Analysis - ESCOS.

Module 5 :Industrial Case Studies (8 hrs)

Assessment of Energy Generation/Consumption in Thermal Station - Steel Industry - Cement Industry - Textile Industry Etc.

Text Books:

1. Godfrey Boyle, “Renewable Energy: Power for a Sustainable Future”, 3rd Edition, Oxford University Press, December 2012.
2. K.V. Sharma, Venkateshaiah. P, “Energy Management and Conservation”, Second Edition, I K International Publishing House Pvt. Ltd, November 2015.
3. Rajiv Shankar, “Energy Auditing in Electrical Utilities”, Viva Book Publishers, December 2014.

Reference Books:

1. Energy Audit Manual The Practitioner’s Guide, EMC-Kerala and NPC 2017.
2. Bureau of Energy Efficiency -Energy Management Series, 2006.
3. Eastop T.D and Croft D.R, “Energy Efficiency for Engineers and Technologists”, Logman Scientific and Technical, 1990
4. Reay D.A, “Industrial Energy Conservation”, Pergamon Press, 1979.
5. Openshaw Taylor E, "Utilisation of Electric Energy", Orient Longman Ltd, 2003.
6. Donald R Wulfinhoff, “Energy Efficiency Manual”, Energy Institute Press, 1999

19CH3005	WASTE TREATMENT TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives

1. To understand the different types of pollutants in water and land
2. To understand the environmental problems related to water and land
3. To know the recent developments in pollutant removal

Course Outcome:

1. To know about the components of various water pollutants
2. To characterize the waste in land and water
3. To understand the various physical and chemical treatment methods of water
4. To know about the legislation related to waste

5. To access the origin of hazardous wastes
6. To learn about the Hazardous waste regulation and management

Module 1: Overview of Physical and Chemical Treatment Of Water (9 Hrs)

Physical and Chemical Characteristics of Water – Significance of Physico-chemical Treatment – Principle and Objectives of Physical & Chemical Treatment Units - Screening - Aeration - Coagulation - Flocculation - Sedimentation - Filtration - Back Washing - Disinfection - Evaporation - Gas Transfer – Mass Transfer Coefficient.

Module 2: Chemistry of Water and Soil (9 Hrs)

Chemistry of Water and Waste Water – Water Pollution - Pollutants in Water - Water Quality Requirement - Potable Water Standards – Waste water Effluent Standards - Principles of Determination of Water Quality Parameters Like pH, Alkalinity, BOD, COD, Hardness - Lethal Doses of Pollutants – Sulphides, Chlorides, Ca, Mg, And Analysis of Minerals Fe, Mn, Ca, Mg In Water. Soil Chemistry- Acid Base And Ion Exchange Reactions in Soil, Salt Affected Soil and Its Remediation - Degradation of Food Stuffs, Detergents, Pesticides and Hydrocarbons.

Module 3: Solid Waste Generation and Legislation (9 Hrs)

Definition of Solid Waste- Waste Generation in A Technological Society- Major Legislation, Sources and Types of Solid Waste- Sampling And Characterization- Determination of Composition of MSW- Storage and Handling of Solid Waste - Collection and Transport Of Solid Waste: Collection Of Solid Waste: Type Of Waste Collection Systems, Analysis Of Collection System.

Module 4: Solid Waste Management (9 Hrs)

Separation - Processing and Transformation of Solid Waste: Unit Operations Used for Separation and Processing - Materials Recovery - Waste Transformation Through Combustion and Anaerobic Composting - Anaerobic Methods for Materials Recovery and Treatment - Recycling of Plastic Materials and Metals - Energy Recovery – Incinerators. Transfer and Transport: Methods - Transfer Station Types and Design Requirements. Landfills – Site selection – Design and Operation – Drainage and Leachate Collection Systems Integrated Waste Management Facilities.

Module 5: Hazardous Waste Management (9 Hrs)

Hazardous Waste Management: Definition and Identification of Hazardous Wastes- Sources and Characteristics - Hazardous Wastes in Municipal Waste- Hazardous Waste Regulations– Minimization of Hazardous Waste – Compatibility, Handling and Storage of hazardous Waste- Collection and Transport.

Text Books

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil “Integrated Solid Waste Management, McGraw-Hill International edition, New York, 1993.
2. CPHEEO “Manual on Municipal Solid Waste Management”, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.

References

1. Micheal D. LaGrega, Philip L Buckingham, Jeffrey C. Evans “Hazardous Waste Management”, McGraw-Hill International edition, New York, 2001.
2. Vesilind P A, Worrell W and Reinhart, “Solid Waste Engineering”, Thomson Learning Inc., Singapore, 2002.

19CH3006	PHARMACEUTICAL TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives

1. To make the student understand the basic principles of Pharmaceutical techniques
2. To create interest among students to involve in drug design and discovery
3. To give knowledge about different forms of drugs and production technology.

Course Outcome:

1. To understand the various stages in drug discovery and the process
2. To realize the effect of drug on molecular targets and its action
3. To learn the prodrug design and strategies to overcome drug resistance
4. To analyze the structure activity relationship of several common drugs
5. To design enzyme inhibitors that binds covalently and non-covalently

6. To learn the technology of making different dosage forms

Module 1: Drug Discovery (8 hrs)

Stages of Drug Discovery - Lead Discovery - Identification - Validation and Diversity of Drug Targets - Some Novel Molecular Targets along with their Pharmacodynamic Agents: Polyketide Synthase (Pks13) - Signal Transducer and Activator of Transcription-3 (STAT-3) and Sodium Glucose Cotransporter-2 (SGLT-2) - Stereochemistry and Drug Action: Pharmacodynamic - Pharmacokinetic (Drug Adsorption - Metabolism - Distribution and Elimination)-Toxicological Aspects of Stereoisomers (Geometrical - Optical and Conformational).

Module 2: Prodrug Design (7 Hrs)

Basic Concepts – Prodrugs - Drug Design - Combating Drug Resistance - Causes for Drug Resistance - Strategies to Combat Drug Resistance in Antibiotics Therapy - Genetic Principles Of Drug Resistance.

Module 3: Systematic Study of Drugs-I (7 Hrs)

Study of Drugs – SAR - Mechanism of Action and Synthesis (Synthesis Of Individually Mentioned Drugs only) of New Generation Molecules of Following Classes: Adrenergic Agents (Celiprolol - Olodaterol) - Cholinergic Agents (Sazetidine-A) - Antidepressants (Vortioxetine - Levomilnacipram) - Anticonvulsants (Levetiracetam - Perampanel) and Psychoactive Drugs (Brexipiprazole - Iloperidone).

Module 4: Systematic Study of Drugs –II (8 Hrs)

Systematic Study - SAR - Mechanism of Action and Synthesis (Synthesis Of Individually Mentioned Drugs Only) Of New Generation Molecules Of Following Classes: Anti-Hypertensive Drugs (Cilazapril - Sapisartan) - H1 And H2 Receptor Antagonists (Dimetindene - Olopatadine - Lafutidine) - Oral Hypoglycemic (Omargliptin - Dulaglutide) - Antineoplastic Agents (Alectinib - Capacitabine) - Anti-HIV Agents (Dolutegravir - Elvitegravir).

Module 5: Rational Design of Enzyme Inhibitors (7 Hrs)

Enzyme Kinetics and Principles of Enzyme Inhibitors - Enzyme Inhibitors in Medicine - Rational Design of Non-Covalently and Covalently Binding - Enzyme Inhibitors - Introduction To Artificial Enzymes – Introduction - Design and Therapeutic Applications of Peptidomimetics.

Module 6: Dosage Forms and Preparation (8 Hrs)

Emulsion – Tablets - Capsules (Hard - Soft) – Aerosol – Solution - Need For Different Dosage Forms - Ingredients in Pharmaceuticals - Colouring Agents – Cyclodextrin - Gels and Jellies - Flavours -Tablet Coating Technology - Drug Drying Technology – Dryers - Freeze Dryers – Evaporators – Filters – Extrusion - Equipment Cleaning – SOP - GLP and GMP.

Text Books

1. D. J. Abraham, “Burger’s Medicinal Chemistry and Drug Discovery”, John Wiley and Sons Inc., New York. 6th Ed. 2003
2. J. H. Block and J. M Beale, “Wilson and Gisvold’s Textbook of Organic Medicinal and Pharmaceutical Chemistry”, Lippincott Williams and Wilkins, Philadelphia. 12th Ed. 2010
3. T. L. Lemke and D. A. Williams, V. F. Roche and S. W. Zito, “Foye's Principles of Medicinal Chemistry”, Lippincott Williams and Wilkins, Philadelphia. 7th Ed. 2012

Reference Books:

1. R. S. Vardanyan and V. J. Hruby, “Synthesis of Essential Drugs”, Elsevier, Philadelphia. 2006
2. T. Nogrady, “Medicinal Chemistry: A Biochemical Approach”, Oxford University Press, New York. 3rd Ed. 2015
3. J. Swarbrick. “Encyclopedia of Pharmaceutical technology”, volume 1, 3rd ed., 2007

19CH3007	BATTERY TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the electrochemical reactions
2. To know the recent developments in battery technology
3. To understand the environmental problems related to batteries

Course Outcomes:

Students will be able to

1. To recognize the basic physical concepts of thermodynamics and kinetics involved in electrochemical reactions
2. To select the appropriate battery system with respect to application
3. To analyse the characterization methods of batteries and interpret the concepts describing battery performance
4. To describe the recent developments battery systems
5. To understand the requirements of battery systems for automotive applications and understand the modelling of battery systems
6. To discuss the Life Cycle Analysis according to cost and environmental aspects; material and energy consumption - reuse - recycling

Module 1: Introduction to Electrochemical Energy Storage (9 Hrs)

Introduction to Battery Technologies- Electromotive Force- Reversible Cells- Relation Between Electrical Energy and Energy Content of a Cell-Free Energy Changes and Electromotive Force in Cell- Current Challenges in Energy Storage Technologies.

Module 2: Major Battery Chemistries Development and Testing (9 Hrs)

Battery Performance Evaluation- Primary Battery - Service Time- Voltage Data- Service Life – Ohmic Load Curve- Effect of Operating Temperature on Service Life. Secondary Batteries- Discharge Curves - Terminal Voltages- Plateau Voltage –Lead Acid Batteries – Construction and Application.

Module 3: Recent Technologies (9 Hrs)

Recent Development of Electrode Materials in Lithium Ion Batteries- Recent Development Of Solid Electrolytes and their Application to Solid State Batteries-Polymer Solid Electrolytes for Lithium Ion Conduction– Thin Film Solid State Batteries: Fundamentals - Construction and Application – Super Capacitors: Fundamentals - Construction and Application.

Module 4: Batteries for Automotives (9 Hrs)

Batteries for Automotives - Future Prospects: Degrees of Vehicle Electrification – Battery Size Vs. Application -USABC And DOE Targets for Vehicular Energy Storage Systems

Module 5: Analysis and Simulation of Batteries (9 Hrs)

Equivalent Circuit and Life Modeling – Environmental Concerns in Battery Production – Recycling of Batteries

Text Books:

1. David Linden, Thomas B. Reddy, “Handbook of Batteries”, 3rd Edition, Mc-Graw Hill, New York, 2001.
2. Helena Berg, “Batteries for Electric Vehicles: Materials and Electrochemistry”, 1st Edition, Cambridge University Press, UK, 2015.

Reference books:

1. T. Minami, M.Tatsumisago, M.Wakihara, C. Iwakura and S. Kohjiya, “Solid State Ionics for Batteries”, Springer Publication, 2009.
2. Sandeep Dhameja, “Electric Vehicle Battery Systems” - Newnes Publication - 2001.

19CH3008	CORROSION ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the corrosion phenomenon and various types of corrosion
2. To know the methods involved in corrosion testing
3. To understand the effect of corrosion in industries

Course Outcomes:

1. To know the theoretical basis of corrosion formation the effects of corrosion
2. To analyze various types of corrosion
3. To apply various corrosion testing methods

4. To understand the various types of corrosion prevention methods
5. To describe the various types of corrosion occurring in industries
6. To apply the techniques to control corrosion in industries

Module 1: Principles of Corrosion Phenomenon (9 Hrs)

Thermodynamics and Kinetics: Emf/Galvanic Series - Pourbaix Diagram - Exchange Current Density - Passivity - Evans Diagram - Flade Potential.

Module 2: Different Forms Of Corrosion (9 Hrs)

Atmospheric/Uniform - Pitting/Crevice - Intergranular - Stress Corrosion - Corrosion Fatigue - Dealloying - High Temperature Oxidation-Origin and Mechanism with Specific Examples.

Module 3: Corrosion Testing And Monitoring (9 Hrs)

Non-Electrochemical and Electrochemical Methods - Weight Loss Method - Tafel - Linear Polarization and Impedance Techniques - Lab - Semi Plant & Field Tests - Susceptibility Test.

Module 4: Corrosion Prevention (9 Hrs)

Corrosion Prevention through Design - Coatings - Inhibitors - Cathodic - Anodic Protection- Specific Applications- Economics of Corrosion Control.

Module 5: Corrosion & Its Control In Industries (9 Hrs)

Power - Process - Petrochemical - Ship Building - Marine and Fertilizer Industries - Some Case Studies- Corrosion and its Control in Different Engineering Materials: Concrete Structures - Duplex - Super Duplex Stainless Steels - Ceramics - Composites and Polymers -Corrosion Auditing in Industries - Corrosion Map of India.

Text Books:

1. Raj Narayan, "An Introduction to Metallic Corrosion and Its Prevention", Mohan Primlani for Oxford & IBH Publishing Company, 1983.
2. R. Winston Revie, "Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering", 4th Edition, Wiley-Interscience, 2010.

Reference Books:

1. Mars G. Fontana, "Corrosion Engineering" - 3rd Edition, Tata McGraw Hill, New Delhi, 2005.
2. Denny A. Jones, "Principles and Prevention of Corrosion", 2nd Edition, Prentice Hall, 1996.

20CH1001	Essentials of Chemistry for Aerospace Engineers	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the students to

1. conversant with the fundamentals of atomic structures
2. develop curiosity towards fuels, energy resources and storage devices
3. acquire knowledge about spectroscopy

Course Outcomes:

The Student will be able to

1. formulate atomic structures and correlate its properties
2. realize the potential applications of protective coating
3. relate the unique properties of fuels
4. analyze the combustion process of common fuels
5. learn the various energy storage systems and conversion devices
6. describe the techniques involved in spectroscopy.

Module 1: Atomic structure (8 Hours)

Introduction, dual nature of electron, Heisenbergs uncertainty principle, quantum mechanical model of an atom, wave mechanical model of hydrogen atom, concept of atomic orbital's, electron spin, Pauli Exclusion Principle.

Module 2: Protective coatings (7 Hours))

Introduction, metallic coating, electroplating and its methods, electroless plating, organic coating, paints, analysis of oils, formulation of paints, failure of paint films, enamels, Varnishes, lacquers, emulsion paints, high temperature paints, special paints

Module 3: Fuels and combustion (7 Hours))

Fuels-classification, Characteristics of good fuel, calorific value, bomb calorimeter, - Proximate analysis of coal and its significance- -Knocking-octane number, cetane number, antiknocking characteristics of petrol, cracking, synthetic petrol, refining of gasoline, diesel, kerosene, biomass - Biogas-production, Flue Gas Analysis Orsat Method

Module 4: Explosives and propellants (7 Hours))

Introduction to explosives, classification of explosives, primary explosives, low explosives, high explosives, precautions during storing of explosives, blasting fuses, rocket propellants, classification of propellants.

Module 5: Energy sources and storage devices (8 Hours))

Redox reactions electrode potential - Nernst Equation - Electrochemical series and significance - Electrochemical cell, reference electrode - Batteries dry cell -Lead acid battery - Fuel cell - Solar battery- Electrochemical sensors -Relationship between electrical energy and heat energy Gibbs Helmholtz equation, Photovoltaics

Module 6: Spectroscopy (8 Hours))

Introduction, types of energy present in molecules, general features of absorption spectrometer, infrared spectra, Frank Condon principle, UV and visible spectra, microwave spectroscopy, Nuclear magnetic spectroscopy, Raman spectroscopy, flame photometer, Atomic absorption spectroscopy, mass spectroscopy.

Content beyond syllabus

Prepare a high temperature paint with Nano-additives and determine its heat transfer rate or any other topic from the syllabus.

Text Books:

1. Jain and Jain “Engineering Chemistry” 16th Edition, Dhanpat Rai Publishing Company, NewDelhi, 2017
2. Mahan B. M and Meyers, R. J, “University Chemistry”, 4th edition, Pearson, 2009

Reference Books:

1. Sienko M. J. and Plane R. A., “Chemistry: Principles and Applications”, 3rd Edition, McGrawHill, 1980
2. Tembe B. L., Kamaluddin and M. S. Krishnan, “Engineering Chemistry” (NPTEL Web-book)
3. Atkins P. W and Julio de Paula “Physical Chemistry”, 8th Edition, Oxford University press, 2007

20CH1002	Applied Chemistry for Electrical and Computer Engineering	L	T	P	C
		2	0	2	3

Course Objectives

Enable the students to

1. apply the properties of nanomaterials in electrical engineering
2. familiarize with energy storage devices and corrosion coatings
3. describe the importance of liquid crystals

Course Outcomes

The students will be able to

1. summarize the importance of electrochemical cells
2. describe various types of corrosion
3. apply various corrosion control methods
4. summarize various types of energy storage devices
5. infer the importance of liquid crystalline materials
6. discuss the importance of nanomaterials

Module 1: Electrochemistry (5 Hours)

Redox reactions, electrode potential, Nernst Equation, Electrochemical series and significance, Electrochemical cell – EMF of an electrochemical cell – Potentiometric titration

Module 2: Corrosion and Types: (5 Hours)

Definition – Consequences of corrosion - Dry Corrosion – types – mechanism – Wet corrosion – Mechanism – Galvanic corrosion – concentration cell corrosion – passivity – Pitting corrosion - Galvanic series

Module 3: Factors affecting Corrosion and Control Methods (5 Hours)

Factors influencing corrosion - Nature of metal –Nature of the environment - Corrosion control methods –Proper designing – using metals – metal alloys – cathodic protection – modifying the environment – Use of inhibitors – Application of protective coatings - Organic coatings

Module 4: Energy sources and storage devices (5 Hours)

Batteries – types – Primary cells - Dry batteries – Secondary cell - Lead acid batteries- Hydrogen – fuel cells – Microbial fuel cells - Solar battery – photovoltaics - -Electrochemical sensors

Module 5: Liquid Crystals (5 Hours)

classification, thermotropic and Lyotropic liquid crystals, Applications of liquid crystals – Liquid crystal display – Importance of lyotropic liquid crystals – Application of graphene oxide liquid crystal in energy storage – Liquid crystalline semiconductor materials

Module 6: Nanomaterials (5 Hours)

Nanomaterials – Classification –Top down and Bottom up Approaches – ball milling - microfabrication - characterization of nanomaterials – Introduction to XRD, SEM -Applications of nanomaterials - Nano-electronics - Nanostructured Solar Cells - Advantages.

LIST OF EXPERIMENTS (Any 8)

1. Estimation of copper in an alloy
2. Determination of percentage of nickel in an alloy
3. Evaluation of corrosion inhibition by weight loss method
4. Measurement of electrode potentials of metals/alloys
5. Construction of a Galvanic cell
6. Preparing batteries from fruits and vegetables
7. Determination of iron by potentiometry
8. Estimation of an acid by conductometry
9. Preparation of nanoparticles
10. Preparation of nanoparticles in polymer matrix
11. Measurement of pH
12. Determination of Melting point and boiling point

Text Books:

1. Jain and Jain “Engineering Chemistry” 16th Edition, Dhanpat Rai Publishing Company, NewDelhi, 2017
2. Mahan B. M and Meyers, R. J, “University Chemistry”, 4th edition, Pearson, 2009
3. Jones R. M., "Mechanics of Composite Materials", Hemisphere Publishing Corporation, New York
4. Elias, A. J., A Collection of Interesting General Chemistry Experiments, Revised Edition, Universities Press, 2007

Reference Books:

1. Sienko M. J. and Plane R. A., “Chemistry: Principles and Applications”, 3rd Edition, McGrawHill, 1980
2. Tembe B. L., Kamaluddin and M. S. Krishnan, “Engineering Chemistry” (NPTEL Web-book)
3. Atkins P. W and Julio de Paula “Physical Chemistry”, 8th Edition, Oxford University press, 2007
4. Chawla, K. K., “Composite Materials, Science and Engineering”, ISBN: 978-0-387- 74365, Springer.
5. Daniel, I. M. and Ishai O., Engineering Mechanics of Composite Materials, Oxford University Press, 2nd Edition, 2005.

20CH1003	Applied Chemistry for Food Processing Technology	L	T	P	C
		2	0	0	2

Course Objectives

Enable the students to

1. summarize the importance of polymers and colloids in food processing technology

2. familiarize with nanomaterials and composites
3. discuss about renewable batteries and characterization techniques

Course Outcomes

The students will be able to

1. categorize various types of polymers used in food processing technology
2. describe the applications of colloids in food processing
3. summarize the use of nanomaterials in food processing technology
4. apply the nanocomposites in food processing technology
5. describe the use of bio-batteries
6. discuss about the characterization techniques of biomolecules

Module 1: Polymers for Food Processing (5 Hours)

Introduction - thermosetting plastics - thermoplastics- ingredients used in compounding of plastics — Polymers in Food processing industries – Characteristics – Plastics in Food Technology - Examples - Polytetrafluoroethylene (PTFE)- Poly ether ether ketone (PEEK)

Module 2: Food Colloids (5 Hours)

Colloids – types – Micelles - application of colloids in food industry – food hydrocolloids - classification- colloidal medicines

Module 3: Nanomaterials for food processing and preservation (5 Hours)

Nanomaterials – Classification –Top down and Bottom up Approaches – ball milling - microfabrication - - Fullerenes – carbon nanotubes --Applications in food technology – edible coating --encapsulation –

Module 4: Application of composites in Food Processing Technology (5 Hours)

Composite materials - Constituents – Classification - Advantages of Composites materials — Applications – Difference between Alloys and composites – nanocomposites – types (ceramic matrix, polymer-matrix, metal-matrix) — Composites for food packaging – reducing food spoilage -examples

Module 5: Renewable energy for food preservation (5 Hours)

Batteries – types - Dry battery – Lead acid battery – Hydrogen – Oxygen Fuel Cells– Bio-mass – Bio-gas - Bio-battery – working principles – Enzymatic bio-battery - Microbial bio-battery – Applications – Generating renewable energy from food waste using bio-battery

Module 6: Spectroscopic techniques for food analysis (5 Hours)

Electromagnetic spectrum – Spectroscopic techniques – Applications of electronic and vibrational spectroscopy in characterization of food analysis

Text Books:

1. Jain and Jain “Engineering Chemistry” 16th Edition, Dhanpat Rai Publishing Company, NewDelhi, 2017
2. Mahan B. M and Meyers, R. J, “University Chemistry”, 4th edition, Pearson, 2009
3. Rath, P, “Engineering Chemistry”, Cengage Learning, 2015

Reference Books:

1. Gutiérrez, T. J, “Polymers for Food Applications” Springer International Publishing, 2018
2. Gao, Y, Mohammadifar, M and Choi, S, "From Microbial Fuel Cells to Biobatteries: Moving toward OnDemand Micropower Generation for Small Scale Single Use Applications", Advanced Materials Technologies, 2019, 190079, DOI:10.1002/admt.201900079
3. Tembe B. L., Kamaluddin and M. S. Krishnan, “Engineering Chemistry” (NPTEL Web-book)
4. Chawla K. K, “Composite Materials-Science and Engineering”, Springer, 2019 ISBN: 978-3-030-28982-9
5. Banwell, C. N, “Fundamentals of Molecular Spectroscopy”, 4th Edition, Tata McGraw-Hill India Ltd, 2010

20CH1004	Applied Chemistry Laboratory for Food Processing Technology	L	T	P	C
		0	0	3	1.5

Course Objectives

Enable the students to

1. perform quantitative estimation of biomolecules
2. demonstrate experiments based on electrochemical techniques
3. synthesize and characterize nanomaterials

Course Outcomes

The students will be able to

1. demonstrate the spectroscopic techniques of analysis
2. quantitative estimation of biomolecules
3. prepare nanomaterials
4. analyze samples using electrochemical techniques
5. separate compounds using chromatographic techniques
6. perform conductance based experiments

LIST OF EXPERIMENTS

1. Qualitative tests for carbohydrates
2. Quantitative method for amino acid
3. Quantitative method for protein estimation
4. Quantitative method for cholesterol estimation
5. Synthesis of biodiesel from vegetable oil
6. Preparing batteries from fruits and vegetables
7. Estimation of nucleic acids by absorbance at 260 nm and its hyperchromic effect.
8. Determination of iron by potentiometry
9. Estimation of iron by spectrophotometry
10. Construction of a Galvanic cell
11. Analysis of Water
12. Investigation of biodiesel fuel and petroleum based fuel using IR spectroscopy
13. Extraction of lipids and analysis by paper chromatography and TLC.
14. Determination of free fatty acid content in fats and oils
15. Qualitative and quantitative estimation of adulterant in common food items
16. Estimation of non nutritive sweeteners
17. Estimation of effects of antioxidants usage in foods.
18. Observation of the effect of anticaking agents in foods.
19. Estimation of thickeners and their effects in foods.
20. Measurement of electrode potentials of metals/alloys
(Minimum 10 Experiments to be conducted)

Text Books:

1. Elias A. J., "A Collection of Interesting General Chemistry Experiments", Revised Edition, Universities Press, 2007
2. Khosla, B. D., Garg, V. C., and Gulati, A. R., "Senior Practical Physical Chemistry" Chand & Co.: New Delhi, 2011.
3. Garland, C. W.; Nibler, J. W. and Shoemaker, D. P., "Experiments in Physical Chemistry", 8th Edition, McGraw-Hill, New York, 2003.
4. Halpern, A. M. and McBane G. C., "Experimental Physical Chemistry", W.H. Freeman & Co. New York, 2003.
5. Jain and Jain "Engineering Chemistry" 16th Edition, Dhanpat Rai Publishing Company, NewDelhi, 2017

20CH1005	Principles of Environmental Chemistry	L	T	P	C
		3	0	0	3

Course Objectives

Enable the students to

1. develop to understand the water technology, waste water and its treatment
2. conversant with the fundamentals of Corrosion and corrosion control
3. acquire knowledge about solid waste management

Course Outcome

Students will be able to

1. understand the various factors in water quality
2. learn the various water purification process and their applications
3. describe the process of corrosion

4. identify the methods to control corrosion
5. analyze the components present in cement
6. realize the solid waste management applications

Module 1: Water Technology (8 Hours)

Sources of water – Impurities in water - Hardness, Units and calculation of hardness – Determination of hardness by EDTA method -Disadvantages of water – Scales – Sludges – Internal conditioning – Calgon& carbonate conditioning In Caustic embrittlement – causes (DO, CO₂, acids) & removal methods – Alkalinity – Calculation of alkalinity – Determination of dissolved oxygen – water borne diseases

Module 2: Water Treatment (7 Hours)

Unit operations and processes - principle and functions of flash mixers, flocculators, sedimentation tanks, filtration, aeration, disinfection - distribution network - water softening. - Desalination – Electrodialysis - Reverse Osmosis

Module 3: Waste Water Treatment (7 Hours)

Layout of municipal wastewater treatment plant, physical unit operation – screening - flow equalization - flocculation, sedimentation - chemical precipitation - aerobic and anaerobic treatment process –sewage treatment plant (stp) - septic tank.

Module 4: Corrosion and its control (8 Hours)

Dry Corrosion – Oxidation corrosion – mechanism – Wet corrosion – Mechanism – Galvanic corrosion – Galvanic series – Factors influencing corrosion - Corrosion control methods

Module 5: Cement and its effects on Environment (8 Hours)

Cement – Introduction – classification, Portland cement – Manufacture – Properties, Chemical composition of cement -Setting and Hardening of Portland cement –. Special cements – CO₂ emission from cement manufacturing and its effect on the environmental pollution

Module 6: Solid Waste Management (7 Hours)

Municipal solid waste (MSW) - composition and various chemical and physical parameters of MSW - Effects of solid waste on environment

Text Books:

1. Jain and Jain “Engineering Chemistry” 16th Edition, Dhanpat Rai Publishing Company, NewDelhi, 2017
2. Mahan B. M and Meyers, R. J, “University Chemistry”, 4th edition, Pearson, 2009
3. Jones R. M., "Mechanics of Composite Materials", Hemisphere Publishing Corporation, New York

Reference Books:

1. Sienko M. J. and Plane R. A., “Chemistry: Principles and Applications”, 3rd Edition, McGrawHill, 1980
2. Tembe B. L., Kamaluddin and M. S. Krishnan, “Engineering Chemistry” (NPTEL Web-book)
3. Chawla, K. K., “Composite Materials, Science and Engineering”, ISBN: 978-0-387- 74365, Springer. (2012),
4. Daniel, I. M. and Ishai O., “Engineering Mechanics of Composite Materials”, Oxford University Press, 2nd Edition, 2005.

20CH1006	Public Health Service Laboratory	L	T	P	C
		0	0	2	1

Course Objectives

Enable the students to

1. Analyze the water properties
2. Utilize electrochemistry based experiments
3. Estimate the amount of an analyte in a sample

Course Outcomes

The students will be able to

1. perform experiments related water analysis
2. perform conductance based experiments
3. demonstrate the spectroscopic techniques of analysis
4. quantitative estimation of analyte present in a sample

5. investigate an unknown compound
6. perform corrosion related experiments

List of Experiments

1. pH in given sample
2. Electrical conductivity and Total Dissolved Solids (TDS).
3. Total solids and settleable solids present in given sample
4. Alkalinity in given sample
5. Acidity in given sample
6. Turbidity and optimum coagulant dose of a sample from jar test experiment
7. Hardness in given sample
8. Chlorides in given sample
9. Dissolved Oxygen (DO) and Bio-chemical Oxygen Demand (BOD) for given sample
10. Chemical Oxygen Demand (COD)
11. Sulphates present in sample
12. Estimation of iron in water sample by spectrophotometry
13. Estimation of copper in an alloy
14. Determination of percentage of nickel in an alloy
15. Evaluation of corrosion inhibition by weight loss method
16. Measurement of electrode potentials of metals/alloys

Text Books:

1. Jain and Jain "Engineering Chemistry" 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017
2. Elias, A. J., A Collection of Interesting General Chemistry Experiments, Revised Edition, Universities Press, 2007

20CH2001	Complementary Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basic concepts in chemistry
2. realize the importance of atomic structure and chemical bonding
3. learn the physical properties of liquids and colloids

Course Outcomes:

The student will be able to

1. realize the importance of acids and bases
2. summarize the importance of the atomic structure
3. understand the theories of chemical bonding
4. learn the physical properties of liquid
5. understand the basics of surface chemistry
6. recognize the importance of colloids in forensic science

Unit 1: Fundamental Concepts in Chemistry (9 Hours)

Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Oxidation number and valency - Equivalent mass. Methods of expressing concentration: Concept of Equilibrium: Acids and Bases - Arrhenius, Lowry-Bronsted and Lewis theories. Ionic product of water - pH and pOH, Strengths of acids and bases - K_a and K_b , pK_a and pK_b . Electrode potential – Electrochemical series - Buffer solution. Preparation of buffer solution having a known pH. Solvation, solubility, solubility product, common ion effect and their applications.

Unit 2: Atomic Structure (9 Hours)

Bohr's theory, atomic spectrum of hydrogen atom, Sommerfield's atomic models, de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrodinger's wave equation. Quantum numbers, Atomic orbitals; shapes, radial and angular probability diagrams of s, p and d orbitals. Pauli's exclusion principle, Hund's rule, Aufbau principle and its limitations. Orbital energy with atomic number.

Unit 3. Chemical bonding (9 Hours)

Types - Ionic bonding - general characterization, types of ion, packing of ion in crystals, lattice energy. Covalent bonding – general characteristics, valence bond approach-, Hybridization – examples - MO Theory: Rules for the LCAO method,, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules and heteronuclear diatomic molecules such as CO and NO. Comparison of VB and MO approaches.valence shell electron pair repulsion (VSEPR) theory. Coordinate covalent bond, Hydrogen bond (theories of hydrogen bonding, valence bond treatment). Weak forces - Metallic bond.

Unit 4: Physical Properties of Liquids (9 Hours)

Physical Parameters of Liquid- Surface tension- Hydrostatic Pressure-Viscosity-Density- Vapor pressure- molar refraction-optical activity structure of liquid- Relative density-free volume of liquid and density measurement- Method of exploring concentration of solutions-binary liquids-vapor pressure-composite diagram of binary liquids and solutions- physical properties of blood

Unit 5: Surface Chemistry and Colloids (9 Hours)

Adsorption – Types – Langmuir and van der Waal's adsorption isotherm – Colloids – Types – preparation and properties – Surfactants – Micelles – Colloids and Forensic science – Application of Electrophoresis

References

1. R.K.Prasad, "Quantum Chemistry" –4th Edition, New Age International (2010)
2. B.R. Puri, L.R. Sharma and K.C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi, 2007.
3. Lee J. D, "Concise Inorganic Chemistry", Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint (2009).
4. CNR Rao, "University Chemistry", Universities Press (1999)
5. Manas Chanda, "Atomic structure and chemical bonding". Tata Mc, Grawhill (2007)
6. Samir K Banerji, "Environmental Chemistry", Prentice – Hall of India PvtLts New Delhi (2007).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					3		
CO2	3		2				2		
CO3	2			3			2		
CO4	2	1						3	
CO5	3				2		3		
CO6	1			1					2

'3'-High, '2'- Medium, '1'-Low, '- ' No correlation

20CH2002	Physical Chemistry Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn the fundamental principles and functions of crime lab services
2. learn various types of chemical analysis.
3. understand the working of the crime labs to fbi.

Course Outcomes:

The student will be able to

1. review the handling physical evidence
2. depict the data on different type of crime cases
3. write report on different type of analysis
4. examine the list of sample characterisation
5. compare and contrast the role of a crime lab services.
6. understand the chemistry of firearms

List of Experiments

1. Crime Lab Services – from local labs to the FBI -I
2. Handling Physical Evidence
3. Identification of evidence using microscopy – The example of hair analysis
4. Crime Lab Services – from local labs to the FBI -II

- Chemistry and Firearms
- Chemistry of Fingerprint Collection
- Introduction to Sample Characterization Using Microscopy
- Fingerprint Chemistry
- Analysis of Glass Samples
- Analysis of Pen Inks by TLC and Spectroscopic Methods
(Minimum 10 Experiments to be conducted)

Text books:

- Skoog, D. A, West, D. M and Holler, F. J, "Fundamentals of Analytical Chemistry", 6th Edition, Saunders College Publishing, Fort Worth (1992).
- W. Kemp, Organic Spectroscopy, 3rd Edition, Macmillan, Hampshire (1991).
- J.W. Robinson, Undergraduate Instrumental Analysis, 5th Edition, Marcel Dekker, Inc., New York (1995).
- D.R. Redsicker, The Practical Methodology of Forensic Photography, 2nd Edition, CRC Press, Boca Raton (2000).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		2			3	1		3	3	2
CO2	1	3						2	1	
CO3	1	2			3		2	2	2	2
CO4					1	3	1	3	3	1
CO5						2	3	2	3	3
CO6				3	2			3	2	3

'3'-High, '2'- Medium, '1'-Low, '-'No correlation

20CH2003	Inorganic Chemistry for Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

- learn about periodic properties and nuclear chemistry
- understand the chemistry of transition metals
- learn the applications of various metals in Forensic Science

Course Outcomes:

The student will be able to

- understand the periodic properties
- learn the applications of radioisotopes
- understand the nature of bonding in coordination complexes
- predict the factors affecting the stability of metal complexes
- summarize the importance of metals in biology
- realize the role of metals in Forensic science

Unit 1: Periodic properties (9 Hours)

Periodic Properties: Modern periodic table – General characteristics of periods and groups –Periodicity in properties: Atomic radii, ionic radii, ionization enthalpy, electron affinity (electron gain enthalpy) and electronegativity (Pauling scale)Diagonal relationships – General characteristics of s, p, d and f block elements: introduction, properties, and their position in periodic table.

Unit 2: Nuclear Chemistry and Radioactivity (9 Hours)

Nucleus – composition – Binding energy – Stability – Isotopes, Isobars and isotones – Radiation – characteristics of α , β and γ radiation – Nuclear reactions – Applications of radioisotopes – Radioactive tracers

Unit 3: Coordination Chemistry (9 Hours)

Ligands – Examples – Complex formation – Werner's theory – Sidgwick theory – Valence bond theory – Tetrahedral and octahedral complexes – Crystal field theory – CFSE –Factors affecting magnitude of $10Dq$ –Spectrochemical series – MO theory - stability – Factors affecting stability – Chelate and macrocyclic effect - Detection of complex formation

Unit4: Bioinorganic Chemistry (9 Hours)

Metal ions in biological systems – Biochemistry of iron – Haemoglobin and Myoglobin, Mechanism of O₂, CO₂ transportation, Elementary idea of structure and mechanism of action of sodium potassium pump, Biochemistry of zinc and cobalt – Enzyme action – Examples

Unit 5: Metal complexes in Forensic science (9 Hours)

Heavy metal poisoning – Arsenic, Antimony, Barium, Copper, Iron, Lead, mercury, Thallium, Zinc – methyl mercury – detection - Schiff bases and their applications in forensic sciences – cupric arsenite

Text Books:

1. Lee J. D, "Concise Inorganic Chemistry", Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Shriver and Atkins, "Inorganic Chemistry", Oxford University Press, New Delhi, India, 4th edition, 2009.
3. Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
4. Madan W. H, Tuli G. D, Madan R. D., "Selected Topics in Inorganic Chemistry", S. Chand & Company Ltd, Reprint 2009.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					3		
CO2	3		2				3		
CO3	3			3			2		
CO4	2	1						2	
CO5	3				2		3		
CO6	1			1					2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH2004	Inorganic Chemistry Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn the principle of volumetric titration and estimate the given unknown solution
2. understand the principles of chemical analysis
3. practice precise and accurate analysis

Course Outcomes:

The student will be able to

1. prepare standard solutions of known concentration
2. estimate different species in the unknown solution
3. identify qualitatively the inorganic salt
4. prepare inorganic metal complexes
5. estimate the given acid by instrumentation methods
6. enhance the analytical skill

LIST OF EXPERIMENTS

1. Preparing 0.01N H₂SO₄ standard solution and finding out the strength of NaHCO₃, in washing Soda
2. To determine the strength of oxalic acid solution by permanganometry.
3. To estimate dissolved oxygen in water sample
4. Qualitative Analysis of Inorganic salt I.
5. Qualitative Analysis of Inorganic salt mixture-II
6. Qualitative Analysis of Inorganic salt-III
7. Qualitative Analysis of Inorganic salt mixture-IV
8. To prepare metal complex -I
9. To Prepare metal complex- II
10. Estimation of Fe³⁺ by spectrophotometer
11. To determine the strength of acid by pH meter

12. To determine the strength of acid by conductometry
 (Minimum 10 experiments to be conducted)

Text books:

1. Svehla G., "Vogel's Textbook of Qualitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression 2008.
2. J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas "Vogel's Quantitative Chemical Analysis", 6th edition, 7th Impression, Dorling Kindersley limited, New Delhi, India, 2008

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1		1			2		2		
CO2		2	3	1	2		3		
CO3		2			3		2	1	
CO4		1			2		1	2	
CO5		1			2	3	1	1	3
CO6		3	1	2			2		1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH2005	Analytical Chemistry for Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the procedure for handling chemicals and analysis
2. know the general purification techniques and titrimetric methods
3. learn the general separation techniques and thermoanalytical methods

Course Outcomes:

The student will be able to

1. know the methodology to handle chemicals, heating methods and error analysis
2. understand the principle of techniques used for the purification of compounds
3. know about importance of various titrimetric methods
4. get knowledge about solubility criteria, precipitation titrations and gravimetric analysis
5. receive the importance of thermogravimetric, differential thermal and electrogravimetry analysis
6. understand the basics of analytical chemistry for application in forensic science

Unit 1: Handling of Chemicals and Analysis (9 Hours)

Safety and hygiene in the Chemistry lab- Storage and handling of chemicals, handling of acids, ethers, toxic and poisonous chemicals, antidotes, threshold vapour concentration and first aid procedure – Heating methods, stirring methods, filtration techniques – Error in chemical analysis – Accuracy, precision, types of error-absolute and relative error, methods of eliminating or minimizing errors – Methods of expressing precision: mean, median, deviation, average deviation and coefficient of variation – Significant figures and its application with respect to the glassware used - Normal error curve and its importance.

Unit 2: General Purification Techniques (9 Hours)

Purification of solid organic compounds, recrystallisation, use of miscible solvents, use of drying agents and their properties, sublimation - Purification of liquids - Experimental techniques of distillation, fractional distillation, distillation under reduced pressure. Extraction, use of immiscible solvents, solvent extraction - Chemical methods of purification and test of purity.

Unit 3: Titrimetric Methods (9 Hours)

General principle - Types of titrations - Requirements for titrimetric analysis - Concentration systems: Molarity, formality, normality, wt%, ppm, milliequivalence and millimoles-problems - Primary and secondary standards, criteria for primary standards – preparation of standard solutions, standardization of solutions - Limitation of volumetric analysis, endpoint and equivalence point - Acid-base equilibria - pH of strong and weak acid solutions - Buffer solutions - Henderson equations - Preparation of acidic and basic buffers. Relative strength of acids and bases from K_a and K_b values - Neutralisation-titration curve, theory of indicators, choice of indicators - Use of phenolphthalein and methyl orange - Complexometric

titrations - Stability of complexes, titration involving EDTA - Metal ion indicators and characteristics - Problems based on titrimetric analysis.

Unit 4: Solubility Equilibria (9 Hours)

General separation techniques -Solubility and solubility products, expressions for solubility products - Determination of solubility from solubility products - Precipitation titrations -Argentometric titrations, indicators for precipitation titrations involving silver - Determination of chloride by Volhard's method - Adsorption indicators - Gravimetric methods of analysis - Separation by precipitation, factors affecting solubility, gravimetric factor. Purity of precipitates, von Weiman ratio - Co-precipitation, post precipitation.

Unit 5: Thermoanalytical Methods (9 Hours)

Thermoanalytical methods - principle involved in thermogravimetric analysis and differential thermal analysis - characteristics of TGA and DTA - thermograms – factors affecting TGA and DTA curves - discussion of various components of the instrument with block diagrams - Applications of thermogravimetry - Applications of DTA - thermometric titration - Electrogravimetry - principle and applications.

Text Books:

1. D.A. Skoog, D.M. West and F.J. Holler, Analytical Chemistry: An Introduction, 5th edition, Saunders college publishing, Philadelphia, 1990.
2. U.N. Dash, Analytical Chemistry: Theory and Practice, Sultan Chand and sons Educational Publishers, New Delhi, 1995.
3. R.A. Day Jr. and A.L. Underwood, Quantitative Analysis, 5th edition, Prentice Hall of India Private Ltd., New Delhi, 1988.
4. R. Gopalan, Ps Subramanian and K. Rengarajan, Elements of Analytical Chemistry, S. Chand and Co., New Delhi, 2004.
5. Gurdeep R. Chatwal and Sham K. Anand, Instrumental Methods of Chemical Analysis, 5th edition, Himalaya Publishing House, 2018.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	1	2	1
CO2	-	1	1	1	1	1	1	2	3
CO3	-	1	1	1	1	1	1	2	3
CO4	-	1	1	1	1	1	1	2	3
CO5	-	1	1	1	1	1	1	2	3
CO6	1	1	1	1	1	1	1	2	3

“3”– High; “2”– Medium; “1”– Low; “-”– No correlation

20CH2006	Organic Chemistry for Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the chemical reactions, which are mostly used to synthesize compounds of various types, and their mechanism
2. distinguish the types of reactions and structure determination
3. understand the stereochemistry of compounds and biological molecules.

Course Outcomes:

The student will be able to

1. describe the basic principles of chemical structures and its bonding characteristics
2. predict the organic reaction mechanisms of organic reactions
3. understand the structures of heterocyclic compounds
4. describe the reaction intermediates
5. explain the principles of stereochemistry.
6. relate the applications of the biological molecules in various domains

Unit 1: Introduction to Electronic Effects (7 Hours)

Nature of bonds, Hybridisation in organic molecules, Homolysis and heterolysis of bonds, Electron displacement in organic compounds – Inductive, Electronic and Mesomeric effects- Influence of Inductive effect on acidic and basic properties of organic compounds. Hyperconjugation and steric effects

Unit 2: Reaction Intermediates and Heterocyclic Compounds (8 Hours)

Reaction intermediates-carbocation, free radicals and carbenes. Structure and stability of benzene-molecular orbital description- Aromaticity and Huckel's rule, Non benzenoid aromatic compounds, Heterocyclic compounds- structures of pyrrole, furan, pyran, thiophene, pyrazole, pyridine and pyrimidine.

Unit 3: Organic Reaction Mechanisms (10 Hours)

Nucleophilic substitution of alkyl halides: S_N1 and S_N2 mechanisms- walden inversion. Electrophilic addition to ethane and propene- Markownikoff's rule, free radical addition and peroxide effect. Elimination reactions- E1 and E2 mechanism- Mechanisms of dehydrohalogenation of alkyl halides, Aromatic Electrophilic substitution – mechanism of nitration, bromination, sulphonation and Fridel Crafts reactions- Aromatic nucleophilic substitution.

Unit 4: Stereochemistry (10 Hours)

Conformation and configuration, Rotation about carbon-carbon single bond, conformation of ethane, cyclohexane, methyl cyclohexane-explanation of more stable conformation. Geometrical isomerism: Explanation taking 2-butene, maleic and fumaric acid as examples. Optical isomerism- Optical activity, Chirality, racemisation and resolution (Lactic acid and tartaric acid examples).

Unit 5: Amino acids, Peptides and Proteins (10 Hours)

Amino acids – classification and properties, polypeptides and proteins – peptide linkage, primary, secondary, tertiary and quaternary structure of proteins, test for proteins. Nucleic acids, structure of DNA and RNA differences, Functions, Different types of RNA, Genetic code, Self replication, mutation. Enzymes, characteristics, catalytic action, theory of enzyme catalysis Michaelis-Menten theory- Elementary treatment of the metabolism of carbohydrates, proteins and lipids

Text books

1. M.K. Jain, S.C. Sharma. Modern Organic Chemistry, Vishal Publishing Co., 2019.
2. Bahl Arun and Bahl B.S. Text book of Organic Chemistry, S Chand & Company, 2016.
3. I.L. Finar, Organic chemistry – Vol I and II, Pearson Education India; 6th Edition, 2002.
4. Peter Sykes, A guide book to mechanism in organic chemistry. Pearson Education, 6th edition, 2003.
5. C.N. Pillai, Organic chemistry for undergraduates, Universities Press (India) Pvt Ltd. 2008
6. Tiwari, Mehrotra and Vishnoi, Text book for Organic Chemistry, 4th Edition, Vikas Publishing House Pvt. Ltd. New Delhi, 2017
7. Michael B. Smith, Jerry March, Advanced Organic Chemistry: Reactions, Mechanisms, and Structure John Wiley & Sons, Inc. 6th Edition, 18 May 2006

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3				1		3		
CO2	2	1			3		2	2	
CO3			2						
CO4				1	1		1		
CO5					3		2		
CO6	1		3	2		2		3	1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH2007	Instrumentation Techniques for Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the concepts of absorption and emission spectroscopic techniques
2. know importance of electrochemical techniques in forensic investigation
3. learn about radio analytical techniques and sensors

Course Outcomes:

The student will be able to

1. know the importance of ir and nmr spectroscopy techniques and their application in forensic science
2. understand the forensic applications of uv and visible spectroscopic techniques
3. know the principle and instrumentation of fluorescence and phosphorescence spectrophotometry
4. understand the importance of electrochemical techniques in forensic science
5. understand the principle of radio analytical techniques
6. know the concepts and forensic applications of advanced techniques

Unit 1: Introduction to IR and NMR Spectroscopy (9 Hours)

Introduction – Properties of light, interaction of matter and light - Electromagnetic spectrum – Infrared (IR) spectroscopy, theory, instrumentation and its application in forensic Science –Nuclear magnetic resonance (NMR) spectroscopy, theory, instrumentation and its application in forensic science.

Unit 2: Ultraviolet and Visible Spectroscopy (9 Hours)

Ultra violet (UV) and visible spectrophotometry – Types of sources and stability, wavelength selection, filters – cells and sampling devices, detectors, resolution, qualitative detection and quantitative measurements – Application in forensic science.

Unit 3: Fluorescence and Phosphorescence Spectrophotometry (9 Hours)

Fluorescence and phosphorescence spectrophotometry – Types of sources, structural factors, instrumentation – Applications in forensic science.

Unit 4: Electrochemical Methods (9 Hours)

Electrochemical techniques – Introduction – Principles, instrumentation, techniques and applications of potentiometry, coulometry, polarography and ion selective electrodes.

Unit 5: Radioanalytical techniques and sensors (9 Hours)

X-ray spectrometry - Electrophoresis – fundamental principles and forensic applications – Application of neutron activation analysis and isotope dilution methods – Introduction to sensors – Biosensors.

Text Books:

1. D.A. Skoog, D.M. West and F.J. Holler, Analytical Chemistry: An Introduction, 5th edition, Saunders college publishing, Philadelphia, 1990.
2. F.A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, 1997.
3. James W. Robinson, Atomic spectroscopy, 2nd Edition – Revised & Expanded, Marcel Dekkar, Inc., NY, 1996.
4. Gurdeep R Chatwal & Sham K. Anand, Instrumental methods of chemical analysis, Himalaya Publishing House, 2004.
5. S.H. James and J.J. Nordby, Forensic Science – An introduction to scientific and investigative techniques, CRC press, USA, 2003.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	1	1	2	1	1	1	2	1
CO2	1	1	1	2	1	1	1	2	1
CO3	1	2	1	2	1	1	1	2	1
CO4	1	1	1	2	1	1	1	2	3
CO5	1	1	1	2	1	1	1	1	2
CO6	1	1	1	2	1	3	1	2	1

“3”– High; “2”– Medium; “1”– Low; “-”– No correlation

20CH2008	Analytical Chemistry Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. understand experiments based on thin layer chromatography
2. learn colorimetric analysis
3. know crime scene photography and videography

Course Outcomes:

The student will be able to

1. experiment thin layer chromatography of ink samples
2. do the separation of organic compounds by paper chromatography
3. understand the crime scene exhibits by photography and videography
4. work out problems related to mean, median and standard deviation
5. know about data representation
6. know the applications of mass spectrometry in forensic science

LIST OF EXPERIMENTS

1. To carry out thin layer chromatography of ink samples
2. To determine the concentration of a colored compound by colorimetry analysis
3. To carry out separation of organic compounds by paper chromatography
4. To identify drug samples using UV – visible spectroscopy
5. To take photographs using different filters
6. To take photographs of crime scene exhibits at different angles.
7. To record videography of a crime scene
8. Work out the problems related to mean, median, mode, standard deviation, probability, Chi-square test, t-test and correlation
9. Familiarize the technique of data representation (tables, bar-diagram, histogram, pie- diagram and frequency curve (manual and using computer)
10. Applications of mass spectrometry in forensic science

(Minimum 10 Experiments to be conducted)

Text Books:

1. Frank Lundquist, Methods of Forensic Science, Vol. 1, New York, Interscience, 1962.
2. Frank A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, Upper Saddle River, 1997.
3. S.H. James and J.J. Nordby, Forensic Science: An Introduction to scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton, 2005.
4. Thomas Catalano, Good Laboratory Practices for Forensic Chemistry, Springer, 2014
5. Thomas Kubic and Nicholas Petraco, Forensic Science Laboratory Manual and Workbook, CRC Press, 2009.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	2	2	2
CO2	1	1	1	1	1	1	2	2	3
CO3	1	1	1	1	1	1	1	2	3
CO4	-	1	1	1	1	1	1	2	3
CO5	1	1	1	1	1	1	1	2	3
CO6	1	1	1	1	1	1	1	2	3

“3” – High; “2” – Medium; “1” – Low; “-” – No correlation

20CH2009	Forensic Chemistry						L	T	P	C
							3	0	0	3

Course Objectives:

Enable the student to

1. get ideas on petroleum products.
2. learn the methods of searching and analyzing arson evidence etc
3. understand the classification of explosives and bomb scene management

Course Outcomes:

The student will be able to

1. understand the methods of analyzing trace amounts of petroleum products in crime scene evidence.
2. comprehend the method of searching, collecting, preserving and analyzing arson evidence.

3. deliver the process of post-fire analysis of materials.
4. realize the classification of explosives, including the synthesis and characterization of representative analogs.
5. apply the techniques of locating hidden explosives and
6. interpret the significance of bomb scene management.

Unit 1: Petroleum and Petroleum Products (9 Hours)

Distillation and fractionation of petroleum. Commercial uses of different petroleum fractions. Analysis of petroleum products. Analysis of traces of petroleum products in forensic exhibits. Comparison of petroleum products. Adulteration of petroleum products.

Unit 2: Cases Involving Arson (8 Hours)

Chemistry of fire. Conditions for fire. Fire scene patterns. Location of point of ignition. Recognition of type of fire. Searching the fire scene. Collection and preservation of arson evidence.

Unit 3: Post-fire Analysis of Materials (8 Hours)

Analysis of fire debris. Analysis of ignitable liquid residue. Post-flashover burning. Scientific investigation and evaluation of clue materials. Information from smoke staining.

Unit 4: Explosives (10 Hours)

Classification of explosives – low explosives and high explosives – Homemade explosives – Military explosives – Blasting agents - Synthesis and characteristics of TNT, PETN and RDX.

Unit 5: Explosion Process and Detection (10 Hours)

Explosion process. Blast waves. Bomb scene management. Searching the scene of explosion. Mechanism of explosion. Post blast residue collection and analysis. Blast injuries. Detection of hidden explosives.

Text Books:

1. S. Ballou, M. Houck, J.A. Siegel, C.A. Crouse, J.J. Lentini and S. Palenik in Forensic Science, D.H. Ubelaker (Ed.), Wiley-Blackwell, Chichester (2013).
2. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's, Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).
3. J.D. DeHaan, Kirk's Fire Investigation, 3rd Edition, Prentice Hall, New Jersey (1991).
4. A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, Scientific Evidence in Civil and Criminal Cases, 4th Edition, The Foundation Press, Inc., New York (1995).
5. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1		2						1	
CO2	1			1	1	2	2		2
CO3	2	3	2						
CO4	2				2	3		1	1
CO5			2	1				1	2
CO6		2				1	1		

'3'-High, '2'- Medium, '1'-Low, '-'- No correlation

20CH2010	Forensic Toxicology						L	T	P	C
							3	0	0	3

Course Objectives:

Enable the student to

1. analyze trace amounts of petroleum products in crime scene evidence.
2. understand the methods of analyzing contaminants in petroleum products
3. classify and characterise of the narcotics, drugs and psychotropic substances.

Course Outcomes:

The students will be able to

1. know about chemistry of petroleum products forensic science.
2. understand the method of searching, collecting, preserving and analyzing arson evidence
3. know the techniques of locating hidden explosives.
4. know the narcotics, drugs and psychotropic substances forensic science

5. know the forensic identification of illicit liquors.
6. know about toxicology and poisons

Unit 1: Petroleum and Petroleum Products (9 Hours)

Introduction to Petroleum Products, Properties of Petroleum Products, Testing of Petroleum and Petroleum Products, Adulteration of petroleum products, Analysis of petroleum products as per BIS specifications. Analysis of Dyes used in petroleum products and forensic exhibits, Chemical fingerprinting of petroleum products.

Unit 2: Narcotics, Drugs and Psychotropic Substances (9 Hours)

Broad classification – Narcotics, stimulants, depressants and hallucinogens. General characteristics and common example of each classification. Natural, synthetic and semi-synthetic narcotics, drugs and psychotropic substances. Drug addicts and crimes, Tolerance, addiction and withdrawal symptoms of narcotics, drugs and psychotropic substances. Presumptive and screening tests for narcotics, drugs and psychotropic substances in breast milk, saliva, urine, hair and antemortem blood. Dope tests. Analysis of narcotics, drugs and psychotropic substances in postmortem blood. Postmortem changes affecting the analysis of narcotics, drugs and psychotropic substances. Collection and preservation of drug evidence, excretion of drugs, Testing of narcotics, drugs and psychotropic substances- thin layer chromatography, gas – liquid chromatography and high performance liquid chromatography.

Unit 3: Alcoholic Beverages (Study and Analysis) (9 Hours)

Introduction, Definition of alcohol and illicit liquor, Alcoholic and non-alcoholic beverages and their composition, Proof spirit, absorption, de-toxication and excretions of alcohol, problems in alcohol cases and difficulties in diagnosis, Alcohol and prohibition, Consequences of drunken driving, Estimation of ethyl alcohol in blood and urine, Analytical techniques in the analysis of alcohol and other articles, Crime scene management in illicit liquor cases.

Unit 4: Fire & Arson: (9 Hours)

Chemistry of Fire, Combustion reaction, Fire Triangle, Fire Tetrahedron, Conditions for fire, Backdraft, Thermo-chemistry of Fire, Heat Capacity and Phase changes, Accelerants & types of accelerants, Combustible and Flammable liquids, Flash point, Fire point, Ignition point, Auto Ignition point, vapour density, vapour pressure, Fire extinguisher. Arson: Legal Definition, Arson motives, Degrees of Arson, Forensic and legal Concepts, Determining origin and cause; Fire patterns, Collection/Preservation of Arson Evidences, Flashover, Live or dead at time of arson; Documenting the fire or crime scene; Scheme of analysis: Extraction of samples from debris (Direct and solvent extraction methods, Head Space method, SPME, Distillation), Clean-up (Filtration & Acid stripping), Analysis (GC, GC-MS, FTIR & SEM etc.), Interpretation of GC-MS spectra., Scientific investigation and evaluation of clue materials

Unit 5: Basics of Toxicology and Poisons(9 Hours)

Classification of poisons-Plant Poison, Animal Poison, Metallic Poison, Physico-chemical characteristics and mode of action of poisons. Accidental, suicidal and homicidal poisonings. signs and symptoms of poisoning, mode of action and its effect on vital functions, medico-legal and post mortem examination report/finding studies, specific analysis plan/ approach to toxicological examination of poisoning samples, excretion of poisons, detection of poisons on the basis of their metabolic studies, interpretation of analytical data Animal poisons. Snake venom. Mode of action. Carbon monoxide poisoning. Significance of toxicological findings. Techniques used in toxicology. Toxicological analysis and chemical intoxication tests. Postmortem Toxicology. Human performance toxicology. Dose-response relationship.

Text books:

1. A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, Scientific Evidence in Civil and Criminal Cases, 4th Edition. The Foundation Press, Inc., New York (1995)
2. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004)
3. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's , Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).
4. F.G. Hofmann, A Handbook on Drug and Alcohol abuse, 2nd Edition, Oxford University Press, New York (1983)
5. S.B. Karch, The Pathology of Drug Abuse, CRC Press, Boca Raton (1996). 6. A. Poklis, Forensic toxicology in, Introduction of Forensic Sciences, 2nd Edition.
6. Laboratory procedure Manual, Forensic Toxicology: DFS, 2005

7. Levine Barry, Principles of Forensic Toxicology, 2nd Edn., (2006)

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					2		
CO2	3		2				3		
CO3	2			3			2		
CO4	3	1						2	
CO5	3				2		3		
CO6	2			1					2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH2011	Forensic Toxicology Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. understand the methods of analyzing trace amounts of petroleum products in crime scene evidence.
2. learn the methods of analyzing contaminants in petroleum products
3. classify and characterize of the narcotics, drugs and psychotropic substances.

Course Outcomes:

The students will be able to

1. know about chemistry of petroleum products forensic science.
2. know the method of searching, collecting, preserving and analyzing arson evidence
3. know the techniques of locating hidden explosives.
4. know the narcotics, drugs and psychotropic substances forensic science
5. know the forensic identification of illicit liquors.
6. know about toxicology and poisons

LIST OF EXPERIMENTS

1. To identify biocides.
 2. To identify metallic poisons.
 3. To identify organic poisons.
 4. To identify ethyl alcohol.
 5. To identify methyl alcohol.
 6. To carry out quantitative estimation of ethyl alcohol.
 7. To prepare iodoform.
 8. To identify drugs of abuse by spot tests.
 9. To perform color tests for barbiturates.
 10. To separate drugs of abuse by thin layer chromatography.
- (Minimum 10 Experiments to be conducted)

Text books:

1. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
2. F.G. Hofmann, A Handbook on Drug and Alcohol Abuse, 2nd Edition, Oxford University Press, New York (1983).
3. S.B. Karch, The Pathology of Drug Abuse, CRC Press, Boca Raton (1996).
4. A. Poklis, Forensic toxicology in, Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (Ed.), CRC Press, Boca Raton (1997).
5. A.W. Jones, Enforcement of drink-driving laws by use of per se legal alcohol limits: Blood and/or breath concentration as evidence of impairment, Alcohol, Drug and Driving, **4**, 99 (1988).
6. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's, Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		2			3	1		2	3	1
CO2	1	3						1	1	
CO3	1	2			3		2	2	2	2

CO4		2			1	3	2	3	3	1
CO5						2	3	2	3	3
CO6				3	2			3	2	3

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’No correlation

20CH2012	Crime Investigation Techniques	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn the importance of chromatographic techniques in processing crime scene evidence.
2. learn the utility of surface characterization techniques
3. learn the significance of microscopy in visualizing trace evidence and comparing it with control samples.

Course Outcomes:

The student will be able to

1. know principle of chromatographic techniques.
2. know applications of chromatographic techniques.
3. understand the principles of X-ray diffraction techniques
4. realize the importance of Electron microscopy
5. understand the applications of electron microscopic techniques
6. understand advance photographic methods for forensic science

Unit 1: Chromatography-I

Liquid Chromatography Introduction, History, Classification, Principle & basic theory of chromatography, Column adsorption chromatography, Partition chromatography, Band broadening & column efficiency, Factors affecting, Plate theory & Rate theory of chromatography, Types of Liquid chromatography, Theory, principle and Instrumentation of HPLC, Types of column, Column efficiency, Pumps, Various types of detector, Injection system, Isocratic and gradient elution, Normal phase and Reverse phase liquid chromatography, Development of HPLC and UPLC method, Choice of stationary and mobile phase, Difference between HPLC and UPLC, Applications.

Unit 2: Chromatography II

Thin Layer Chromatography Introduction, Theory, Principle and Instrumentation of TLC, Method for the preparation of thin layers on plates, Application of sample on the chromo plates, Choice of adsorbent, Choice of mobile phase, Detecting reagent, Developing chamber, Developing and detection, Ascending, Descending and two dimensional TLC development, Impurity profiling with the help of TLC, Applications. Sample preparation for chromatographic and spectroscopic evidence. Chromatographic methods. Fundamental principles and forensic applications of thin layer chromatography, gas chromatography and liquid chromatography.

Unit 3: X-Ray Diffraction Techniques

Properties of X-rays -crystallography, geometry of crystals, diffraction and experimental methods like powder XRD and applications like crystal size, crystal structure, amorphous materials, precise parameter measurements, phase diagram determination and multiphase quantitative analysis. Introduction to X-ray diffraction. Electron diffraction Neutron diffraction About crystal structures and diffraction patterns. Practical aspects of electron diffraction Instrumental details and analysis of XRD pattern. Residual stress measurements.

Unit 4: Microscopy SEM, TEM

Introduction to materials and methods, Fundamentals of Materials Characterization, Basic operation, sample preparation and interpretation of data. Basic failure analysis of materials using different characterization equipment. Introduction to Scanning electron microscopy, Instrumental details and image formation,. Various imaging techniques and spectroscopy Sample preparation and Applications- Introduction to Transmission electron microscopy (TEM) Science of Imaging and diffraction TEM instrumental details and variants in imaging techniques. Sample preparation procedures and instruments for various materials, Fundamental principles. Different types of microscopes. Electron microscope. Comparison Microscope. Forensic applications of microscopy.

Unit 5: Forensic photography

Basic principles and applications of photography in forensic science. 3D photography Photographic evidence. Infrared and ultraviolet photography. Digital photography-Crime scene and laboratory photography

Text books:

1. D.A. Skoog, D.M. West and F.J. Holler, Fundamentals of Analytical Chemistry, 6th Edition, Saunders College Publishing, Fort Worth (1992).
2. W. Kemp, Organic Spectroscopy, 3rd Edition, Macmillan, Hampshire (1991).
3. J.W. Robinson, Undergraduate Instrumental Analysis, 5th Edition, Marcel Dekker, Inc., New York (1995).
4. D.R. Redsicker, The Practical Methodology of Forensic Photography, 2nd Edition, CRC Press, Boca Raton (2000).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					3		
CO2	3		2				3		
CO3	3			3			2		
CO4	2	1						2	
CO5	3				2		3		
CO6	1			1					2

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20CH2013	Nanochemistry in Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn about nanomaterials
2. understand about the synthesis of nanomaterials
3. learn the use of nanomaterials in Forensic Science

Course Outcomes:

The student will be able to

1. know the evolution of nanotechnology
2. understand the classification of nanomaterials
3. understand the various types of synthesis of nanomaterials
4. characterize the nanomaterials
5. know the applications of nanomaterials
6. understand the application of nanomaterials in forensic science

Unit 1: Basics of Nanotechnology (9 Hours)

Historical landmarks - terminology-scales. Classification of nanomaterials based on dimension - Top-down and bottom-up approaches - Comparison. – Challenges in nanotechnology - Top down methods – Core shell nanomaterials – Toxic effect of nanomaterials- Existing laws and regulations of nanotechnology- regulatory agencies- green nanotechnology- nanoethics - future of nanotechnology.

Unit 2: Synthesis of Nanomaterials (9 Hours)

Synthesis of metallic, semiconductor and oxide nanoparticles – sol-gel- method – Synthesis by reduction - One dimensional nanoparticles – nanowires and nanorods – VLS method – electrospinning – Lithography – Two dimensional nanomaterials – PVD – Molecular beam epitaxy - CVD - Self Assembly

Unit 3: Special Nanomaterials and Methods: (9 Hours)

Fullerenes – types - carbon nanotubes – types - Micro and mesoporous nanomaterials – Soft lithography - Dip pen nanolithography

Unit 4: Applications of Nanotechnology-I (9 Hours)

Applications of nanotechnology in various fields – Electronics, Catalysis and Biology - Nanobiology and its applications- Nanomedicines- immuno targeted drug delivery-- nanoparticle drug systems for oral, nasal, and ocular administration- nanomaterials in medical diagnosis - therapeutic applications. Nanosensors- smart dusts.

Unit 5: Applications of Nanotechnology-II (9 Hours)

utilization of nanotechnology in analysis of physical evidences, selectivity of nanoparticles with compatibility and feasibility, Application of nanotechnology in forensic evidence analysis- Forensic Applications: Collection and analysis of evidence of different types of crime scenes including drugs, DNA analysis, blood splattering, serology, toxicology

References

1. Guozhong Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial press, 2004
2. Pradeep, Nano: The Essentials, Mc Graw Hill Publishing Company, New Delhi (2007).
3. V. S. Muraleedharan and A. Subramania, Nanoscience and nanotechnology, Ane Books Pvt. Ltd. New Delhi, 2009.
4. C. N. R. Rao and A. Govindraj, Nanotubes and Nanowires, Royal Society of Chemistry (2005).
4. J. M. M. Duart, R. J. M. Palma and F.A. Rueda, Nanotechnology and Microelectronics and optoelectronics, Elsevier (2002).
5. R. Booker and , E. Boysen, Nanotechnology, Wiley India Pvt Ltd, 2008.
6. K. J. Klabunde, Nanoscale materials in chemistry, John Wiley and Sons.
7. C. P. Poole Jr and F J Owens, Introduction to nanotechnology, Wiley India Pvt Ltd 2009.
8. L. E. Foster, Nanotechnology: Science, Innovation and Opportunity, Pearson Education (2008).
9. The Chemistry of Nanomaterial: Synthesis, Properties and Applications, Vol. I and II, CNR Rao, Springer (2006).
10. Nanotechnology: Basic Science and Emerging Technologies, Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press (2005)

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					3		
CO2	3		2				3		
CO3	3			3			2		
CO4	2	1						2	
CO5	3				2		3		
CO6	1			1					2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2001	Fundamentals of Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn about the fundamental principles and functions of forensic science
2. understand the significance of forensic science to human society
3. know the working of the forensic establishments in india

Course Outcomes:

The student will be able to

1. point out the importance of forensic sciences
2. understand the techniques involved in forensic sciences
3. know various laboratories available to serve forensic science
4. understand the importance of police organization
5. describe the crime and filing a crime
6. investigate the crime scene

Unit 1: Development and Tools and Techniques in Forensic Science (10 Hours):

History, scope, functions and need of forensic science – definitions and concepts in forensic science. basic principles -branches of forensic science. Frye case and Daubert standard - Forensic science in international perspectives – Forensic scientists – duties, code of conduct and qualifications

Unit 2: Organizational set up of Forensic Science Laboratories in India (9 Hours)

Hierarchical set up of Central Forensic Science Laboratories, State Forensic Science Laboratories, Fingerprint Bureaus, National Crime Records Bureau, Police & Detective Training Schools, Bureau of

Police Research & Development, Directorate of Forensic Science and Mobile Crime Laboratories. Police Academies -Services of crime laboratories. Basic services and optional services - Drug enforcement administrator. Defense research and development organization.

Unit 3: Police Organization (8 Hours)

Organizational set up of Police at central and state level, Functions of Police, Relationship of Police and Forensic Scientist, History of different para-military forces (BSF, CISF, CRPF, ITBP, Assam Rifles, SSB, NSG etc.)

Unit 4: Legal aspects of crime(9 Hours)

Crime – Introduction,definition, types, causes and consequences - Broad concepts of criminal Justice system, Procedures involved in the detection of crime, Filing of criminal charges, Indian police system – The Police Act, Human rights and criminal justice system in India. Set up of INTERPOL.

Unit 5: Crime Scene (9 Hours)

Introduction, Significance, Role of Investigator, Evaluation of crime scene, protection of crime scene, Photography of Crime scene, Tools and techniques, Significance of Photography and Videography, Introduction of Sketching, Purpose of Sketching, Making of Sketches, Types of Sketches, Methods of Sketching, Procedure of Sketching, Searching Methods, Chain of Custody types, Significance and their evaluation

Text Books:

1. B.B. Nanda and R.K Tiwari, “Forensic Science in India: A vision for the Twenty First Century”, select publishers, New Delhi, 2001.
2. V. N. Sehgal, Surinder Nath and M. K. Bhasin, “Studies in Forensic Science No. 3: Society, Crime and Prosecution”, Kamla-Raj Enterprises, New Delhi, 2005.
3. S.H James and J.J Nordby, “Forensic Science:An introduction to scientific and Investigative Techniques”, 2ndEdition, CRC Press, Boca Raton, 2005.
4. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2ndEdition, W.G. Eckert (ED), CRC Press, Boca Raton, 1997.
5. B. A. J. Fisher, D. R. Fisher, “Techniques of Crime Scene Investigation”, CRC Press, 8th Edition, 2012.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3		3	1		1	2		1
CO2	2	2					2	3	
CO3		3	2	2	1		2	3	
CO4				3		1			2
CO5			2	3		1	3		
CO6	2		3	3		1	3	2	

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS2002	Crime and Society	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand the concepts and approaches of crime
2. Know the major form of crime in India and changing profile of crime
3. Learn the theories of punishment and prevention of crime

Course Outcomes:

The student will be able to

1. Know the recent trends in criminology, changing profile of crime and criminals
2. Understand the forms and recent trends in crime
3. Learn the theories of Punishment and Prevention of crime
4. Take up the professional roles of correctional agents in agencies of criminal justice administration
5. Understand the social and governmental regulations with regard to crime
6. Understand about Indian judicial system

Unit 1: Concepts of crime and approaches to crime (9 Hours)

Crime: Nature and definition - Characteristics of crime in modern society - Causes of crime (social, economic, political and cultural) - Approaches to Crime - A Functionalist perspective: Emile Durkheim (Crime as inevitable), Robert Merton (Social structure and anomie) - An Interactionist perspective: Howard Becker (Labelling theory) - Marxist perspective: William Chambliss (Capitalism and crime), Laureen Snider (Corporate crime), David Gordon (Selective law enforcement) - Neo-Marxist [perspective: Ian Taylor, Paul Walten, Jock Young (The new criminology).

Unit 2: Major forms of crime in India and changing profile of crime (9 Hours)

Crime against SCs, STs and DTNTs: Meaning and forms - Crime against Women: Meaning, forms and causes. (Sex selective abortions, domestic violence, dowry deaths, sexual abuse, sexual harassment at work place, rape, violence, trafficking etc.) - Juvenile delinquency and crime against children: Meaning and causes - White collar crime: Meaning and features - Organised crime: Meaning and features - Terrorism: Concept, features and causes - Custodial crime: Meaning and features.

Unit 3: New forms of crime and recent trends in crime (9 Hours)

Corporate crime - Human rights violation - Cyber crime - Criminalization of politics - Environmental crimes - International crimes.

Unit 4: Theories of Punishment and Prevention of crime (9 Hours)

Deterrent Theory - Preventive theory - Reformatory theory - Punishment, prison and alternative imprisonment (open prison, probation, parole) - Rehabilitation of prisoners - Human right perspective - Crime and the role of media.

Unit 5: An introduction to IPC (Indian Penal Code) and Judiciary (9 Hours)

An outline of Indian Penal Code (IPC) – Offences related to marriage – Offences related to religion – Judiciary – Criminal Procedure Code – Outline – Role of police – Indian judicial system.

Text Books:

1. Ahuja Ram, Criminology, Rawat Publishers & Distributors, Jaipur, 2000
2. Ahuja Ram, Social Problems in India, Rawat Publications, Delhi and Jaipur, 1997.
3. Bhosale, Smriti. Female Crime in India, Kalpaz Publications, New Delhi, 2009.
4. Gill, S.S., The Pathology of Corruption, Harper Collins Publishers, New Delhi, 1998.
5. Russel, William, Crime: Vol. I & II, Stevens and sons, London, 1964.
6. Tapas K. Banarjee, Background to Indian Criminal Law, Cambray, Kolkata, 1963.
7. Goel, Rakesh and Manohar Powat. Computer Crime: Concept, Control and Prevention. Saymson Computers Pvt.Ltd., Bombay, 1994.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	1	1	1
CO2	1	1	1	1	2	2	1	2	2
CO3	1	-	1	1	1	1	1	-	1
CO4	1	1	1	1	1	1	2	2	3
CO5	1	1	1	1	1	1	2	1	3
CO6	1	1	1	1	1	1	1	-	1

“3”– High; “2”– Medium; “1”– Low; “-”– No correlation

20FS2003	Forensic Physics	L	T	P	C
		3	0	0	3

Course Objectives

Enable the student to

1. understand the physics of speech which is important in speaker identification,
2. describe the causes and investigation of vehicular accidents, and its legal implications.
3. explain the parts of a camera, different types of photography and importance of forensic photography used in the investigation of crime.

Course Outcomes

The students will be able to:

1. understand the physics of sound production
2. apply phonetics and voice analysis in Forensic Science,

- understand the causes and investigations done in vehicular accidents
- explain the legal provisions about forensic photography
- Interpret the various methods of photographing a crime scene etc.
- describe the various tool marks

Unit 1: Forensic Speaker identification (9 Hours)

Human Vocal cord anatomy, Voice Production, Speaker identification and authentication, Forensic phonetics, Voice analysis, Forensic Significance

Unit 2: Automobile Accidents- Causes and Investigation (9 Hours)

Vehicular accidents-Introduction, Information sources: eye witnesses, Tire and other mark, Pedestrian impacts and vehicle speed, vehicle condition, vehicle damage, curved scuffmarks, Time and distance, reaction time, Vehicular Accident Photography

Unit 3: Automobile Accidents- Legal Aspects (7 Hours)

Relevant Provisions of Motor Vehicle Act, 1988 (Offenses and Penalties); Relevant Provisions of Indian Penal Code, 1860, (Sections 337 (causing hurt), 304 A (causing death due to negligence) and 279 (rash and negligent driving)

Unit 4: Forensic Photography (10 Hours)

Introduction, 35 mm film Camera, Digital SLR camera, Digital photo imaging, ISO number, Exposure Index, Photo imaging evidence: angle, scale, depth of field, light, ambient light, colour, temperature, flash/ strobe; Surveillance photography and Aerial photography and accessories used for the same; Various methods for developing photographs; High-speed photography; Image magnification, U. V. and I. R. illumination, legal aspects of visual evidence

Unit 5: Introduction to Tool Marks (10 Hours)

Definition, types of tool marks: compression marks, striated marks, combination of compression and striated marks, repeated marks: class characteristics and individual characteristics, tracing and lifting of marks, Photographic examination of tool marks; Restoration of Erased / Obliterated Marks: methods of making-cast, punch, engrave; methods of obliteration, methods of restoration- etching (etchings for different metals), magnetic, electrolytic etc., recording of restored marks.

Text Books

- Encyclopedia of Forensic Science, Volume 1-3: Jay A Siegel, Pekka J Saukko, Geoffrey Knupfer. Academic Press. 2nd Edition, 22 February 2013.
- Criminalistics: An Introduction to Forensic Science: Richard Saferstein, Pearson Education International, 12th Edition, 3 January 2017.
- Redsicker, D. R., The Practical methodology of Forensic Photography, CRC Press, London, 2nd Edition, 26 September 2000.
- Stuart H. James and Jon J. Nord, Forensic Science: An Introduction to Scientific and Investigative Techniques, CRC Press, 4th Edition, 13 January 2014.
- Edward M Robinson, Crime Scene Photography, Academic Press, 3rd Edition, 15 August 2016.
- Tom Ang, Digital Photography, reprint, 2013.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1							1
CO2	3	1		3					2
CO3	1		3	3	1	1	3	3	1
CO4			2	2	2	1	3	3	
CO5	1		1		3	2	2	2	
CO6		2		1			1	2	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2004	Fundamentals of Forensic Science Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

- learn the fundamental principles and functions of forensic science.
- know the divisions in a forensic science laboratory.

3. know the working of the forensic establishments in india and abroad.

Course Outcomes:

The students will be able to

1. review the sections in forensic science
2. depict the data on different type of crime cases
3. write report on different type of crime cases
4. examine the list of projects undertaken by the bureau of police research and development.
5. compare and contrast the role of a police academy.
6. compare the code of conduct prescribed by forensic scientists.

LIST OF EXPERIMENTS

1. To study the history of crime cases from forensic science perspective.
2. To cite examples of crime cases in which apprehensions arose because of Daubert standards.
3. To review the sections of forensic science at INTERPOL and compare with those in Central Forensic Science Laboratories in India. Include suggestions for improvements if any.
4. To study the annual reports of National Crime Records Bureau and depict the data on different type of crime cases by way of smart art/templates.
5. To write report on different type of crime cases.
6. To review how the Central Fingerprint Bureau, New Delhi, coordinates the working of State Fingerprint Bureaus.
7. To examine the hierarchical set up of different forensic science establishments and suggest improvements.
8. To examine the list of projects undertaken by the Bureau of Police Research and Development and suggest the thrust areas of research in Police Science.
9. To compare and contrast the role of a Police Academy and a Police Training School.
10. To compare the code of conduct prescribed by different establishments for forensic scientists.
(Minimum 10 Experiments to be conducted)

Text Books:

1. M. Houck, Jay Siegel, "Fundamentals of Forensic Science", Academic Press, 3rd Edition, 2015.
2. T. Kubic, N. Petraco, "Forensic Science Laboratory Manual and Workbook", CRC Press, 3rd Edition, 2009.
3. K. Mirakovits, G. Londino-Smolar, "The Basics of Investigating Forensic Science" CRC Press; 1st edition, 2015.
4. V. N. Sehgal, Surinder Nath and M. K. Bhasin, "Studies in Forensic Science No. 3: Society, Crime and Prosecution", Kamla-Raj Enterprises, New Delhi, 2005.
5. S.H James and J.J Nord, "Forensic Science: An introduction to scientific and Investigative Techniques", 2nd Edition, CRC Press, Boca Raton, 2005.
6. B. A. J. Fisher, D. R. Fisher, "Techniques of Crime Scene Investigation", CRC Press, 8th Edition, 2012.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1	1			2		1
CO2	2	2			1		3	3	
CO3			2	3					2
CO4	3	2			2	1	2		
CO5	1		1	3		1	1		3
CO6	2			3	2	2	2		3

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2005	Indian Constitution, Fundamental Laws and Procedure	L	T	P	C
		4	0	0	4

Course Objectives:

Enable the student to

1. learn elements of criminal procedure code related to forensic science.
2. learn acts and provisions of the constitution of india related to forensic science.

3. learnacts governing socio-economic crimes.

Course Outcomes:

The students will be able to

1. understand various types of crime laws
2. understand section laws
3. understand witnessrelated laws
4. know the principles and basics of indian constitution
5. recognize social crimes
6. recognize environmental crimes

Unit 1: Law to Combat Crime (12 Hours)

Classification – civil, criminal cases. Essential elements of criminal law. Constitution and hierarchy of criminal courts. Criminal Procedure Code. Cognizable and non-cognizable offences. Bailable and non-bailable offences. Sentences which the court of Chief Judicial Magistrate may pass. Summary trials – Section 260(2). Judgements in abridged forms – Section 355.

Unit 2: Section Laws (12 Hours)

Indian Penal Code pertaining to offences against persons – Sections 121A, 299, 300, 302, 304A, 304B, 307, 309, 319, 320, 324, 326, 351, 354, 359, 362. Sections 375 & 377 and their amendments. Indian Penal Code pertaining to offences against property Sections – 378, 383, 390, 391, 405, 415, 420, 441, 463, 489A, 497, 499, 503, 511.

Unit 3: Evidence & Witness Laws (12 Hours)

Indian Evidence Act – Evidence and rules of relevancy in brief. Expert witness. Cross examination and re-examination of witnesses. Sections 32, 45, 46, 47, 57, 58, 60, 73, 135, 136, 137, 138, 141. Section 293 in the code of criminal procedure.

Unit 4: Constitution of India (12 Hours)

Preamble, Fundamental Rights, Directive Principles of State Policy. – Articles 14, 15, 20, 21, 22, 51A.

Unit 5: Acts Pertaining to Socio-economic and Environmental Crimes (12 Hours)

Narcotic, Drugs and Psychotropic Substances Act. Essential Commodity Act. Drugs and Cosmetics Act. Explosive Substances Act. Arms Act. Dowry Prohibition Act. Prevention of Food Adulteration Act. Prevention of Corruption Act. Wildlife Protection Act. I.T. Act. Environment Protection Act. Untouchability Offences Act

References:

1. D.A Bronstein, Law for the Expert witness, CRC press, Boca Raton (1999)
2. Vipa P. Sarthi, Law of Evidence, 6th Edition, Eastern Book Co. Lucknow (2006)
3. A.S. Pillia, Criminal Law, 6th Edition, N.M. Tripathi Pvt Ltd, Mumbai (1983)
4. R.C Nigam, Law of crimes in India, Volume I, Asia Publishing House, New Delhi, (1965)
5. (Chief Justice) M.Minor, Law of Evidence, 6th Edition, Universal Law of Publishing Co. Pvt. Ltd. New Delhi (2002)

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					3		
CO2	2		2				2		
CO3	3		2	3			3		
CO4	2	1						2	
CO5	3				2		3		
CO6	3			1					3

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS2006	Forensic Dermatoglyphics						L	T	P	C
							3	0	0	3

Course Objectives:

Enable the student

1. learn types and importance of fingerprinting
2. understand the methods to develop the fingerprints
3. learn about other types impressions in the crime scene region

Course Outcomes:

The student will be able to

1. understand the fundamental principles on which the science of fingerprinting is based.
2. learn the importance of fingerprints
3. learn the methods of recording fingerprints
4. summarize the methods of classifying criminal records by fingerprints
5. understand the ways of physical and chemical techniques of developing fingerprints on crime scene evidence.
6. The significance of foot, palm, ear and lip prints

Unit 1: Basics of fingerprinting (8 Hours)

Introduction and history, with special reference to India. Biological basis of fingerprints. Formation of ridges. Fundamental principles of fingerprinting. Types of fingerprints. Fingerprint patterns. Fingerprint characters. Plain and rolled fingerprints. Classification

Unit 2: Record of fingerprinting (8 Hours)

method for fingerprint record keeping. Automated Fingerprint Identification System. Classification and cataloguing of fingerprint record. Automated Fingerprint Identification System. Significance of poroscopy and edgeoscopy.

Unit 3: Development of Fingerprints-I (8 Hours)

Latent prints. Constituents of sweat residue. Latent fingerprints' detection by physical and chemical techniques. Mechanism of detection of fingerprints by different developing reagents.

Unit 4: Development of fingerprints-II (9 Hours)

Application of light sources in fingerprint detection. Preservation of developed fingerprints. Digital imaging for fingerprint enhancement. Fingerprinting the deceased. Developing fingerprints on gloves.

Unit 5: Foot prints Other impressions (12 Hours)

Importance of footprints. Casting of foot prints, Electrostatic lifting of latent foot prints. Palm prints - Lip prints – Nature, location, collection and examination of lip prints. Ear prints and their significance. Palm prints and their historical importance.

Text Books:

1. J.E. Cowger, Friction Ridge Skin, CRC Press, Boca Raton (1983).
2. D.A. Ashbaugh, Quantitative-Qualitative Friction Ridge Analysis, CRC Press, Boca Raton (2000).
3. C. Champod, C. Lennard, P. Margot and M. Stoilovic, Fingerprints and other Ridge Skin Impressions, CRC Press, Boca Raton (2004).
4. Lee and Gaenslen's, Advances in Fingerprint Technology, 3rd Edition, R.S. Ramotowski (Ed.), CRC Press, Boca Raton (2013).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3		2	3	2		3		
CO2	3	2	1				1	3	
CO3	2	3			1		2	3	
CO4	3	3		3	2		3	3	2
CO5	2	3			1		2	3	
CO6	3	3	1		2	1	2	1	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2007	Forensic Science Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn about evaluation of crime scene
2. classify poisons and their modes of actions
3. know the forensic significance of dna typing

Course Outcomes:

The students will be able to

1. evaluate of crime scene
2. correlate the nature of injuries
3. examine poisons and their modes of actions
4. determine whether the crime was staged to appear as suicide or accident.
5. carry out analysis of explosive substances
6. write report on the role of forensic significance of dna typing

LIST OF EXPERIMENTS

1. To prepare a report on evaluation of crime scene
 2. To prepare a case report on a case involving arson
 3. To correlate the nature of injuries with distance from which the bullet was fired.
 4. To identify metallic poisons
 5. To identify organic poisons
 6. To carry out analysis of explosive substances.
 7. To prepare a case report on bomb scene management.
 8. To design a checklist for the forensic scientists at the death scene
 9. To carry out the separation of amino acids by thin layer chromatography
 10. To prepare a report on the role of DNA typing in solving paternity disputes.
- (Minimum 10 Experiments to be conducted)

Text Books:

1. M. Houck, Jay Siegel, "Fundamentals of Forensic Science", Academic Press, 3rd Edition, 2015.
2. T. Kubic, N. Petraco, "Forensic Science Laboratory Manual and Workbook", CRC Press, 3rd Edition, 2009.
3. K. Mirakovits, G. Londino-Smolar, "The Basics of Investigating Forensic Science" CRC Press; 1st edition, 2015.
4. V. N. Sehgal, Surinder Nath and M. K. Bhasin, "Studies in Forensic Science No. 3: Society, Crime and Prosecution", Kamla-Raj Enterprises, New Delhi, 2005.
5. S.H James and J.J Nord, "Forensic Science: An introduction to scientific and Investigative Techniques", 2nd Edition, CRC Press, Boca Raton, 2005.
6. B. A. J. Fisher, D. R. Fisher, "Techniques of Crime Scene Investigation", CRC Press, 8th Edition, 2012.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3		2	3	2		3		
CO2	3	2	1				1	3	
CO3	2	3			1		2	3	
CO4	3	3		3	2		3	3	2
CO5	2	3			1		2	3	
CO6	3	3	1		2	1	2	1	

'3'-High, '2'- Medium, '1'-Low, '-'- No correlation

20FS2008	Forensic Science and Criminal Justice System	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student

1. understand basic principles of forensic science
2. know the scene of crime, physical evidence and collection of biological stains
3. learn the theories of causation of crime, indian penal code and criminal justice system.

Course Outcomes:

The student will be able to

1. know the development of forensic science
2. understand the types, protection of scene of crime and preservation of scene of crime
3. understand the theories of causation of crime and forms of punishment

4. understand the importance of criminal procedure code and indian evidence act
5. know the operation of criminal justice systems and related procedures
6. understand about report formats of crime scene and laboratory findings

Unit 1: Crime (9 Hours)

Crime: Definition, theories of causation of crime - Pre-classical and Neoclassical, constitutional, geographical, economic, physiological, sociologist, Multiple causation approach - General factors of crime, forms of punishment in brief.

Unit 2: Scene of crime (9 Hours)

Scene of crime - Types, protection of scene of crime, preservation (recording) of scene of crime-photography and sketching methods - Physical evidence: Meaning, types, search methods, collection and preservation - Forwarding - Chain of custody - Collection, preservation, packing and forwarding of: blood, semen and other biological stains, firearm exhibits, documents, fingerprint, viscera, hair & fibre, glass, soil and dust, petroleum products and drugs and poisons.

Unit 3: Criminal Justice system - I(9 Hours)

Introduction to constitution of India - Administration of civil and criminal justice - Hierarchy of courts - Powers of courts - Types of courts - Lok Ayukta system - Organization of courts in India, jurisdiction of courts in criminal cases - Human rights and criminal justice system in India - prosecution

Unit 4: Criminal Justice System - II (9 Hours)

Broad components of criminal justice system. The structure of Police organizations in India - Functions and duties of police Policing styles and principles. Police's power of investigation. Filing of criminal charges. Community policing. Policing a heterogeneous society. Correctional measures and rehabilitation of offenders. F.I.R., case diary, roznamacha - Report Writing and Evidence Evaluation - Report formats of crime scene and laboratory findings.

Unit 5: Indian Penal Code (9 Hours)

Indian Penal Code: Introduction, General exceptions, offences against person - Offences against property - Attempt to suicide - sexual offences - Criminal procedure code - Introduction and general ideal of sections: 291-93, 154, 155, 156, 157, 158, 159, 160, 161, 162, 172, 173, 174, 175, and 176 - Indian Evidence Act : Introduction and general ideal of sections : 32, 45, 46, 47, 57, 58, 60, 73, 135, 136, 137, and 159.

Text Books:

1. Saferstein, Criminalistics - An introduction to Forensic Science, Prentice hall Inc., USA, 1995.
2. C.G.G. Aitken and D.A. Stoney, The use of statistics in Forensic Science, Ellis Harwood Limited, England, 1991.
3. James, S.H. and Nordby, J.J., Forensic Science; an introduction to Scientific and Investigative Techniques, CRC Press, USA, 2003.
4. Jon J. Nordby, Dead Reckoning: The Art of Forensic Detection, CRC Press LLC, Boca Raton FL, CRC Press, 2000.
5. Schmalleges Frank, Criminal Justice Today, Prentice Hall, New Jersey, 1999.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	-	1	1	1	1	1	1	2
CO2	1	1	1	1	1	1	1	2	2
CO3	1	-	1	1	1	1	1	2	1
CO4	1	1	1	1	1	1	1	1	3
CO5	1	1	1	1	1	1	1	1	1
CO6	1	1	1	1	1	1	1	2	3

“3”- High; “2”- Medium; “1”- Low; “-”- No correlation

20FS2009	Forensic Physics Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. understand the analysis of soil, paint and glass samples
2. know about tool marks
3. understand about microscopic examination of different samples

Course Outcomes:

The student will be able to

1. do density gradient method
2. experiment paint samples by physical matching and thin layer chromatography methods
3. know about spectrochemical analysis of samples
4. examine and authenticate audio and video recordings
5. know about storage media and its authentication
6. know about the methodology to collect digital evidences

LIST OF EXPERIMENTS

1. To compare soil samples by density gradient method
2. To compare paint samples by physical matching method
3. To compare paint samples by thin layer chromatography method
4. To compare glass samples by refractive index method
5. To identify and compare tool marks
6. To compare cloth samples by physical matching
7. Physical and microscopic examination of automobile paints and its spectrochemical analysis
8. Tool marks examination using comparison / stereo microscope
9. Auditory and spectrographic analysis of audio evidence for speaker identification
10. Examination and authentication of audio video recording.
11. Identification of storage media and its authentication
12. Collection of digital evidences using different softwares
(Minimum 10 Experiments to be conducted)

Text Books:

1. W. Robinson, Undergraduate Instrumental Analysis, 5th Edition, Marcel Dekker, Inc., New York, 1995.
2. D.R. Redsicker, The practical Methodology of Forensic Photography, 2nd Edition, CRC Press, Boca Raton, 2000.
3. Kathy Mirakovits and Gina Londino, The Basics of Investigating Forensic Science, CRC Press, 2015.
4. Franck H and Franck D, Forensic Engineering Fundamentals (1st edn), CRC Press, Boca Raton, Florida, USA, 2013.
5. Li CT, Computational Forensics, Digital Crime, and Investigation, Yurchak Printing Inc, Hershey, USA, 2011.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	-	1	1	1	1	1	1	2	3
CO2	1	1	1	1	1	1	1	2	2
CO3	1	1	1	1	1	1	1	2	2
CO4	2	1	1	1	1	1	1	2	2
CO5	2	1	1	1	1	1	1	2	3
CO6	1	2	1	1	1	1	1	2	3

“3”– High; “2”– – Medium; “1”– - Low; “-”– No correlation

20FS2010	Cyber Forensics Laboratory	L	T	P	C
		0	0	3	2

Enable the student to

1. develop their skills identify, seize and preserve digital evidence from crime scenes and identify hidden files
2. have a competence in the skills required to use digital signatures for securing e-mail and online transactions
3. have the hands on training to carry out imaging of hard disks

Course Outcomes:

The student will be able to

1. identify encrypted files and IP address of the sender e – mails
2. detect, seize and preserve digital evidence from crime scenes
3. recognize hidden files
4. demonstrate concealment techniques using cryptographic PGP
5. carry out imaging of hard disks
6. identify encrypted files.

LIST OF EXPERIMENTS

1. To identify, seize and preserve digital evidence from crime scenes.
2. To detect deletions, obliterations and modifications of files using encase software.
3. To trace routes followed by e-mails and chats.
4. To identify the IP address of the sender of e – mails.
5. To demonstrate concealment techniques using cryptographic PGP.
6. To identify encrypted files.
7. To identify hidden files.
8. To use digital signatures for securing e-mail and online transactions.
9. To acquire data from PCs/laptop/HDDs/USBs, open drives, memory cards and SIM cards.
10. To use symmetric and asymmetric keys for protection of digital record.
11. To carry out imaging of hard disks.

(Minimum 10 experiments to be conducted)

Text books

1. Computer Forensics : Investigating Network Intrusions and Cyber Crime, EC-Council, ISBN-13: 978-1-4354-8352-1, ISBN-10: 1-4354-8352-9
2. Computer Forensics : Investigating Wireless Networks and Devices, EC-Council, ISBN-13: 978-1-4354-8353-8, ISBN-10: 1-4354-8353-7
3. Handbook of Digital Forensics and Investigations, Eoghan Casey ed., Elsevier Academic Press, ISBN 13: 978-0-12-374267-4

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1		2	1	1		1	1	3	
CO2				1	2			1	
CO3		2					2	2	
CO4	1		1		1				1
CO5		3		2		1	1	2	1
CO6		3		2	1		2		

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS2011	Questioned Documents	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn examining the questioned documents using various detection apparatus
2. identify the forgery by comparing documents
3. learn to identify the forgery

Course Outcomes:

The student will be able to

1. Choose the correct method to examine the questioned documents
2. Apply various method to analyze questioned documents
3. Compare the questioned documents with standards
4. Analyze the questioned documents of various types
5. Identify the different types of forgery in the documents
6. Examine the documents that has forgery

Unit 1: Nature and Scope of Questioned Documents (7 Hours)

Definition of questioned documents. Types of questioned documents. Preliminary examination of documents. Basic tools needed for forensic documents

Unit 2 Examination of Questioned Documents (9 Hours)

examination – ultraviolet, visible, infrared and fluorescence spectroscopy, photomicrography, microphotography, visible spectral comparator, electrostatic detection apparatus. Determining the age and relative age of documents.

Unit 3: Comparison of Documents (12 Hours)

Comparison of handwriting. Development of individuality in handwriting. Natural variations and fundamental divergences in handwritings. Class and individual characteristics. Merits and demerits of exemplar and non-exemplar samples during comparison of handwriting. Standards for comparison of handwriting. Comparison of paper, ink, printed documents, typed documents, Xeroxed documents.

Unit 4: Forgeries (9 Hours)

Alterations in documents, including erasures, additions, over-writings and obliterations. Indented and invisible writings. Charred documents.

Unit 5: Examination of forgery (8 Hours)

Examination of counterfeit Indian currency notes, passports, visas and stamp papers. Disguised writing and anonymous letters.

Text books:

1. O. Hilton, Scientific Examination of Questioned Documents, CRC Press, Boca Raton (1982).
2. A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, Scientific Evidence in Civil and Criminal Cases, 4th Edition, Foundation Press, New York (1995).
2. R.N. Morris, Forensic Handwriting Identification: Fundamental Concepts and Principles, Academic Press, London (2000).
3. E. David, The Scientific Examination of Documents – Methods and Techniques, 2nd Edition, Taylor & Francis, Hants (1997).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1		3	2			1	2	3	1
CO2		3		2	1		1	3	2
CO3		3	1	2			2	3	1
CO4		3		1	2		2	3	1
CO5		3			2	1		3	2
CO6		3	1		2		2	3	

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS2012	Questioned Documents Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. identify the forgery by analyzing the handwriting
2. identify forgery by comparing handwriting
3. analyze the security features

Course Outcomes:

students will be able to

1. record variations in handwriting
2. compare the handwriting pattern
3. differentiate various types of forgeries
4. find defects in handwriting samples
5. compare the documents
6. analyze computer printouts

LIST OF EXPERIMENTS

1. To identify handwriting characters
2. To study natural variations in handwriting
3. To compare handwriting samples.
4. To detect simulated forgery
5. To detect traced forgery
6. To study the line quality defects in handwriting samples.
7. To examine the security features of currency notes, passports and plastic money.
8. To study alterations, obliterations and erasure in handwriting samples.
9. Identification of normal / disguise writing
10. Examination of computer printouts.

(Minimum 10 experiments to be conducted)

Text books:

R.N. Morris, Forensic Handwriting Identification: Fundamental Concepts and Principles, Academic Press, London (2000).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1		3				1	2	3	1
CO2		3		2		1	2	3	1
CO3		3				2	2	3	1
CO4		2		3			1	3	2
CO5		2				1	1	3	2
CO6		3		1		2	2	3	1

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’No correlation

20FS2013	Forensic Dermatoglyphics Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student

1. Understand the principle of recording fingerprints
2. Know ridge tracing and ridge counting
3. Understand the methodology of fingerprint detection

Course Outcomes:

The student will be able to

1. know the fundamental principles on which the science of fingerprinting is based.
2. understand the method of classifying criminal record by fingerprints
3. know about the tools required for examination of fingerprints.
4. know about ridge tracing and ridge counting
5. examine the significance of foot prints
6. know about physical methods to identify fingerprints

LIST OF EXPERIMENTS

1. To record plain and rolled fingerprints
2. To carry out ten digit classification of fingerprint.
3. To identify different fingerprint patterns
4. To identify core and delta
5. To carry out ridge tracing and ridge counting.
6. To investigate physical methods of fingerprint detection.
7. To investigate chemical methods of fingerprint detection.

8. To use different light sources for enhancing developed fingerprints
9. To prepare cast of foot prints.
10. Analyzing Bite mark casting and comparison
(Minimum 10 experiments to be conducted)

Text Books:

1. J.E. Cowger, Friction Ridge Skin, CRC Press, Boca Raton, 1983.
2. D.A. Ashbaugh, Quantitative- Qualitative Friction Ridge Analysis, CRC Press Boca Raton, 2000
3. C. Champod, C. Lennard, P. Margot and M. Stoilovic, Fingerprints and other Ridge Skin Impressions, CRC Press, Boca Raton, 2004.
4. Lee and Gansslen's, Advances in Fingerprint Technology, 3rd Edition, R.S. Ramotowski (Ed.), CRC Press Boca Raton, 2013.
5. O. Hilton, Scientific Examination of Questioned Documents, CRC Press, Boca Raton, 1982.
6. A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, Scientific Evidence in Civil and Criminal Cases, 4th Edition, Foundation Press, New York, 1995.
7. R.N. Morris, Forensic Handwriting Identification: Fundamental Concepts and Principles, Academic Press, London, 2000.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	-	1	1	1	1	1	1	2	3
CO2	-	1	1	1	1	1	1	2	3
CO3	-	2	1	1	1	1	1	2	3
CO4	-	1	1	1	1	1	1	2	3
CO5	-	1	1	1	1	1	1	2	3
CO6	1	1	1	1	1	1	1	2	3

“3”– High; “2”– Medium; “1”– Low; “-”– No correlation

20FS2014	Forensic Biology and Serology -I	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the significance of serological evidence.
2. know the importance of biological fluids – blood, urine, semen, saliva, sweat and milk – in crime investigations.
3. learn the usefulness of genetic markers in forensic investigations.

Course Outcomes:

The students will be able to

1. understand importance of blood fluids in forensic science
2. understand the significance of forensic semen
3. understand the importance of other body fluids in forensic science
4. analyze genetic markers and fluid stain patterns.
5. document crime scene

Unit 1: Forensic Importance of Blood (9 Hours)

Common body fluids. Composition and functions of blood. Collection and preservation of blood evidence. Distinction between human and non-human blood. Determination of blood groups. Antigens and antibodies. Forensic characterization of bloodstains. Typing of dried stains. Blood enzymes and proteins.

Unit 2: Forensic Importance of semen (9 Hours)

Semen. Forensic significance of semen. Composition, functions and morphology of spermatozoa. Collection, evaluation and tests for identification of semen. Individualization on the basis of semen examination.

Unit 3: Other Body Fluids (9 Hours)

Composition, functions and forensic significance of saliva, sweat, milk and urine. Tests for their identifications.

Unit 4: Genetic Marker Analysis (9 Hours)

Cellular antigens. ABO blood groups. Extracellular proteins and intracellular enzymes. Significance of genetic marker typing data. Sexual assault investigations. Bloodstain characteristics. Impact bloodstain

patterns. Cast-off bloodstain patterns. Projected bloodstain patterns. Contact bloodstain patterns. Blood trails. Bloodstain drying times.

Unit 5: Documentation (9 Hours)

Documentation of bloodstain pattern evidence. Crime scene reconstruction with the aid of bloodstain pattern analysis.

References:

1. W.G. Eckert and S.H. James, Interpretation of Bloodstain Evidence at Crime Scenes, CRC Press, Boca Raton (1989).
2. G.T. Duncan and M.I. Tracey in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (Ed.), CRC Press, Boca Raton (1997).
3. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
4. T. Bevel and R.M. Gardner, Bloodstain Pattern Analysis, 3rd Edition, CRC Press, Boca Raton (2008).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2					2		
CO2	3		3		2		3		
CO3	3			3			2		
CO4	3	2						2	2
CO5	3				2		3		
CO6	2			1					2

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS2015	Forensic Biology and Serology Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. develop their skills to identify the hair morphology
2. determine blood group and identify stain in saliva and urine
3. prepare case reports

Course Outcomes:

The student will be able to

1. examine human hair
2. carry out microscopic examination of pollen grains and diatoms
3. identify blood groups of both fresh and dried blood samples
4. demonstrate concealment techniques using cryptographic PGP
5. handle and get the stains from Saliva and Urine
6. prepare case reports on entomology and wildlife forensics

LIST OF EXPERIMENTS

1. To prepare slides of scale pattern of human hair.
2. To examine human hair for cortex and medulla.
3. To carry out microscopic examination of pollen grains.
4. To carry out microscopic examination of diatoms.
5. To cite a crime case in which diatoms have served as forensic evidence.
6. To prepare a case report on forensic entomology.
7. To prepare a case report on problems of wildlife forensics
8. To determine blood group from fresh blood samples.
9. To carry out the crystal test on a blood sample.
10. To identify blood samples by chemical tests.
11. To identify the given stain as saliva.
12. To identify the given stain as urine.
13. To carry out cross-over electrophoresis.
14. To study the correlation between impact angle and shape of bloodstain.
15. To identify the point of convergence from the bloodstain patterns.

(Minimum 10 experiments to be conducted)

Text Books

1. R. Saferstein, Forensic Science Handbook, Vol. III, Prentice Hall, New Jersey, digitized, 23 Jul 2008.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1		1		1		1		3	
CO2		1	1	1			2	3	
CO3	3			2		1	1	2	
CO4	3		1						2
CO5	2	2	2	1	2			2	
CO6		3	1		1	1	3	1	1

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS2016	Forensic Ballistics				L	T	P	C
					3	0	0	3

Course Objectives:

Enable the student to

1. learn about firearms and their classification
2. learn about ammunition and fire marks.
3. learn about nature of fireman injuries.

Course Outcomes:

The student will be able to

1. understand the detailed classification of firearms.
2. learn types of ammunition and headstamp markings on ammunitions.
3. classify various kinds of firing marks.
4. know the types of firearm evidences
5. understand the mechanism of formation of gunshot residues
6. identify the nature of fireman injuries.

Unit 1: Firearms (10 Hours)

History, development and classification of firearms. Weapon types and their operation. Firing mechanisms of different firearms -Internal ballistics – Definition, ignition of propellants, shape and size of propellants, manner of burning, and factors affecting the internal ballistics: lock time, ignition time, barrel time, erosion, corrosion and gas cutting -External Ballistics – Vacuum trajectory, effect of air resistance on trajectory, base drag, drop, drift, yaw, shape of projectile and stability, trajectory computation, ballistics coefficient and limiting velocity, Measurements of trajectory parameters, introduction to automated system of trajectory computation and automated management of ballistic data - Terminal Ballistics – Effect of projectile on hitting the target: function of bullet shape, striking velocity, striking angle and nature of target, tumbling of bullets, effect of instability of bullet, effect of intermediate targets, influence of range. Ricochet and its effects, stopping power

Unit 2: Ammunition and firing marks (12 Hours)

Types of ammunition. Constructional features and characteristics of different types of cartridges and bullets. Primers and priming compounds. Projectiles. Headstamp markings on ammunitions.-Various kinds of firing marks – rifling marks, base marking, chamber marking, extraction and Ejection marking. Comparison microscope – instrumentation

Unit 3: Firearm Evidence (7 Hours)

Matching of bullets and cartridge cases in regular firearms. Identification of bullets, pellets and wads fired from improvised, country made firearms. Automated method of bullet and cartridge case comparison. Determination of range of fire and time of fire.

Unit 4: Gunshot residues (7 Hours)

Mechanisms of formation of gunshot residues. Methods of analysis of gunshot residues from shooting hands and targets, with special reference to clothings.

Unit 5: Identification and nature of fireman injuries (9 Hours)

Identification and nature of fireman injuries, Shotgun, pistol, revolver, rifle, air guns. Bullet hole examinations – entry and exit hole determination, Estimation of caliber from bullet holes, Wave and

cavitation effect, Bullet and trajectory through glass and other targets. Reconstruction with respect to accident, suicide, murder and self defence.

Text books

1. B.J. Heard, Handbook of Firearms and Ballistics, Wiley and Sons, Chichester (1997)
2. W.F. Rowe, Firearms identification, Forensic Science Handbook, Vol. 2, R. Saferstein (Ed.), Prentice Hall, New Jersey (1988).
3. A.J. Schwoeble and D.L. Exline, Current Methods in Forensic Gunshot Residue Analysis, CRC Press, Boca Raton (2000).
4. E. Elaad in Encyclopedia of Forensic Science, Volume 2, J.A. Siegel, P.J. Saukko and G.C. Knupfer (Eds), Academic Press, London (2000).
5. T.J. Gardener and T.M. Anderson, Criminal Evidence, 4th Ed. Wadsworth, Belmont (2001).
6. S.H. James and J.J. Nordby, Forensic Science : An Introduction to scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).
7. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's, Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013)

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					3		
CO2	3		2				3		
CO3	3			3			2		
CO4	2	1						2	
CO5	3				2		3		
CO6	1			1					2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2017	Forensic Ballistics Laboratory	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn the importance of fireman injuries.
2. learn the nature of fireman injuries
3. learn the methods for characterization of gunshot residue.

Course Outcomes:

The student will be able to

1. classify the firearms and their firing mechanisms.
2. dismantle and assemble all types of small arms
3. understand the methods of identifying firearms.
4. measure rifling details on fired bullets
5. know the characteristics of ammunition
6. understand the reconstruction of sequence of events in shooting incidents.

LIST OF EXPERIMENTS

1. Photography and sketching of crime scene involving firearms (3 practical).
2. Collection, preservation and packing of exhibits.
3. To dismantle and assemble all types of small arms, and to record their data, lock mechanism and trigger pull.
4. To open all types of cartridges, study and record their data.
5. Determination of shot size from diameter and weight of shots/pellets.
6. To prepare sulphur cast of inside of barrels and study the rifling details, caliber, size of bore, etc.
7. Opening of parcels, various precautions, preparations of observation sheet, marking of exhibits.
8. To determine / measure rifling details on fired bullets – determination of make/model of suspected firearms firing the bullet.
9. Restoration of erased serial numbers on firearms.
10. To perform chemical tests of powder residues (Walker's Test) around gunshot holes in fabrics

11. Reconstruction of sequence of events in shooting incidents.
12. To conduct firing in plate glass and study direction of firing, sequence of shots.
13. Determination of distance/ direction of firing from deceased / injuries.
(Minimum 10 experiments to be conducted)

Text books:

1. Heard, B.J; "Handbook of Firearms and Ballistics", John Wiley, England, 1997.
2. Warlow, T.A.; "Firearms, The Law and Forensic Ballistics", Taylor and Francis, London, 1996.
3. Sellier, K.G. et al; "Wound Ballistics and the Scientific Background", Elsevier Pub. Co., London, 1994.
4. Jauhari M; "Identification of Firearms, Ammunition, & Firearms Injuries", BPR&D, New Delhi.
5. Ordog, G.J; "Management of Gunshot wounds", Elsevier Pub. Co., NY, 1983.
6. Schooeble, A.J. and Exline, L.D; "Current methods in Forensic Gunshot Residue Analysis", CRC Press, NY, 2000

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		2			3	1		2	3	1
CO2		3						1	1	
CO3	1	2			3		2	2	2	2
CO4					1	3	2	3	3	1
CO5						2	3	2	3	3
CO6				3	2			3	2	3

'3'-High, '2'- Medium, '1'-Low, '-No correlation

20FS2018	Moot Court for Forensic Science	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. Collect the samples for evidence
2. Analyze the sample
3. Enhance the communication skill

Course Outcomes:

The student will be able to

1. know the methods of collecting evidences from the crime scene
2. analyze the evidences
3. enhance the reasoning ability
4. improve communication skill
5. draft the documents
6. improve analytical skill

LIST OF EXPERIMENTS

A moot court is an activity in which students take part in simulated court proceedings, which usually involves participating in oral argument and draft documents. The student has to study the already solved case in Indian and Foreign court of law and explain how it was solved with the help of scientific aids. (It is a role play by students as forensic experts of different discipline ie. DNA, Fingerprint, Pathologist, Forensic Botanist etc) The course involves registration of the case, Proceeding to the spot with Experts, Collection of evidence to prove the crime, Place of occurrence and to connect the crime and the criminal, Collection of evidence from the Scene of crime, Victim, Accused.

(Sample cases are given, Other cases may be chosen)

1. The 16-year-old Gudiya went missing on July 4, 2017 while returning from school. She was kidnapped, gang-raped and brutally murdered. The girl's body was found in the forest on July 6 and the post-mortem report confirmed rape. The case was handed over to the CBI by the Himachal Pradesh High Court. Bring to the court the admissible evidence that helped in solving the case.
2. Chandigarh Police registered a case on May 25, 2009, as per which two taxi drivers Amar Lal and Davinder Singh were murdered by accused Lalit Kumar, Pardeep Kumar and Anil Kumar.

The accused had robbed Rs 8,000 and car of Davinder Singh and Amar Lal in the ditches of Morni hills and Sahmbu Barrier respectively. Produce to the court admissible and relevant forensic evidences to solve case as murder.

3. Everything pointed to Bell as the main suspect after the horrendous crime was committed in 1981, Bell, however, maintained his innocence. After the development of forensic investigation and the analysis of the evidence found at the scene of the crime, At the end of March 2017, the Birmingham Crown Court, England, found Osmond Bell (60) guilty of murdering his ex-wife, Nova Walsh (24), 36 years ago. Bell could not be charged with the homicide and was released soon after his arrest due to lack of evidence. For years the case remained open and without suspects. The victim's family asked the court for a new review of the evidence involved in the case. In 2014, forensic scientists carried out further analysis of the evidence and proved Bell guilty. As a forensic expert bring to court the evidences that helped in solving the crime.
4. Jeffrey MacDonald case: Early in the morning of February 17, 1970, the family of Army doctor Jeffrey MacDonald was attacked, leaving the doctor's pregnant wife and two young daughters dead from multiple stab wounds. MacDonald himself was injured by what he claimed to be four suspects, but he survived with only minor wounds. Doubt was immediately cast on the doctor's story, based on the physical evidence on the scene that suggested that he was the killer. However, the Army dropped the case because of the poor quality of the investigative techniques. Several years later, though, MacDonald was brought to trial in a civilian court. Key evidence was provided by a forensic scientist. Produce in court the evidences accepted to prove the case.
5. Ross Compton, 60, was indicted in January for aggravated arson and insurance fraud for allegedly setting fire to his Court Donegal house. The blaze caused nearly \$400,000 in damages. Show case how with the help of forensic evidences Ross Compton was found guilty.
6. Bernard Josephs returns to his house in Bromley, England, and finds his wife Claire lying under the bed, her throat slashed and severed to the spine. Defensive wounds to her hands appeared to be caused by a serrated knife. No weapon was found at the Josephs' house, and police had no other clues to go on. However, the murder was solved, and the killer convicted within four months, through solid forensic investigation. Bring light to this court the forensics evidences used to solve the case.
7. When the bodies of 10-year-old schoolgirls Holly Wells and Jessica Chapman were discovered in a ditch in Suffolk, England, the horrific crime baffled the local community. Forensic botanist Patricia Wiltshire was brought in to investigate the scene. This case proved that even the smallest, silent witnesses can provide crucial information toward solving a crime. Trace the case and submit to the court the evidences used by forensic botanist to solve the case.
8. Sister Abhaya a Catholic sister, was found dead in a water well in St Pius Convent in Kottayam on 27 March 1992. Investigation into this death is by far the longest running murder investigation in the State of Kerala. The local police which investigated the case initially closed it with a theory of suicide. The Crime Branch which took up the investigation later tried to strengthen the suicide theory, with claims of psychological illness of the deceased. On a writ petition, the High Court of Kerala transferred the investigation to the Central Bureau of Investigation. The first team of CBI failed to find the reason of death. Upon the instruction of the court a second team was set up, which concluded that it was indeed a murder, but there were not enough evidence leading to the murderer(s). Court installed a third team of CBI, and they finally found two priests and a sister responsible for the murder and arrested them on 19 November 2008. On 17 July 2009, charges of murder, and destruction of evidence were filed against the three. Bring to court the evidences used in proving the guilty in the case.
9. Sabir Malik from Ghaziabad in Uttar Pradesh and his accomplices had allegedly committed a burglary at the house of businessman Lalit Batra in December 2006. They made away with Rs 30,000 Jewellery and other valuables. The crime remained unsolved and declared a blind case as identities of the suspect could not be established despite all efforts. But in 2006 the investigators solved the crime and arrested the suspect. Present the forensic evidence that helped the police to solve the case.
10. Around 2 a.m. on the night of September 19, 1910, Clarence Hiller woke to the screams of his wife and daughter in their home at 1837 West 104th Street in Chicago. After a spate of robberies,

residents of this South Side neighborhood were already on edge. Hiller, a railroad clerk, raced to confront the intruder. In the ensuing scuffle, the two men fell down the staircase. His daughter, Clarice, later recalled hearing three shots, followed by her mother screaming upstairs. Neighbors came running but the man had fled the home, leaving a dying Hiller by his front door.

20FS2019	Cyber Crimes and Cyber Forensics	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basics of computers
2. know about cyber crimes
3. understand the principle of investigating cyber crimes

Course Outcomes:

The student will be able to

1. know the principle of operation of computer hardware and accessories
2. understand the types of computer crimes
3. know crimes related to intellectual property rights, computer terrorism and hacking
4. understand the concept of collecting of magnetic data
5. know about extraction of information from the hard disk
6. understand the principle of restoration of deleted files, encryption and decryption methods.

Unit 1: Computer fundamentals (9 Hours)

Fundamentals of computer hardware and accessories, development of hard disk, physical construction, CHS and LBA addressing, encoding methods and formats - Memory and processors – methods of storing data, Operating systems, Networks – LAN, WAN and MAN.

Unit 2: Cyber crimes – I (9 Hours)

Definition - computer crimes - Distinction between computer crimes and conventional crimes. Reasons for commission of computer crimes - Breaching security and operation of digital systems - Computer virus, and computer worm – Trojan horse, trap door, super zapping, logic bombs.

Unit 3: Cyber crimes – II (9 Hours)

Types of computer crimes – computer stalking, pornography, hacking, crimes related to intellectual property rights, computer terrorism, hate speech, private and national security in cyber space - An overview of hacking, spamming, phishing and stalking.

Unit 4: Computer Forensic Investigations – I (9 Hours)

Seizure of suspected computer - Preparation required prior to seizure - Collection and seizure of magnetic data, Treatment of exhibits, Extraction of information, Restoration of deleted files – familiarization of software, Encase, Cyber check suites, Encryption and decryption methods. Protocol to be taken at the scene.

Unit 5: Computer Forensic Investigations – II (9 Hours)

Extraction of information from the hard disk - Treatment of exhibits. Creating bitstream of the original media - Collection and seizure of magnetic media - Legal and privacy issues. Examining forensically sterile media - Restoration of deleted files. Password cracking and E-mail tracking -Encryption and decryption methods - Tracking users.

Text Books:

1. R.K. Tiwari, Sastry and K.V. Ravikumar, Computer Crimes and Computer Forensic, Select publishers, New Delhi, 2003.
2. C.B. Leshin, Internet Investigations in Criminal Justice, Prentice Hall, New Jersey, 1997.
3. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey, 2004.
4. E. Casey, Digital Evidence and Computer Crime, Academic Press, London, 2000.
5. Nina Godbole and Sunit Belapore, Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley Publications, 2011.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	2	1	1	1	1	1	-	3

CO2	1	2	1	1	1	1	1	-	3
CO3	1	2	1	1	1	1	1	-	3
CO4	-	2	1	1	1	1	1	-	3
CO5	-	2	1	1	1	1	1	-	3
CO6	1	2	1	1	1	1	1	2	2

“3”– High; “2”– Medium; “1”– Low; “-”– No correlation

20FS2020	Fundamentals of Forensic Psychology						L	T	P	C
							3	0	0	3

Course Objectives:

Enable the student to

1. overview of forensic psychology and its applications
2. understand psychology and criminal behavior.
3. learn about tools for detection of deception.

Course Outcomes:

The student will be able to

1. overview of forensic psychology and its applications.
2. explain legal aspects of forensic psychology.
3. describe the significance of criminal profiling.
4. outline the importance of psychological assessment in gauging criminal behavior.
5. illustrate the tools and techniques required for detection of deception.
6. demonstrate the critical assessment of advanced forensic techniques like polygraphy, narcoanalysis and brain electrical oscillation signatures.

Unit 1: The Science of Psychology (8 Hours)

Concepts of psychology, History of psychology, modern perspectives, types of psychological professionals psychology, The science and research methods, professional and ethical issues in psychology

Unit 2: Theories of Personality (9 Hours)

Understanding personality, type and Trait, theories of personality, psychoanalytic model, behavioristic model social cognitive model, Humanistic model, Biological model assessment of personality.

Unit 3: Basics of Forensic Psychology (9 Hours)

Definition and fundamental concepts of forensic psychology and forensic psychiatry. Psychology and law. Ethical issues in forensic psychology. Assessment of mental competency. Mental disorders and forensic psychology. Psychology of evidence – eyewitness testimony, confession evidence. Criminal profiling. Psychology in the courtroom, with special reference to Section 84 IPC.

Unit 4: Psychology and Criminal Behavior (10 Hours)

Psychopathology and personality disorder. Psychological assessment and its importance. Serial murderers. Psychology of terrorism. Biological factors and crime – social learning theories, psycho-social factors, abuse. Juvenile delinquency – theories of offending (social cognition, moral reasoning), Child abuse (physical, sexual, emotional), juvenile sex offenders, legal controversies.

Unit 5: Detection of Deception (9 Hours)

Tools for detection of deception – interviews, non-verbal detection, statement analysis, voice stress analyzer, hypnosis. Polygraphy – operational and question formulation techniques, ethical and legal aspects, the guilty knowledge test. Narco analysis and brain electrical oscillation signatures – principle and theory, ethical and legal issues.

Text books

1. M J. Baron, R.A. Kolsher, “Psychology: from science to Practice”, Pearson, 2nd edition, 2007.
2. C. Cronin, “Forensic Psychology”, Kendall Hunt Pub Co; 2nd edition, 2009.
3. C.R. Bartol, A.M. Bartol, “History of Forensic Psychology”, John Wiley & Sons Inc., 2014.
4. V. Veeraraghavan, “Textbook of Criminology”, Selective & Scientific Books, 2018.
5. A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, “Scientific Evidence in Civil and Criminal Cases”, 4th Edition, The Foundation Press, Inc., New York, 1995.
6. R. Saferstein, “Criminalistics”, 8th Edition, Prentice Hall, New Jersey, 2004.

7. J.C. DeLadurantey, D.R. Sullivan, "Criminal Investigation Standards", Harper & Row, New York, 1980.
8. J. Niehaus, "Investigative Forensic Hypnosis", CRC Press, Boca Raton, 1999.
9. J. Siegel, P. Saukko "Encyclopedia of Forensic Sciences," 2nd edition, J, Academic Press, 2013.
10. R.S. Fieldman "Understanding Psychology", McGraw Hill Education, Twelfth edition, 2017.
11. B.B. Lahey, "Psychology: An introduction", McGraw-Hill Education; 11th edition, 2011.
12. J.W. Kalat, "Introduction to Psychology", Cengage Learning; 11th edition, 2016.
13. Clifford T. Morgan, Richard A. King, John R. Weisz, John Schopler, "Introduction to Psychology", McGraw-Hill Education, 7th edition, 2001

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2		3	2		1	3	1	
CO2	3	2	1	2	1	3	1		3
CO3				2		2	2	1	
CO4	1		2	3			3		
CO5	2	1			2		2	3	
CO6	2	1			2	3	2	3	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2021	Crime Scene Investigation	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the concepts of crime and crime scene
2. know about documentation of crime scene
3. know about preservation of evidences

Course Outcomes:

The student will be able to

1. know the reasons for committing crime and types of crime scenes
2. understand the objectives of documentation and evidence classification
3. know the methods relevant to crime scene documentation
4. understand the methodology of collecting, packaging and preservation of evidences
5. understand the concepts of crime scene reconstruction
6. know about stages of crime scene reconstruction

Unit 1: Crime and crime scene – I (9 Hours)

Definition of crime - IPC and crime – mensrea - reasons for committing crime in India and worldwide - Crime scene, Types of crime scenes: primary, secondary, indoor, outdoor - Role of different agencies involved in crime scene management: police medico legal experts, judicial officers.

Unit 2: Crime and crime scene – II (9 Hours)

Actions of initial responding officer - objectives - Documentation: statements of victim, witness suspects, database and records, officer safety, emergency care, secure and control, release scene to appropriate authorities - Locards principle of exchange - concept of evidence – evidence classification - direct, circumstantial physical, biological, corroborative, conclusive, trace, testimonial.

Unit 3: Documenting crime scene (9 Hours)

Documenting crime scene: crime scene photography, crime scene notes - Crime scene sketching: indoor and outdoor, triangulation method, baseline method, polar coordinate method - Search: definition, objectives search patterns - strip method, grid method, zone/quadrant method spiral method (inward and outward), point to point method, wheel method.

Unit 4: Preservation of evidences (9 Hours)

Collection, packaging and preservation of evidences and general considerations -Physical evidences: fingerprints, impressions (tyreprints, footprints, lipprints, bitemarks), fiber, trace evidences (glass, soil, paint) firearms and tool marks, explosive materials, questioned documents - Biological evidences: body fluids (blood, urine, semen, secretions), tissue, hair, nail.

Unit 5: Crime scene reconstruction (9 Hours)

Cases of special consideration: arson, mass disasters-their scene management and evidence collection for human identification - Crime scene reconstruction: introduction, importance, nature and principles: recognition, identification, individualization and reconstruction, stages: data collection, conjecture, hypothesis formulation, testing, theory formation.

Text Books:

1. Barry A. J. Fisher, Barry A. J. Fisher, David R. Fisher, David R. Fisher, Techniques of crime scene investigation, CRC Press, 2012.
2. Tom Bevel, Ross M. Gardner, Bloodstain Pattern Analysis with an Introduction to Crime Scene Reconstruction, 3rd Edition, CRC Press, 2008.
3. Suzanne Bell, Forensic Science: An Introduction to Scientific and Investigative Techniques, Fifth Edition, CRC Press, 2019.
4. Stuart H. James and Jon Nordby, An Introduction To Forensic Scientific and Investigative Techniques, Third Edition, CRC Press, 2007
5. W. Jerry Chisum and Brent E. Turvey, Crime Reconstruction, Elsevier academic press, 2011.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	1	-	3
CO2	1	2	1	1	1	1	1	2	3
CO3	1	2	1	1	1	1	1	2	3
CO4	-	1	1	1	1	1	1	2	3
CO5	-	1	1	1	1	1	2	2	2
CO6	1	1	1	1	1	1	1	2	2

“3” – High; “2” – Medium; “1” – Low; “-” – No correlation

20FS2022	DNA Typing	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basic principle of DNA analysis and Typing
2. obtain knowledge on parentage testing
3. be exposed to report writing in DNA typing

Course Outcomes:

The student will be able to

1. recognize the basic principle of DNA analysis
2. apply the forensic significance of DNA typing
3. understand the importance of short tandem repeats and restriction fragment length polymorphism in DNA technique
4. comprehend the principles of parentage testing
5. write a detailed report on DNA typing
6. analyse the probability determination in a population database

Unit 1: Basic Principles (7 Hours)

DNA as biological blueprint of life. Extraction of DNA for analysis. Quantitation of DNA – yield gel quantitation and slot blot quantitation. Mitochondrial DNA – sequence analysis.

Unit 2: Forensic DNA Typing (10 Hours)

Collection of specimens. Polymerase chain reaction – historical perspective, sequence polymorphisms, individualization of evidence.

Unit 3: Short Tandem Repeat (STR) in DNA Technique (10 Hours)

Short tandem repeats (STR) – role of fluorescent dyes, nature of STR loci. Restriction fragment length polymorphism (RFLP) – genetic markers used in RFLP, typing procedure and interpretation of results. Touch DNA.

Unit 4: Parentage Testing (10 Hours)

Principles of heredity. Genetics of paternity. DNA testing in disputed paternity. Mendelian laws of parentage testing. Mathematical basis of parentage identification. Missing body cases. Reference populations and databases.

Unit 5: Report Writing (8 Hours)

Role of DNA typing in identifying unrecognizable bodies - Allele frequency determination. Hardy-Weinberg law. Probability determination in a population database.

Text books

1. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's, Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).
2. J.M. Butler, Forensic DNA Typing, Elsevier, Burlington (2005).
3. K. Inman and N. Rudin, An Introduction to Forensic DNA Analysis, CRC Press, Boca Raton (1997).
4. H. Coleman and E. Swenson, DNA in the Courtroom: A Trial Watcher's Guide, GeneLex Corporation, Washington (1994).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1			1					2	
CO2			2	2	1	2	1	1	
CO3		1	3					3	
CO4				3	1				
CO5	1	3	1	2		1	2	2	1
CO6	1	2	2	1		1	1	1	1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2023	Forensic Medicine	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. explore the death investigations and crime scene management
2. obtain knowledge on evidence processing
3. be exposed to autopsy techniques

Course Outcomes:

The student will be able to

1. do the duties of the first responding officer who receives a call on homicide or suicide case
2. practice the steps involved in processing the death scene
3. explore the crime scene management in death cases
4. understand the process of collecting and documenting the evidences in death cases
5. realise the importance of autopsy
6. to understand the changes happening after death

Unit 1: Death Investigations (9 Hours)

Fundamental aspects and scope of forensic medicine -Approaching the crime scene of death.Obtaining first hand information from the caller.Rendering medical assistance to the victim, if alive.Protecting life.Recording dying declaration. Identifying witnesses and, if possible, suspect. Interviewing onlookers and segregating possible witnesses. Suspect in custody – initial interrogation and searching for evidence. Miranda warning card.

Unit 2: Crime Scene Management in Death Cases (9 Hours)

Assessing the crime scene.Request for forensic team.Importance of command post and log book.Management of crowd and media.Importance of taking notes.Items to be a part of noting.Documenting the death scene.

Unit 3: Processing the Evidence (9 Hours)

Processing evidence.Evaluation of injuries.Importance of canvass form.Indexing the death investigation. Handling buried body cases – search for buried bodies, methods of exhumation. Suicide cases – evaluating the type of injuries, gauging the psychological state of victim, suicide notes.

Unit 4: Autopsy (12 Hours)

Forensic pathology.Medico-legal aspects of death.Causes of death.Determination of time since death.Investigation of sexual offences.Death by drowning.Injuries.Types and classification of injuries.Antemortem and post mortem injuries.Aging of injuries.Artificial injuries.

Unit 5: Changes after Death (6 Hours)

Early changes- Rigor mortis - postmortem hypostasis – Body cooling – Estimation of time of Death

Text Books:

1. T. Bevel and R.M. Gardner, Bloodstain Pattern Analysis, 3rd Edition, CRC Press, Boca Raton (2008).
2. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's, Techniques of Crime Scene Investigation, CRC Press, Boca Raton, 1st edition, 22 August 2012.
3. K. Smyth, The Cause of Death, VanNostrandReinhold, New York, 1 April 1983.
4. M. Bernstein, Introduction to Forensic Sciences, 2nd Ed., W.G. Eckert (Ed.), CRC Press, Boca Raton (1997).
5. J. Dix, Handbook for Death Scene Investigations, CRC Press, Boca Raton (1999).
6. H.B. Baldwin and C.P. May in, Encyclopedia in Forensic Science, Volume 1, J.A. Siegel, P.J. Saukko and G.C. Knupfer (Eds.), Academic Press, London (2000).
7. V.J. Geberth, Jean Schimpff, Hans-JorgSenn, Practical Homicide Investigation, CRC Press, Boca Raton, 4th Edition, 8 February 2006.
8. Shepherd R. "Simpson's Forensic Medicine", 12th Edition, A Hodder Arnold Publication, 2003

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1		2			3	3		2
CO2		1		1	2	1			1
CO3				2	3	1	2	3	
CO4	2	3	1	1				3	
CO5		2	1		1		3	2	2
CO6		1			1		3	2	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2024	Forensic Anthropology and Odontology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand basics of forensic anthropology
2. know about ossification and its importance
3. learn the chemistry of bones

Course Outcomes:

The student will be able to

1. know the importance of skeletal system
2. understand the anatomy of different bones
3. understand the chemistry of bones and biological profiling
4. know the facial anatomy of humans and facial superimposition
5. know about forensic odontology and recovery of forensic evidences from graves
6. understand about skeletal variation.

Unit 1: Introduction to forensic anthropology (9 Hours)

Forensic Anthropology - Introduction, definition, history, scope and importance - Skeletal system - Structure and functions - Bones: identification and classification - Characteristics of bones - Anatomy of bones.

Unit 2: Ossification and its importance (9 Hours)

Ossification - Introduction and importance - Anatomy of different bones – the skull, clavicle, scapula and ribs, vertebral column, Humerus radius ulna, carpals, metacarpalsd and phalanges, pelvis, Femur tibia, fibula, patella, tarsals, metatarsals.

Unit 3: Chemistry of bones (9 Hours)

Chemistry of bones - field and laboratory management of skeletal remains - Biological profiling or skeletal remains - Demography, sex, age, stature and race estimation.

Unit 4: Application in investigation (9 Hours)

Facial reconstruction: two and three dimensional methods, facial anatomy of humans, facial tissue, thickness with MRI and other methods - Facial superimposition: comparison and analysis of facial features of human skull and the antemortem photograph - Superimposition: photographic and computerized methods

Unit 5: Forensic Odontology (9 Hours)

Forensic Odontology: introduction, definition, history and scope - Teeth : types and structures, age determination and role in personal identification - Recovery of forensic evidences from graves and skeletal variation.

Text Books:

1. Angi M. CHoursistensen, Eric Bartelink and Nicholas V. Passalacqua, Forensic Anthropology : Current Methods and Practice, Elsevier, 2014.
2. Jane A. Taylor and Jules A. Kieser, Forensic Odontology : Principles and Practice, John Wiley & Sons, Ltd., 2016
3. Tim D. White and Pieter A. Folkens, The Human Bone Manual, Elsevier, 2005.
4. Karen Ramey Burns, Forensic Anthropology Training Manual, Pearson Education Inc., 2013.
5. Mark Nielsen and Shawn D. Miller, Atlas of Human Anatomy, 1st edition, Kindle edition, 2011.
6. Omar Faiz, Simon Blackburn and David Moffat, Anatomy at a Glance, 3rd edition, Kindle edition, Wiley Blackwell, 2011.
7. Gale Sloan Thompson, Understanding Anatomy&Physiology: A Visual, Auditory, Interactive Approach, 2nd edition, F.A. Davis Company, 2015

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	-	-	-	-	1	1	1	1	2
CO2	-	-	-	-	1	1	1	-	3
CO3	-	-	-	-	1	1	1	-	3
CO4	-	2	-	-	1	1	1	-	3
CO5	-	-	-	-	1	1	1	-	3
CO6	-	2	1	1	1	1	1	2	2

“3” – High; “2” – Medium; “1” – Low; “-” – No correlation

20FS2025	Accident Investigation						L	T	P	C
							3	0	0	3

Course Objectives:

Enable the student to

1. understand the basic principle of dna analysis and typing
2. obtain knowledge on parentage testing
3. be exposed to report writing in dna typing

Course Outcomes:

The student will be able to

1. realize the background of vehicle accidents
2. analyze motor accidents
3. assess the post-crash movement
4. do systematic analysis of injuries in accidents
5. perform the tachographic data analysis
6. analyse the falsification and diagnostic signals

Unit 1: Motor Vehicle Accidents (9 Hours)

Accident scene. Sources of forensic information. Eyewitness accounts. Extent of vehicle damage. Visibility conditions. Photographs of accident site.

Unit 2: Analysis of Motor Accidents (9 Hours)

Estimation of speed. Tire marks, skid marks, scuff marks. Maintenance of vehicles. Abandoned vehicles. Importance of air bags. Railway accidents.

Unit 3: Accident Analysis (9 Hours)

Post-crash movement. Collision model. Gauging driver's reaction. Occupants's kinematics.

Unit 4: Analysis of Injuries (9 Hours)

Types of injuries resulting from accident. Biomechanics of injuries. Hit and run investigations. Trace evidence at accident sites.

Unit 5: Tachographs (9 Hours)

Forensic significance of tachograph data. -achograph charts. Principles of chart analysis. Accuracy of speed record - Tire slip effects. Falsification and diagnostic signals -Route tracing.

Text Books:

1. S.C. Batterman and S.D. Batterman in Encyclopedia of Forensic Sciences, Volume 1, J.A. Siegel, P.J. Saukko and G.C. Knupfer (Eds.), Academic Press, London (2000).
2. T.S. Ferry, Modern Accident Investigation and Analysis, Wiley, New York (1988).
3. D. Lowe, The Tachograph, 2nd Edition, Kogan Page, London (1989).
4. T.L. Bohan and A.C. Damask, Forensic Accident Investigation: Motor Vehicles, Michie Butterworth, Charlottesville (1995).

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	1	2	2	2		1	1	
CO2				1				2	
CO3		1	3		1		2	1	
CO4	1			1					
CO5	1	2	1		2	1	2	3	
CO6		2		1			1	2	1

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS2026	Forensic Biology And Serology -II	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. genetic variation
2. the methods of sterilization
3. the classification and characteristics of blood samples

Course Outcomes:

students will be able to

1. to know about the measures of genetic variation
2. determination of species of origin-ring test
3. testing procedures and factor effecting
4. human blood group systems
5. new approaches in bloodstain grouping
6. non-genetic approaches to individualization

Unit 1: Human genetic variations (9 Hours)

Human genetic variations. Mendelian Inheritance. Hardy Weinberg Equilibrium. Mutation- their types and causes. Relevance of population genetics. Allele frequency, genotype frequency. Polymorphism and heterozygosity. Measures of genetic variations.

Unit 2: Bloodstain Pattern Analysis (9 Hours)

Bloodstain characteristics. Impact bloodstain patterns. Cast-off bloodstain patterns. Projected bloodstain patterns. Contact bloodstain patterns. Blood trails. Bloodstain drying times.

Documentation of bloodstain pattern evidence. Crime scene reconstruction with the aid of bloodstain pattern analysis.

Unit 3: Biological evidence-I (9 Hours)

Hair – significance, transfer and recovery, structure of human hair, Morphology and biochemistry of human hair, Comparisons of hair samples, Comparison of human and animal hairs.

Unit 4: Biological evidence-II (9 Hours)

Types and identification of microbial organisms of forensic significance - Diatoms and their forensic significance, structure and analysis of skull and bones.

Unit 5: Forensic Entomology (9 Hours)

Insects of forensic importance, Collection of entomological evidence during death investigations. General Entomology- significance of terrestrial and aquatic insects in forensic investigations and their role in crime detection, Insect's succession and its relationship to determine time since death. Impact of ecological factors on insect's developments.

Text books

1. Goodwin, William; "An Introduction to Forensic Genetics", John Wiley & Sons Ltd., 2007.
2. Kapur, V; "Basic Human Genetics", Jaypee Brothers, 1991.
3. Kothari, Manu L; "Essentials of Human Genetics", University Press (India) Pvt. Ltd., 2009.
4. Singh B.D.; "Fundamentals of Genetics", Kalyani Publishers, 2006.
5. Edmund Sinnett; "Principles of Genetics", McGraw Hill Publications, 1950.
6. Giblett, Eloise R.; "Genetic Markers in Human Blood", Blackwell Scientific Publications, 1969.
7. Altenburg, Edgar; "Genetics", Oxford & IBH Publishing Co., 1970.
8. GJV Nossal; "Antigens, Lymphoid Cells and the Immune Response", Academic Press, 1971.
9. Wiener, Alexander S; "Advances in Blood Grouping II", Grune & Stratton, 1965.
10. Boorman, Kathleen E & Churchill; "Blood Group Serology", Livingstone, 1977.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2					3	1	
CO2	3		1				3		
CO3	3			3			2		
CO4	2	1						2	
CO5	3				2		3		
CO6	1			1					2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2027	Modern Techniques in Explosives and Bomb Detection	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. analyze trace amounts of petroleum products in crime scene evidence.
2. analyze contaminants in petroleum products
3. classify and characterize of the narcotics, drugs and psychotropic substances.

Course Outcomes:

students will be able to

1. know about chemistry of explosives petroleum products forensic science.
2. understand about the blasting agents
3. know the bomb initiating mechanism.
4. know the explosive detection methods
5. know the bomb disposal equipments.
6. understand about dog in detection of explosives and handler team

Unit 1: Introduction to Explosives (9 Hours)

Definition for explosives, History of explosives, Classification of explosives, high & low explosives, Properties of explosives, Basic Explosive terms, Explosive substances, Detonation, Smokeless powder, Improvised low explosive substances, Flexible Sheet Explosives, Secondary High Explosive Substances, Detonating Cord, Boosters, Blasting Accessories, Initiation of Explosives, Working of Explosives, Explosive Train, Blast Effects.

Unit 2: Blasting Agents (9 Hours)

RDX,PETN,TNT,HMX,CE, Lead azide-Silver azide-Fulminate of mercury-Lead styphnate-Tetrazene-Plastic Explosive C4,Semtex PEK-Sheet explosives-Combination of explosives-Low explosives-Black Powder-Pyrotechnics-Civil explosives-Permitted and non permitted explosives-Dynamite-Ammonium nitrate-ANFO,Gelatine-Slurries and wattergel-Blasting accessories.

Unit 3: Explosive Detection Methods (9 Hours)

Explosive Detection Principles, Limitation of explosive, Vapour Detections, Principles of explosive detection system, Electron capture detection system (ECD), Gas Chromatography (GC), Ion Mobility spectrometry (IMS), Thermal Neutron Analysis, Microwave Technology, Ion Trap Mass spectrometry (ITMS), Surface acoustic Wave, Chemiluminescence, Nuclear Quadrupole resonance (NQR), Back scatter X-ray-Penetrating, Electromagnetic Radiation, Marking of Explosives, Tagging of explosives, Explosive Detection by chemical method.

Unit 4: Bomb Detection and Disposal Equipments (9 Hours)

Bomb Detection System, Quantitative requirement of explosive detection Equipments, Detection by trained team, Explosive Detectors, Letter Bomb detector, Walkthrough explosive detection system, Buster Contraband detector, Metal Detectors, Computer aided detection, Protection equipment, Disposal equipment, Hand entry technique, Remote entry techniques, burning technique, Remote opening letter bomb, Transportation and final disposal, Dos and Don'ts.

Unit 5: Dog in Detection of Explosives and Handler Team (9 Hours)

Why dogs are preferred, Selection Procedure, Training technique, Summary of find rate, Bomb incident investigation, Reasons for bombing, Qualities of explosion investigator, Composition of investigation team, Equipment and Tools, Investigation techniques, Action on arrival of scene, Injury to persons, Seat of explosion, Fragments, Spot test, Preparation of report, Explosion investigation, Bomb Detection & Disposal Equipments.

Text books

1. Narayanan, T. V: Modern Techniques of Bomb Detection and Disposal, R. A. Security System, 1995.
2. Svehla, G. Ed.: Vogel's Qualitative Inorganic Analysis, Longman, 1998.
3. Beveridge, A: Forensic Investigation of Explosives, Taylor & Francis, 2000.
4. Yallop, H. J: Explosion Investigation, Forensic Science Society & Scottish Academic Press, 1980.
5. Yinon, J. and Zitrin, S: Modern Methods and Applications in Analysis of Explosives, John Wiley, 1993.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1					3		
CO2	3	1	2				3		
CO3	3			3			2		
CO4	3	1			1			3	
CO5	3				2		3		
CO6	2			2					2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS2028	Foundation Course on Computer Fundamentals and Office	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student

1. Learn the fundamentals of MS office and internet.
2. Explore the concepts of C programming
3. Be exposed to ideas related to pointers

Course Outcomes:

The student will be able to

1. Analyse the fundamentals of MS Office
2. Utilize the Internet
3. Understand the fundamentals of C programming.
4. Know the basic concepts of arrays and functions in C.
5. Apply the concepts of structures in C programming.
6. Understand the concept of pointers.

Unit 1: MS Office (9 Hours)

MS word, excel, power point, Internet

Unit 2: Fundamentals of C Programming (9 Hours)

History of C -Characteristics of C - C Program Structure - Data Types - Variables and Constants - Operators - Conditional Statements - Looping and Iteration.

Unit 3: Arrays and Functions in C (9 Hours)

Single Dimensional Array -Multi Dimensional Array - Types of functions - Functions and Arrays - String Functions - Recursive Functions

Unit 4: Structures (9 Hours)

Basics, Structures and functions - Arrays of structures - Pointers to structures - Self referential structures - Typedef - Union - Bitfields - Enum Data Types

Unit 5: Pointers (9 Hours)

Pointers :introduction - declaration - passing function to pointers - pointers with arrays - dynamic memory allocation.

Text Books:

1. E. Balagurusamy , Programming in Ansi C , 6th Edition, TMG - India 2012.
2. Herbert Schildt, The Complete Reference C, 4th Edition, Tata Mc - Graw Hill, 2000.
3. Byron C Gottfried, Programming with C, Schaums' outline series 2nd Edition, Tata Mc - Graw Hill, 2006.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	3					3		
CO2	2	3	2	2	2	2	3	3	1
CO3	3	3					2	2	
CO4		2	1		2	2			
CO5	2	3					2	1	
CO6	1	2		1			1		

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3001	Chemical Kinetics and Chemical Thermodynamics	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basics of chemical thermodynamics
2. learn the kinetics of rate equations
3. get thorough knowledge about catalysis

Course Outcomes:

Student will be able to

1. understand the principles of chemical thermodynamics
2. know the parameters relevant to chemical thermodynamics
3. understand the types and kinetics of fast reactions
4. know the kinetics of flow techniques
5. understand the theory of acid – base catalysis
6. know about the concepts of heterogeneous catalysis

Unit 1 : Chemical thermodynamics – I (9 Hours)

Thermodynamics - State variables – Thermodynamic equilibrium - reversible process – Irreversible process – Heat and work – First law of thermodynamics - Mathematical formulation of first law of thermodynamics – Enthalpy – Relationship between ΔH and ΔE – Enthalpy of reaction – Types – The effect of temperature on ΔH – Kirchhoff's equation – Hess law – Limitation of first law of thermodynamics - Second law of thermodynamics – Spontaneous process and spontaneity – Non spontaneous process – Third law of thermodynamics – Entropy – Entropy change in phase transformations – Entropy changes

of an ideal gas in different processes – Entropy at absolute zero – Determination of absolute entropies of solids, liquids and gases – Trouton's rule.

Unit 2: Chemical thermodynamics – II (9 Hours)

Gibbs free energy – Gibbs free energy and spontaneity – Prediction of feasibility of a chemical reaction – Effect of temperature on spontaneity – Helmholtz energy – Maxwell's relations – Gibbs Helmholtz equation – Applications - Thermodynamics of open systems – Partial molar properties – Chemical potential – Gibbs – Duhem equation – Variation of chemical potential with temperature and pressure – Clapeyron equation – Clapeyron – Clausius equation – Applications – Activity – Activity coefficient – Ideal solution – Real solution – Fugacity – Determination of a fugacity of a gas – Chemical equilibrium – Characteristics of chemical equilibrium – Law of mass action – Equilibrium law – Equilibrium constant expression for a reaction in general terms – Van't Hoff Isotherm – Van't Hoff isochore – Relationship between K_p , K_c and K_x .

Unit 3: Chemical Kinetics – I (9 Hours)

Chemical kinetics – Basic concepts – rate law – rate equation – Kinetics of zero, first, second and third order reactions – Kinetics – composite reactions (complex reaction) – Opposing (reversible) reactions – Consecutive reactions – Chain reactions – Stationary chain reaction – Collision theory of bimolecular and unimolecular reactions – Arrhenius theory of reaction rates – Theory of absolute reaction rates – Thermodynamic treatment of reaction rate - Lindemann's theory – Kinetics of fast reactions.

Unit 4: Chemical Kinetics – II (9 Hours)

Study of kinetics of stopped flow techniques – flash photolysis – shock tubes – Reaction rates in solution – Effect of dielectric constant and ionic strength – Kinetic isotope effects – Hammett relationship - ionic reactions in solution – effect of ionic strength – Linear free energy relationships – Taft equation – Yukawa-Tsuno equation – Luminescence and energy transformations – Chemiluminescence – reactions in molecular beam.

Unit 5: Catalysis (9 Hours)

Acid – Base catalysis – general scheme – Arrhenius complex – Vant Hoff's complex – specific and general catalysis – catalytic constants – Bronsted relationship – Hammett acidity functions – mechanism of acid-base catalysed reaction – Catalysis by metal salts (transition metal complex) – enzyme catalysis – theory and applications - Mechanism of heterogeneous catalysis - Langmuir-Hinshelwood mechanism and Langmuir Reidel mechanism - Examples of heterogeneous catalytic reactions - hydrogenation of ethylene, synthesis of ammonia, oxidation of SO_2 and Fischer- Tropsch method for the synthesis of methanol.

Text books:

1. B.R., Puri, L.R. Sharma and Madan S. Pathania, "Principles of Physical Chemistry", Shoban Lal Nagin Chand & Co., Jalandhar, 2000.
2. Kundu and S.K. Jain, "Physical Chemistry" S. Chand & Company Ltd., New Delhi, 1984
3. P.W. Atkins, "Physical Chemistry", 8th edition, Oxford University Press, 2006
4. Kalidas, C. "Chemical Kinetic Methods: Principles of Relaxations Techniques and application", New Age International (P) Ltd, Chennai, 2005.

Reference Books:

1. S. Glasstone and D.Lewis, "Elements of Physical Chemistry", 2nd Ed., 1982
2. M.J. Piling and P.W. Seakins, "Reaction Kinetics", Oxford University Press, 2nd edition, 1996.
3. J. C. Kuriacose and J.Rajaram, "Thermodynamics", Shoban Lal Nagin Chand & Co., Jalandhar, 1996.
4. G.W. Castellan, "Physical Chemistry", Narosa publishing house, Chennai, 1989.
5. H. Snehe, "Comprehensive Physical Chemistry", Prgati Prakashan, Meerut, 1987.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	-	1	2	1	1
CO2	1	1	-	1	1	1	1	2	1	1
CO3	1	1	1	1	1	2	-	1	1	2
CO4	1	1	1	1	2	1	-	1	2	3
CO5	1	1	1	1	1	1	-	1	1	2

CO6	1	1	1	1	1	1	-	1	1	2

“3” – High; “2” – Medium; “1” – Low; “-” – No correlation

20CH3002	Theories of Chemical Bonding							L	T	P	C
								3	0	0	3

Course Objectives:

Enable the student to

1. describe the theory of acids and bases and non-aqueous solvents.
2. distinguish various types of bonding.
3. Summarize the factors affecting the strength of the bonds

Course Outcomes:

Student will be able to

1. explain the theory of acids and bases
2. summarize the importance and applications of non-aqueous solvents
3. discuss the various theories of ionic bonding.
4. describe the theories related to covalent bond
5. compare the theories of coordinate bond
6. relate the properties of coordinate bond with CFSE

Unit 1: Acid-Base Chemistry (8 Hours)

Periodicity – Bronsted-Lowry Theory – Lewis Theory – Measures of acid-base strength - Hard and Soft acids and bases – Classification – Symbiosis – Electronegativity and hardness and softness

Unit 2: Non-aqueous Solvents (7 Hours)

Protic and Aprotic solvents - Leveling Effect – Reactions in Non-aqueous solvents – Liquid Ammonia – Sulfuric acid – Hydrofluoric Acid – Sulfur dioxide – Dinitrogen tetroxide

Unit 3: Ionic Bonding (9 Hours)

Lattice energy – Born Lande Equation – Born Haber Cycle – Fajan’s rule – Size effects – Factors affecting the radii of ions – Radius Ratio - Structures of Compounds of types AX – NaCl, CsCl, ZnS, NiAs, Structures of type AX₂ – CaF₂, TiO₂ – Structures of type ABX₃ – Perovskite, Ilmenite - Crystal Systems – Defects

Unit 4: Covalent Bond (9 Hours)

VB Theory – Hybridization – MO Theory of Diatomic Molecules – Delocalization – Resonance – Electronegativity and MO Theory – Group Electronegativity - VSEPR Theory – Experimental determination of Molecular structure – Berry pseudorotation – Ion-dipole Interaction – Hydrogen Bonding

Unit 5: Coordinate bond (12 Hours)

Ligands – Classification - Formation of Complexes – Bonding theories – Werner’s theory – Sidgwick Theory - VB Theory – Advantages and Defects - Crystal Field Theory – Shapes of d orbitals – Assumptions - CFSE – Measurement of 10Dq - Factors Affecting 10Dq – Spectrochemical Series – Consequences – Merits and limitations of Crystal field theory - MO Theory – sigma Bond and pi Bond – Advantages

Reference Books:

1. Lee J. D, “Concise Inorganic Chemistry”, Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Huheey J. E, Keiter E. A & Keiter R. L, “Inorganic Chemistry – Principles of structure and reactivity”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
3. Sharpe A.G. “Inorganic Chemistry”, Dorling Kindersley (India) Pvt. Ltd, 2nd impression, 2008.
4. Satyaprakash, Tuli G. D, Basu S. K & Madan R. D, “Advanced Inorganic Chemistry” Vol I and II, S. Chand and Company Ltd, New Delhi, India, Reprint: 2009.
5. Mido Y, Taguchi S, Sethi M.S & Iqbal S. A, “Chemistry in Aqueous and Non-aqueous Solvents”, Discovery Publishing House, New Delhi, 2003

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	1			1			1	2	1
CO2	2	2	2		1			1	2	

CO3	3	1		2				2	3	
CO4	3	1							3	
CO5	2				2			3	2	
CO6	1			1						

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20CH3003	Organic Reaction Mechanism and Stereochemistry						L	T	P	C
							3	0	0	3

Course Objectives:

Enable the student to

1. understand the electronic effects on reaction pathway.
2. realize the various types of reaction mechanism
3. acquire knowledge about stereochemistry and asymmetric synthesis.

Course Outcomes:

Student will be able to

1. explain the role of electronic effects in predicting the reaction pathway.
2. propose the possible mechanism for organic transformation.
3. predict the product formed in the reaction by applying the mechanism
4. explain the product selectivity in the organic reactions
5. assign configuration for chiral molecule and predict stable conformer.
6. reason out for the stereoselectivity in organic reactions in the presence chiral environment

Unit 1: Electronic Effect and Aromaticity (9 Hours)

Electronic effects- Inductive effect, Resonance effect, hyperconjugation, steric effect- importance of electronic effects. Quantitative treatments of the effect of structure and reactivity – Derivation of Hammett equation–Linear Free Energy Relationship derivation – Problems on Substitution constant, reaction constant and pK_a calculation using Hammett equation, significance of sigma and rho – Isotopic labelling and types of kinetic isotopic effects-prediction of mechanism. Aromaticity – Huckel’s rule for smaller rings – 8, 10, 12, 14 and 16– Annulenes, heterocycles, fulvene, fulvalene, homoaromaticity.

Unit 2: Nucleophilic Substitution (9 Hours)

Aliphatic nucleophilic substitution mechanism– S_N2, S_N1, Effect of substrate, attacking nucleophile, leaving group and reaction medium, mixed S_N1 and S_N2, S_Ni, single electron transfer mechanism, Anchimeric assistance by lone pair, alkene, aryl groups – addition to allylic carbons S_N2’. Aromatic nucleophilic substitutions – Addition elimination S_NAr, Effect of substrate, leaving group and attacking nucleophile. Elimination Addition-benzyne, generation of benzyne, regioselectivity, Diazonium salt – reactions

Unit 3: Electrophilic Substitution and Elimination (10 Hours)

Aromatic electrophilic substitution – Arenium ion mechanism – alkylation, acylation, nitration, sulfonation, halogenation, Reimer Tiemann and Vilsmeier-Haack reaction, ortho/para, meta selectivity. Orientation in mono and di-substituted benzene rings –Electrophile addition to C-C-multiple bonds, Markovnikov rule.Epoxidation-Addition to 1,3-diene-Elimination – Mechanisms of β elimination – (E2, E1, E1CB) –Effect of substrate, attacking base, leaving group and medium, Saytzeff rule, Bredt’s rule – Hoffman Elimination, 1,1-elimination and carbene generation, synelimination, Chugaev and Cope elimination

Unit 4: Stereochemistry (8 Hours)

Stereoisomerism – Definitions- enantiomer, diastereomer, geometrical isomer, epimer, anomer, chirality, optical rotation, specific rotation-problem.Enantiomeric excess – problem-Topicity-Enantiotopic, diastereotopic and homotopic-Inter conversion between Fischer, Newmann, Saw Horse and Wedge-dash projections-absolute ConfigurationCahn-Ingold-Prelog rule- R&S, E&Z– Axial chirality-atropisomerism-planar chirality and helicity. R&S configuration for biaryls, allenes, spiro compounds, cyclophanes

Unit 5: Conformation and Asymmetric Synthesis (9 Hours)

Conformation of ethane, butane, cyclohexane, decalin. Gauche effect,example. 1,3-diaxial interaction,stable conformer of mono, and disubstitutedcyclohexanes – Stereoselectivity and stereospecificity-Asymmetric synthesis-Cram’s rule, Prelog’s rule, Evan’s chiral auxiliary in aldol

reaction, Sharpless asymmetric epoxidation, Asymmetric dihydroxylation-ADH - kinetic resolution – Enzymatic and kinetic methods

Reference Books:

1. Jerry March, “Advanced Organic Chemistry”, Wiley Eastern Limited, New Delhi, 4th edition, 2008.
2. Jonathan Clayden, Nick Greeves, Stuart Warren. “Organic Chemistry”, 2nd edition, Oxford University Press, 2012
3. Bahl. B.S and ArunBahl, “A Text book of Organic Chemistry”, S. Chand & company Ltd., New Delhi, Reprint, 2011.
4. Peter Sykes, “A Guidebook to Mechanism in Organic Chemistry”, Longman Press, London and New York, Reprint, 2006.
5. Ernest. L. Eliel, “Stereochemistry of carbon compounds”, Tata-McGraw Hill, New Delhi, 22nd Reprint 2009.
6. Nasipuri. D. “Stereochemistry of organic compounds – Principles and applications”, New Age international, 2nd edition, 2002.
7. Kalsi. P.S. “Stereochemistry Conformation and Mechanism”, New Age International Publishers, New Delhi, 6th Edition, Reprint, 2005.
8. Finar. I.L, “Organic Chemistry, Volume 1”, Doorling Kindersley (Indian), 6th Edition, 5th impression, 2008.
9. Raj K. Bansal, “Organic reaction mechanism”, Tata McGraw Hill, New Delhi, 4th Edition, 2005.
10. Carey. F.A. “Organic Chemistry”, McGraw Hill, Inc., 2nd edition, 1992.
11. Morrison and Boyd, “Organic Chemistry”, United States of America, 3rd edition, 1992.
12. Carey, F. A, and Sundberg, R. J, “Advanced Organic Chemistry Part – A”, Plenum Press, 2007.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3	1					2	2	
CO2		2						2	2	
CO3	3				1			3	3	1
CO4				2			3	3	3	
CO5	1	3						1	2	1
CO6							1	1	2	1

“3”– High; “2”– – Medium; “1”– - Low; “-”– No correlation

20CH3004	Statistical Thermodynamics and Quantum Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the principles of statistical thermodynamics
2. learn the importance of quantum chemistry
3. know the concept of quantum chemistry of bonding

Course Outcomes:

Student will be able to

1. relate various thermodynamic parameters
2. know about the applications of irreversible thermodynamics
3. understand the importance and application of quantization in molecular energy levels
4. explain the shape, energy of atomic orbitals and molecular orbitals and the bond formation between atoms
5. Know about LCAO, MO and VB treatments of hydrogen molecule
6. Understand the importance of Huckel theory of linear conjugated systems and cyclic systems

Unit 1: Statistical Thermodynamics – I (9 Hours)

Concepts of probability and Maxwell Boltzmann distribution – Basic derivation – prove that $\beta = 1/KT$ – Relationship between entropy and thermodynamic probability systems with degeneracy – Definitions of partition function – applications – derivation of thermodynamic functions from partition function –

entropy for monoatomic gases – Sackur – Tetrode equation – The Bose – Einstein’s system – Basic derivation – Fermi – Dirac system – Basic derivation – negative Kelvin temperature.

Unit 2: Statistical Thermodynamics – II (9 Hours)

Heat capacity of solids – Debye and Einstein models – Thermodynamics functions of ideal gases, translational, vibrational and rotational contributions at different levels of approximation – Irreversible thermodynamics – the steady – coupled flows – application – over potential – decomposition potential – electrical double layer and electro kinetic phenomena – structure of electrical double layer – capacity – E.K. phenomenon – steaming potential – electro dialysis – the Dorn effect.

Unit 3: Introduction to Quantum Mechanics (9 Hours)

The failures of classical mechanism – heat capacities – black body radiation – The photo electric effect – The Compton effect – The diffraction of electrons – wave particles duality- de Broglie Equation- Problems – Hydrogen spectrum- Uncertainty principle, Problems, operators and commutation relations – Postulates of quantum mechanics.

Unit 4: Quantum Chemistry of Atoms and Molecules(9 Hours)

Schrödinger equation-derivation, Free particle, particle in one dimensional box, three dimensional box Harmonic oscillator, – Rigid rotor – The Schrodinger equation for hydrogen atom – Angular momentum – Spin, coupling of angular momentum – Spin-orbit coupling. Variation and perturbation theory – Application of perturbation / variation theorems to ground state of helium atom.

Unit 5: Quantum Chemistry of Bonding (9 Hours)

Antisymmetry and Pauli’s exclusion principle – Aufbau principle – Slater determinant wave functions – Term symbols and spectroscopic states – Born Oppenheimer approximation –Linear Combination of atomic orbitals (LCAO), MO and VB treatments of hydrogen molecule – Hybridization – Huckel theory of linear conjugated systems ethylene, butadiene – Cyclic systems -cyclobutene – Woodward Hoffman rules.

Text books:

1. N.D. Smith, “Elementary Statistical Thermodynamics”, Plenum Press, New York, 1982.
2. Donald A McQuarrie, “Quantum Chemistry”, University Science Books, Mill Valley, California, 1983.
3. Chandra, A.K. “Quantum Chemistry” Tata McGraw –Hill Pvt. Ltd., New Delhi, 4th Edition, 2002.
4. Hanna, M.W., “Quantum Mechanics in Chemistry”, Addison Wesley, London, 3rd edition, 1981.
5. John C. Schug, “Introductory Quantum Chemistry”, Holt, R & W Publisher, 1972

Reference Books:

1. S. Glasstone and D.Lewis, “Elements of Physical Chemistry”, 2nd Ed.,1982.
2. B.C. McClelland, “Statistical Thermodynamics”, Chapman and Hall, London, 1973.
3. M. C. Gupta, “Statistical Thermodynamics”, Wiley Eastern Limited, 1993.
4. L.K. Nash, “Elements of classical the statistical thermodynamics”, Addison-Wesley (1970)
5. I.N. Levine, “Quantum Chemistry”, 4th edition, Prentice Hall India, 1994

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1	-	1	1	-	1	2	1	2
CO2	1	2	1	1	2	1	1	1	2	1
CO3	1	-	-	1	-	1	1	1	1	3
CO4	1	1	1	1	1	1	1	1	1	1
CO5	1	1	-	-	-	1	1	1	1	1
CO6	1	1	-	-	-	1	1	1	1	1

“3”– High; “2”– Medium ; “1”– Low ; “-”– No correlation

20CH3005	Coordination Chemistry of Transition Elements	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. characterize the electronic spectra and magnetic properties of coordination complexes
2. explain the isomerism and stability of coordination complexes

3. discuss the reaction mechanism in coordination Chemistry

Course Outcomes:

Student will be able to

1. characterize the electronic spectra of metal complexes
2. predict the magnetic properties of coordination complexes
3. discuss the isomerism in coordination complexes
4. summarize the factors affecting the stability of metal complexes
5. categorize the types of mechanisms in reactions of metal complexes
6. describe the importance of metal-metal multiple bonds

Unit 1: Electronic and Magnetic Properties (12 Hours)

Electronic Spectra — Types of Transitions - Term Symbols – Spin-Spin and Spin-orbit Coupling - Ground Terms for d Configuration, - Problems -Terms Generated in Ligand Fields Correlation Diagrams, - Orgel Diagram – Nephelauxetic Ratio - Racah Parameter -Tanabe Sugano Diagram – Selection Rules for Electronic Transitions - Width of the spectra, Jahn-Teller Effect – Electronic Spectra of dⁿ Complexes - CT Spectra –Types - Magnetic Properties – Magnetic moment - Determination of Magnetic Susceptibility - Orbital Contribution to Magnetic Moment – Quenching

Unit 2: Isomerism and Stability of Coordination Complexes (9 Hours)

Isomerism - Structural Isomerism – Stereoisomerism – D and L isomers – Cotton effect -Stepwise and Overall Stability Constant - Irving William Series - Factors Affecting the Stability Constant - Chelate and Macrocyclic Effects – Determination of Stability Constant Problems

Unit 3: Substitution Reactions in Coordination Complexes (12 Hours)

Thermodynamic and Kinetic Stability - Labile and Inert Complexes - Substitution in Octahedral Complexes – Rate constants for water exchange reactions - S_N1, S_N2 and S_N1(CB) Mechanism - Isomerization Reactions, Anation Reactions - Reactions of Coordinated Ligands - Substitution in square Planar Complexes – Trans Effect – Series - Applications of Trans Effect - Theories of Trans Effect

Unit 4: Electron Transfer Reactions in Coordination Complexes (6 Hours)

Electron transfer reactions – Complementary and noncomplementary reactions - Types - Outer sphere electron transfer reaction - Marcus Theory - Innersphere Reactions —Nature of Bridging Ligand - Applications

Unit 5: Compounds with metal-metal multiple bonds (6 Hours)

The origin of σ , π , and δ interactions between the d orbitals– Electronic spectra -Tetracarboxylate and halogen complexes of Molybdenum, Tungsten, Rhodium and Rhenium complexes - Applications

Reference Books:

1. Huheey J. E, Keiter E. A & Keiter R. L, “Inorganic Chemistry – Principles of structure and reactivity”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
2. Purcell K. F & Kotz J. C., “Inorganic Chemistry” Cengage Learning, New Delhi, India, Reprint, 2010.
3. Greenwood N. N. & Earnshaw A, ”Chemistry of the Elements”, Reed Elsevier India Private Ltd, Gurgaon, India, 2nd edition, Reprinted 2010.
4. Miessler G. L & Tarr D. A., “Inorganic Chemistry”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 3rd Edition, 2009.
5. Gopalan R, Ramalingam V, Concise Coordination Chemistry, Vikas Publishing House Pvt. Ltd, 2001
6. Cotton F. A & Wilkinson G, “Advanced Inorganic Chemistry”, 6th edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.
7. Jordan R. B, “Reaction Mechanisms of Inorganic and Organometallic Systems”, Oxford University Press, New York, USA, 3rd Edition, 2007.
8. Satyaprakash, Tuli G. D, Basu S. K & Madan R. D, “Advanced Inorganic Chemistry” Vol I and II, S. Chand and Company Ltd, NewDelhi, India, Reprint: 2009.
9. Shriver and Atkins, “ Inorganic Chemistry”, Oxford University Press, New Delhi, India, 4th edition, 2009.

10. Figgis B. N. & Hitchman M. A, "Ligand Field Theory and Its Applications", Wiley-VCH Verlag GmbH & Co, Weinheim, Germany, 2000.
11. Cotton FA, Murillo CA, Walton RA "Multiple Bonds Between Metal Atoms", Springer, New York, 3rd Ed, (2005)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1						1	2	
CO2	3	2						1	2	
CO3		1		2				2	3	
CO4		1							3	1
CO5	2				1			1	2	
CO6			1	1					1	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3006	Principles of Molecular Spectroscopy				L	T	P	C
					3	0	0	3

Course Objectives:

Enable the student to

1. Discuss the electromagnetic spectrum and electromagnetic radiation
2. Explain the principle and application Vibration and Raman spectroscopy
3. Relate the principle and application NMR, ESR, Mossbauer, PES and fluorescence spectroscopy

Course Outcomes:

Student will be able to

1. Discuss the principle and application of microwave spectroscopy
2. Relate the principle and application of microwave spectroscopy
3. understand the principle and application of Vibration and Raman spectroscopy
4. Show the principle and application of NMR and ESR in organic and inorganic sample analysis
5. Examine the principle and application of Mossbauer and PES in material analysis
6. Explain the principle and application of electronic and emission spectroscopy. in material analysis

Unit 1: Electronic and Rotational Spectroscopy (9 Hours)

Introduction to electromagnetic radiation- Regions of the spectrum, characterization of electromagnetic radiation, Born-Oppenheimer approximation, Electronic spectra of Diatomic Molecules- linear combination of atomic orbitals (LCAO), Molecular term symbols, selection rules for electronic spectra, Franck-Condon principle. Electronic Spectra of polyatomic molecules. Introduction to rotational spectroscopy, rotational spectra diatomic molecules – the rigid diatomic molecule, selection rules for rotational spectra, Effect of isotopic substitution, the non-rigid rotator, Polyatomic molecules- Linear molecules, Techniques and instrumentation and chemical analysis by microwave spectroscopy,

Unit 2: Vibration and Raman spectroscopy (9 Hours)

Introduction, simple harmonic oscillator, Anharmonic oscillator, Infrared spectroscopy of di- and polyatomic molecules-carbon monoxide, fundamental vibrations of polyatomic molecules and their symmetry, Overtone, combination of bands, Fermi resonance, factors affecting vibrational frequencies, Instrumentation and Applications. Raman spectroscopy- introduction, Raman effect-molecular polarizability, Polarization of light and the Raman effect, Pure rotational raman spectra- linear, symmetric top and asymmetric top molecules, Vibrational raman spectra, Mutual exclusion principle, instrumentation and application of Raman spectroscopy.

Unit 3: NMR and ESR spectrometry (9 Hours)

NMR spectroscopy- introduction, Nuclear magnetic resonance phenomenon, The absorption process, Relaxation process- spin spin relaxation, Spin lattice relaxation, Chemical shift, factors influencing chemical shift, NMR spectra of AX, A₃X and AB systems. ESR spectroscopy – introduction, g factor, Spectra of simple organic radicals, Spectra of first row transition metals, Zero field splitting, Kramer's degeneracy

Unit 4: Mossbauer and Photoelectron Spectroscopy (9 Hours)

Mossbauer spectroscopy- introduction, principle, Isomer shift, Quadrupole effects, Hyperfine splitting, Applications of Mossbauer spectroscopy. Photoelectron spectroscopy (PES)-Principle Photoelectron

spectroscopy (PES)- instrumentation, Ultraviolet Photo electron spectroscopy (UPS)X- Ray Photo electron spectroscopy (XPS) Auger electron spectroscopy

Unit 5: Fluorescence spectroscopy (9 Hours)

Fluorescence spectroscopy- introduction, principle, instrumentation, Jablonski diagram, Fluorescence, Phosphorescence, Delayed fluorescence, Characteristics of Fluorescence emission, Fluorescence Lifetimes and quantum yields, Fluorescence Quenching, Resonance energy transfer (RET), Steady state and time resolved Fluorescence.

Reference Books :

1. Banwell, C. N, "Fundamentals of Molecular Spectroscopy", 4th Edition, Tata McGraw-Hill India Ltd, 2010
2. Molecular Spectroscopy. I. N. Levine, Wiley Interscience Publication.
3. Drago R. S, Physical Methods for Chemists, 2nd Revised edition, Saunders (W.B.) Co Ltd;
4. Molecular Spectra & Molecular Structure. G. Herzberg, Van Nostrand Reinhold Company
5. SatyaNarayana D. N, "Vibrational Spectroscopy Theory and Applications", New Age International Publishers, New Delhi, 2004.
6. SatyaNarayana D. N, "Electronic Absorption Spectroscopy and Related Techniques", Universities Press (India) Ltd, Hyderabad, 2001.
7. Lakowicz J. R, "Principles of fluorescence spectroscopy", Springer Science+Business Media, New York, USA, 3rd edition, 2006.
8. Principles of Ultraviolet Photoelectron Spectroscopy, J. W. Rabalais, John Wiley & Sons.
9. SatyaNarayana D.N., "Magnetic Resonance Spectroscopy ESR, NMR, NQR", I. K. International, New Delhi, 2009
10. Graybeal J. D., Molecular Spectroscopy., McGraw Hill.
11. Hollas J. M., Modern Spectroscopy. John Wiley & Sons.

20CH3007	Synthetic Reagents and Methodology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. acquire skills on metal catalyzed coupling reactions
2. realize the potential of various reagents used in organic transformations
3. understand the molecular rearrangement and apply retro synthesis to target molecule

Course Outcomes:

Student will be able to

1. explain the importance of metal catalyzed coupling reactions in synthesis
2. summarize the reagents used for oxidation and reduction reactions
3. apply modern synthetic reagents in organic synthesis
4. describe the usefulness of multi component coupling in synthesis
5. predict the product formed in molecular rearrangements
6. apply retrosynthetic approach to complex target molecules

Unit 1: Organometallics in Coupling Reactions (8 Hours)

coupling reactions-definition, Organometallic reactions-oxidative addition , insertion - reductive elimination, Heck reaction, catalytic cycle, Suzuki Coupling, stereospecificity- aryl and vinyl boron compound synthesis-Stille Coupling, Negishi coupling- Buchwald amination, Sonogashira coupling- Glacier coupling- pi-allyl complex-Tsuji Trost reaction –Regio and stereoselectivity, Ullmann reaction, catalytic cycles.

Unit 2: Reagents for Oxidation and Reduction (10 Hours)

DMSO based oxidation- Swern, Corey Kim, Moffatt-Pfitzner- Metal oxide oxidants- PCC, PDC, Jones reagent, MnO₂, KMnO₄, TPAP- Hypervalent iodine- IBX, Dess-Martin periodinane, Oppeneur oxidation. Reduction – Metal hydrides- NaBH₄, LAH, DIBAL-H, NaCNBH₃, LiBH₄, BH₃, Selectride, Li/liq.NH₃ reduction of aromatic ring, alkyne, cyclohexenone, Bouvel-Banc reduction, Raney/Ni, Pd/C, H₂-MPV reduction

Unit 3: Modern Synthetic Reagents and Multicomponent Reaction (9 Hours)

Modern Synthetic Reagents : NBS- DDQ- DCC, R_2CuLi , Gilmann Reagent, Wittig salt, Wittig-Horner reaction, trimethylsulfonium and sulfoxonium ylide- Corey-Chaykovsky reaction, Tebbe reagent, mCPBA, CH_2I_2 and Zn/Cu-Simmons Smith-diazomethane- SeO_2 , multicomponent reactions, Strecker's amino acid synthesis, Ugi reaction, Passerini reaction, Biginelli reaction, mechanism.

Unit 4: Molecular Rearrangement (10 Hours)

1,2-shift to electrophilic carbon – Wagner –Meerwin, Pinacol-Pinacolone, Benzil-Benzilic acid rearrangement- Favorski- Dieneone phenol- Wolf rearrangement-Demjanov – 1,2-shift to electrophilic Oxygen – Baeyer Villiger Oxidation, Dakin reaction- hydroboration oxidation -1,2-shift to electrophilic nitrogen –Curtius - Schmidt – Hoffmann – Lossen rearrangements, Beckmann rearrangement – Sommelet Hauser-Benzidine rearrangement-Neber rearrangement

Unit 5: Retrosynthesis – The Disconnection Approach (8 Hours)

Synthons and reagents – Strategy I: The order of events – one group disconnection – Strategy II: Chemoselectivity – Two group Disconnection – Strategy III; Reversal of polarity, 1,3-dithiane and cyclization – Strategy IV: protecting groups – Strategy V: Stereoselectivity – Strategy VI: Carbonyl condensation - Strategy VII: Aliphatic nitro compounds – Strategy VIII: Ring synthesis.

Reference Books:

1. Smith M. B., Organic Synthesis, 3rd Edition, Wave Functions Inc. 2010.
2. Jonathan Clayden, Nick Greeves, Stuart Warren. "Organic Chemistry" 2nd edition, Oxford University Press, 2012
3. Jerry March, "Advanced Organic Chemistry", Wiley Eastern Limited, New Delhi, 4th edition, 2008.
4. Carruthers, W.; Coldham, I. Modern Methods of Organic Synthesis, 04th Edition Cambridge University Press, 2004.
5. Joule, J. A. and Mills K. Heterocyclic Chemistry, 05th Edition, Wiley, 2010.
6. Agarwal. O.P, "Chemistry of natural products, Vol.1 & 2", Goel publishing house, 36th Edition, 2009.
7. Organic Chemistry (5thEdn.) Robert. T.Morrison& N. Boyd. Hill edition.
8. Stuart Warren, "Organic Synthesis – The disconnection approach" – A John Wiley and Sons, Ltd., 2nd Edition, reprint, 2010.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	2					2	2	2	1
CO2					3		1	2	2	
CO3	1			3				2	3	1
CO4		2			1			2		1
CO5			2			1		2	1	
CO6					2		3	2	3	1

"3"– High; "2"– – Medium; "1"– – Low; "-"– No correlation

20CH3008	Group Theory and Applied Physical Chemistry				L	T	P	C
					3	0	0	3

Course Objectives:

Enable the student to

1. understand the concepts of group theory to atoms and molecules.
2. learn the importance of surface chemistry and solids
3. know the fundamentals of photochemistry and electrochemistry

Course Outcomes:

Student will be able to

1. appreciate the symmetry in molecules and in nature
2. able to identify and group the objects or molecules of same category based on the symmetry elements
3. distinguish different isotherms
4. recognize the importance of photosensitization of chemiluminescence
5. understand the basic principles of electrochemistry

6. Know about electrokinetics

Unit 1: Group Theory (9 Hours)

Molecular symmetry – symmetry elements and symmetry operations-successive operations, inverse operations - Cartesian coordinate system - relations among symmetry elements - Properties of a group – Abelian, non abelian and Isomorphic groups - Multiplication tables – classes, subgroups - Molecular point groups - Schoenflies symbols - Matrices of symmetry operations - Representations of a group- Reducible and irreducible, representations - Statement and proof of Great orthogonality theorem - Characters and construction of character table (C_{2v}, C_{3v}) – Explanation of a character table - Direct product groups.

Unit 2: Applications of Group Theory (9 Hours)

Standard reduction formula relating reducible and irreducible representations -Symmetries of normal modes of vibration in non-linear molecules (H₂O, NH₃, BF₃) - Selection rules for vibrational spectra – IR and Raman active fundamentals – Mutual exclusion rule - Symmetries of M.O and symmetry selection rule for electronic transition in ethylene and formaldehyde - Hybridization schemes for atoms in methane, ethylene and butadiene.

Unit 3: Surface Chemistry & Colloids (9 Hours)

Adsorption – Difference between adsorption and absorption – Classification of adsorption – Physisorption – Chemisorption – Adsorption isotherm – Freundlich's adsorption isotherm – Applications of adsorption – Types of solutions – Types of colloidal solutions – Preparation of colloidal solutions – Condensation methods – Disintegration methods – Purification of colloidal solutions – Dialysis – Ultrafiltration – Characteristics of colloidal solutions – Emulsions – Micelles.

Unit 4: Photochemistry (9 Hours)

Absorption and emission of radiation – Theories – Spontaneous and induced emission –Laser – Franck Condon principle - Type 1 & 2 – Physical properties of electronic excited state – Emission – Resonance emission – Selection rule – Fluorescence – Phosphorescence – Delayed fluorescence: E-Type and P-Type – Excimer and Exciplex complex formation – Photosensitization and Chemiluminescence – Experimental techniques – Actinometry – Chemical actinometry – Flash photolysis.

Unit 5: Electrochemistry (9 Hours)

Conductance - transport number - Debye- Huckel- Onsager equation- Falkenhagen effect, Wien effect - ionic strength, Debye-Huckel limiting law and its verifications - electrode potential - concentration cells - liquid junction potential - Electro kinetic phenomena: Theories of double layer - Helmholtz-Perrin, Gouy-Chapmann & Stern theories - electrocotics - mechanism of electrode reactions - polarization and over potential - Butler-Volmer equation - electrophoresis and electro osmosis.

Text books:

1. S. Swarnalakshmi, "A Simple Approach to Group Theory in Chemistry" Universities Press, 2009.
2. K.V. Raman, "Group theory and its applications to chemistry", Tata Mac Graw Hill, 2004.
3. A.W. Adamson, "Physical Chemistry of Surfaces", Wiley, 6th edition, 1997.
4. K. K. Rohatgi Mukherjee "Fundamentals of photochemistry", New Age International Pvt. Ltd., New Delhi, 2009.
5. John O'M. Bockris, Amulya K. N. Reddy, "Modern Electrochemistry Vol. I and II", Plenum Publishing, 1970.

Reference Books:

1. Cotton F.A. "Chemical application of group theory", Wiley India Pvt. Ltd., New Delhi, India, 3rd edition, 2009.
2. Carter R.L., Molecular Symmetry and Group Theory, John Wiley & Sons, NY, 2005.
3. Atkins P.W., "Physical Chemistry", Oxford University Press, 8th edition, 2006.
4. Glasstone, "An Introduction to Electrochemistry Van Nostrand Co. Inc., Newyork, 1943.
5. Richard C. Alkire, Dieter M. Kolb, Jacek Lipkowski and Phil Ross, "Advances in Electrochemical Science and Engineering, Volume 9, Wiley, 2006.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	-	-	-	1	1	1	-	1	1	1
CO2	1	1	1	1	1	1	1	1	1	2
CO3	-	-	-	-	1	2	1	1	2	1

CO4	1	2	2	1	1	2	3	1	2	3
CO5	1	1	1	2	1	1	1	1	2	3
CO6	1	1	1	2	1	2	1	1	2	2

“3”– High; “2”– Medium; “1”– Low; “-”– No correlation

20CH3009	Organometallic and Bioinorganic Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. summarize the applications of organometallic chemistry
2. discuss the role of metals in biological chemistry
3. apply the concept of inorganic photochemistry

Course Outcomes :

Student will be able to

1. apply the 18 electron rule
2. describe the structure of various types of transition metal organometallic complexes
3. utilize the reactions of organometallic complexes
4. practice the applications of organometallic complexes in catalysis
5. discuss the role of metals in biology
6. identify the metal complexes that can be used for solar energy conversion

Unit 1: Organometallic Chemistry – Structure (14 Hours)

18 Electron Rule - MO theory and 18 electron rule – Electron Counting - Problems - Metal carbonyl complexes - Preparation and Properties - Polynuclear metal carbonyls - Carbonylate anions - Carbonyl Hydride Complexes - Structure prediction for organometallic cluster - Metal Nitrosyl Complexes - Metal nitrogen complexes - Alkyl complexes - Chemistry of Metal carbene and Carbyne complexes - Alkene and Alkyne complexes - Allyl and Arene complexes - Metallocenes

Unit 2: Reactions In Organometallic Chemistry (6 Hours)

Reactions – Types – Ligand Cone angle – Oxidative addition - Reductive elimination – Insertion – Migration - Nucleophilic and electrophilic attack on coordinated ligands - Carbonylate anions as nucleophile- Fluxionality

Unit 3: Catalysis (6 Hours)

Catalysis – Tolman loop – Hydrogenation - Carbonylation - Hydroformylation - Wacker Process - Zeigler-Natta Catalysis

Unit 4: Biological Inorganic Chemistry (12 Hours)

Essential and Trace elements in Biological Systems – Bioinorganic Chemistry of Fe, Co, Cu, Mn and Zn – Metalloporphyrin and Heme - Fe- Oxygen Binding – Structure and functions of hemoglobin – Myoglobin - physiology of O₂ binding - Electron transport – Ferridoxin, rubridoxin - Blue – Copper Proteins – Photosynthesis - Chlorophyll - Enzymes – Model Complexes - Carboxy peptidase - Carbonic anhydrase - Nitrogen Fixation – Hydrogenase - Vitamin B₁₂ and B₁₂ coenzymes – Model complexes - Platinum anticancer drugs – Biomaterials

Unit 5: Inorganic Photochemistry (7 Hours)

Properties of excited states - Basic Photochemical Processes – Energy transfer – Charge transfer photochemistry – Photodissociation - Photosubstitution reactions – photoisomerization - Photoredox reactions — Ruthenium Polypyridine complexes – Uses

Reference Books:

1. Huheey J.E, Keiter E.A & Keiter R.L, “Inorganic Chemistry – Principles of structure and reactivity”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
2. Shriver and Atkins, “Inorganic Chemistry”, Oxford University Press, New Delhi, India, 4th edition, 2009.
3. Porterfield W.W, “Inorganic Chemistry A Unified Approach”, Reed Elsevier India Private Ltd, Gurgaon, India, 2nd Edition, Reprinted 2009.

- Purcell K.F & Kotz J.C., "Inorganic Chemistry", Cengage Learning, New Delhi, India, Reprint, 2010.
- Cotton F.A. & Wilkinson G, "Advanced Inorganic Chemistry", 6th edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.
- Gupta B.D. & Elias A.J., "Basic Organometallic Chemistry", CRC Press, New Delhi, India, 2010.
- Greenwood N.N. & Earnshaw A, "Chemistry of the Elements", Reed Elsevier India Private Ltd, Gurgaon, India, 2nd Edition, Reprinted 2010.
- Hussain Reddy K, "Bioinorganic Chemistry, New Age International Ltd, 2003.
- Bertini I, Gray H.B, Lippard S. J & Valentine J,S, "Bioinorganic Chemistry", Viva Books Private Ltd, New Delhi, India, 2007.

20CH3010	Pericyclic Reactions and Biomolecules	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

- understand the fundamental principles of pericyclic and photochemical reactions
- acquire knowledge on the synthesis and reactions of heterocyclic compounds
- realize the importance of biomolecules in the functioning of living system

Course Outcomes:

Student will be able to

- apply the principles and applications of pericyclic reactions to predict the product.
- reason out for the product formed in the photochemical reaction
- describe the synthesis of heterocycles molecules from suitable precursors
- summarize the properties and applications of heterocyclic compounds
- elaborate the extraction and structural elucidation of natural products
- explain the structure and role of biomolecules in living system

Unit 1: Pericyclic Reactions (9 Hours)

Pericyclic reaction-definition and types- Electrocyclic ring closing and ring opening-conrotatory and disrotatory, FMO method, correlation diagram- Woodward-Hoffmann rule –Nazarov cyclization,Cycloaddition - FMO method, correlation diagram- Woodward-Hoffmann rule, selectivity-Diels Alder- endo, regio and stereoselectivity – Sigmatropic rearrangement – [3,3], Cope, oxy-cope, Claisen, Johnson-claisen, Ireland-claisen, stereochemistry of sigmatropic reaction, [2,3] sigmatropic reactions-, ene reaction- stereochemistry, chelotropic reactions

Unit 2: Photochemical Reactions (9 Hours)

Reactivity of Electronically excited ketones Norrish Type I, Type II reactions – Photoreduction and oxidation – Paterno-Buchi reaction - Photo rearrangements – Photo Fries rearrangement, di-pi-methane and oxa-di-pi-methane rearrangement, Lumiketone rearrangement, Remote functionalization Barton and Hoffmann-Loftler-Freytag reaction, cis-trans isomerization photostationary state

Unit 3: Heterocyclic Chemistry (8 Hours)

Introduction and Nomenclature, Imidazole synthesis, properties, ionic liquid, N-heterocyclic carbene, pyrazole, synthesis, reactions, indole, Fischer-indole synthesis, Madelung synthesis, Bischler and Reissert synthesis, properties, Synthesis and properties of Pyridazine, Pyrimidine.

Unit 4: Natural products - structural elucidation and synthesis (9 Hours)

Natural products-extraction, Soxhlet extraction, Index of hydrogen deficiency, Empirical formula from CHN- Physical and chemical methods for the structure elucidation of alkaloids, Terpenoids, steroids. Synthesis of menthol, Nicotine, Cholesterol.

Unit 5:Chemistry of Biomolecules (10 Hours)

Structure and functions of Vitamins, structure and reactions of carbohydrates, mutarotation- oxidation, reduction, osazone formation, Diol cleavage, Fischer-Kiliani homologation and Ruff degradation, anomeric effect, Structure and types of Amino acids, isoelectric point, peptide synthesis, Merrifield resin-proteins and enzymes, Edman degradation and Sangers method. Primary, secondary, tertiary and quaternary structure of DNA and RNA.

Reference Books:

1. Jagadamba Singh and Jaya Singh, "Photochemistry and Pericyclic Reactions", New Age International Publishers, New Delhi, 3rd Revised Edition, Reprint, 2011.
2. Finar. I. L., "Organic Chemistry", Volume 2, Doorling Kindersley (Indian), 6th Edition, 2008.
3. Raj.K. Bansal, "Heterocyclic Chemistry", New Age International Publishers, 4th Edition, Reprint, 2009.
4. Finar. I.L., "Organic Chemistry", Volume 2, Doorling Kindersley (Indian), 6th Edition, 5th Impression 2008.
5. Gurdeep R. Chatwal, "Organic Chemistry of Natural Products", Himalaya Publishing Home, New Delhi, 5th & Enlarged Edition, 2008.
6. Lehninger "Principles of Biochemistry" 5th edition, 2008 - Nelson, D. L. and M. M. Cox. (W. H. Freeman & Co.).
7. Carey, F. A., Sundberg. R. J., "Advanced Organic Chemistry Part – B: Reactions and Synthesis", Plenum Press, 2008.
8. Gurdeep R. Chatwal, "Reaction Mechanism and Reagents in Organic Chemistry", Himalaya Publishing House, New Delhi, 2007.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3			1			2	1	
CO2	1	2						3		
CO3		2			2			2	1	
CO4		3		2			2	2	3	1
CO5						2	3	2	3	1
CO6		2					3	2		1

"3" – High; "2" – Medium; "1" – Low; "-" – No correlation

20CH3011	Qualitative and Quantitative Organic Analysis Lab	L	T	P	C
		0	0	6	4

Course Objectives:

Enable the student to

1. Identify the functional group of the organic compound by qualitative analysis
2. Carryout various types of organic reactions to analyse the organic compound
3. Understand the principle and estimate organic compound quantitatively

Course Outcomes:

Student will be able to

1. Carry out systematic analysis of an organic compound
2. Understand the mechanism of the various reactions.
3. Recognize the importance of analysing organic compound
4. Employ various types of organic reaction in synthesis
5. Apply the knowledge in analysing real samples
6. Prepare derivatives for the given organic compound

List of experiments

1. Qualitative analysis of organic mixture-I
2. Qualitative analysis of organic mixture-II
3. Qualitative analysis of organic mixture-III
4. Qualitative analysis of organic mixture-IV
5. Qualitative analysis of organic mixture-V
6. Qualitative analysis of organic mixture-VI
7. Qualitative analysis of organic mixture-VII
8. Qualitative analysis of organic mixture-VIII
9. Estimation of Phenol
10. Estimation of Aniline
11. Estimation of Ascorbic acid

12. Estimation of Glucose
 (Minimum 10 experiments to be conducted)

Reference Books:

1. A.I. Vogel – “Text book of practical organic chemistry”, 5th Ed. ELBS, London, 1989
2. B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
3. Daniel R. Palleros, “Experimental Organic Chemistry” John Wiley & Sons, Inc., New York, 2000
4. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, “Text book of Practical Organic Chemistry”, LBS, Singapore, 1994
5. S.M. Khopar, “Basic concepts of Analytical Chemistry”, John Wiley & Sons, 1984
6. Gnanapragasam N.S., Ramamurthy G, “Organic Chemistry Lab Manual”, revised edition, S. Viswanathan printers and publishers Pvt. Ltd., Chennai, Reprinted 2011.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		2			3	1		2	3	1
CO2		3						1	1	
CO3	1	2			3		2	2	2	2
CO4					1	3	2	3	3	1
CO5						2	3	2	3	3
CO6				3	2			3	2	3

20CH3012	Qualitative Analysis and Inorganic Preparation Lab	L	T	P	C
		0	0	6	4

Course Objectives:

Enable the student to

1. learn about the methods used in qualitative inorganic analysis containing common and less common ions
2. synthesize the metal complexes
3. characterize the metal complexes using spectroscopic techniques

Course Outcomes :

Student will be able to

1. Perform semimicro analysis
2. classify the ions into various groups
3. differentiate between common and less common ions
4. practice complex preparation techniques.
5. understand the mechanism of the various preparative synthetic steps.
6. characterize the inorganic complexes by spectroscopic techniques

Course Description :

1. Semimicro qualitative inorganic analysis-I
2. Semimicro qualitative inorganic analysis -II
3. Semimicro qualitative inorganic analysis -III
4. Semimicro qualitative inorganic analysis -IV
5. Semimicro qualitative inorganic analysis -V
6. Semimicro qualitative inorganic analysis -VI
7. Semimicro qualitative inorganic analysis -VII
8. Semimicro qualitative inorganic analysis –VIII
9. Semimicro qualitative inorganic analysis –IX
10. Semimicro qualitative inorganic analysis –X
11. Preparation of Potassium trioxalato ferrate(III) trihydrate
12. Preparation of Hexathiourea Lead(II)nitrate
13. Preparation of Tetraamine copper (II) sulphate
14. Synthesis of hexaammine cobalt(III) chloride
15. Preparation of Diaquabis (ethylenediamine) copper (II) iodide
16. Preparation of Dichlorobis (ethylenediamine) cobalt(II) chloride

17. Preparation of Potassium trioxalato Chromium(III)
18. Solid phase synthesis of *trans*- bis glycinato copper (II):
19. Preparation of bis(N, N' disalicylaethylene-diamine)- μ - aquadichloro cobalt(II)
20. Synthesis of pentaamminechlorocobalt(III) chloride
21. Preparation of Manganese dioxide nano-particles
22. Preparation of bis-chloro bis-triphenyl phosphine nickel (II)
(Minimum 10 experiments to be completed)

Reference Books :

3. Ramanujam V. V., "Inorganic semimicro qualitative analysis", 3rd edition, The national publishing company, Chennai, India, reprinted 2008.
4. Svehla G., "Vogel's Textbook of Qualitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression 2008.
5. Gopalan R, Ramalingam V, Concise Coordination Chemistry, Vikas Publishing House Pvt. Ltd, 2001
6. Allcock, H. R., "Inorganic Syntheses", Volume 25, John Wiley & Sons, New York, USA, 1989

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	-	1	1	1	1	-	-	1	2	1
CO2	-	-	1	1	-			1	1	1
CO3	-	-	-	1	-			1	1	2
CO4	-	-	-	-	-			1	1	1
CO5	1	1	1	1	1			1	1	1
CO6	1	1	1	1	1			1	2	3

20CH3013	Physical Chemistry Lab	L	T	P	C
		0	0	6	4

Course Objectives:

Enable the student to

1. carryout chemical reaction which would be monitored by electroanalytical and other experimental studies
2. develop skills in the application area of electrochemical based experiments
3. learn the techniques used for kinetics

Course Outcomes:

Student will be able to

1. apply the physical chemistry concepts in chemical kinetics
2. handle the experiments like conductometry, spectrophotometry, potentiometry.
3. understand the importance of the velocity of the reaction, distribution properties and adsorption studies.
4. recognize the factors affecting the rate of the reactions
5. understand the importance of absorption studies.
6. apply the practical knowledge and its solving route.

Course Description:

1. Determination of strength of the mixture of acids
2. Determination of percentage purity of AgNO_3 solution conductometrically
3. Precipitation reaction between BaCl_2 & MgSO_4 – Conductometry
4. Verification of Onsager equation
5. Verification of Ostwald's Dilution law
6. Precipitation Titration of KCl Vs AgNO_3 (Potentiometry)
7. Determination of dissociation constant of weak acid using quinhydrone electrode
8. Determination of strength of unknown KI solution by potentiometric method
9. Determination of pH of a given buffer by potentiometry
10. Precipitation titration (AgNO_3 Vs $\text{KCl} + \text{KI}$) – Potentiometry
11. Ester hydrolysis – Comparison of acid strength
12. Freundlich adsorption isotherm

13. Verification of the validity of Beer – Lambert’s law and determination of the concentration of chromium present in the given $K_2Cr_2O_7$ by spectrophotometry
14. Determination of the strength of ferrous ion present in the given solution by potentiometric method.

(Minimum 10 experiments to be completed)

Reference Books:

1. Svehla G., “Vogel’s Textbook of Qualitative Chemical Analysis”, 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression 2008.
2. Anand A., Kumari R., “Physical Chemistry Laboratory Manual: An Interdisciplinary Approach”, I K International Publishing House Pvt. Ltd, 2019.
3. Sinha S.K., “Physical Chemistry: A Laboratory Manual”, Alpha Science International Ltd; 1st edition, 2014.
4. Gold, “Physical Chemistry Laboratory Manual”, Primis; 2nd edition, 1998.
5. Athawale, V.D., Mathur, P., “Experimental Physical Chemistry”, New Age International Publishers, 2001.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	-	1	1	1	1	1	1	1	2	1
CO2	-	-	1	1	-	1	1	1	1	1
CO3	-	-	-	1	-	-	1	1	1	2
CO4	-	-	-	-	-	1	1	1	1	1
CO5	1	1	1	1	1	-	1	1	1	1
CO6	1	1	1	1	1	1	1	1	2	3

“3”– High; “2”– Medium; “1”– Low; “-”– No correlation

20CH3014	Inorganic Quantitative Analysis lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn about accurate and precise chemical analysis.
2. Perform various types of volumetric analysis
3. Practice gravimetric method of analysis

Course Outcomes:

Student will be able to

1. gain the laboratory skills
2. practice accurate measurement techniques
3. understand the importance of various types of volumetric analysis
4. learn the importance of precipitants
5. perform gravimetric method of analysis
6. estimate the elements in the mixture.

List of Experiments

1. Volumetric Estimation of Zinc (Complexometry)
2. Volumetric Estimation of Calcium (Complexometry)
3. Volumetric Estimation of Nickel (Complexometry)
4. Volumetric Estimation of Aluminium (Complexometry)
5. Volumetric Estimation of Fe^{2+} - Internal indicator method
6. Volumetric Estimation of copper using thio (Iodometry)
7. Volumetric Estimation of Fe^{2+} (Permanganometry)
8. Gravimetric Estimation of Nickel
9. Gravimetric Estimation of Barium
10. Gravimetric estimation of Copper
11. Gravimetric estimation of Magnesium
12. Quantitative estimation of copper (II) and calcium (II) from a mixture
13. Quantitative separation and determination $Mg(II)$ (gravimetrically) and $Ca(II)$ (Volumetrically)

14. Quantitative separation and determination of Ni(II) (gravimetrically) and Cu(II) (Volumetrically)
 15. Quantitative separation and determination of Ba(II) (gravimetrically) and Cu(II) (Volumetrically)
 16. Quantitative separation and determination of Fe(III) (gravimetrically) and Ca(II) (Volumetrically)
- (Minimum 10 experiments to be completed)

Reference Books :

1. J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas “Vogel’s Quantitative Chemical Analysis”, 6th edition, 7th Impression, Dorling Kindersley limited, New Delhi, India, 2008
2. Skoog D. A, West D. M, Holler F. J & Crouch S. R, “Fundamentals of Analytical Chemistry”, Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.

	PO 1	PO2	PO 3	PO4	PO5	PO 6	PO7	PSO 1	PSO 2	PSO 3
CO1	1	2	3	1	3			1	2	
CO2	3	1	2	3		1		1		
CO3				3	1					
CO4		1		3	2			1	1	
CO5			1		1	3		1	2	
CO6				3	2				3	

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20CH3015	Modern Instrumental Analysis Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. understand theory, instrumentation, and applications of separation techniques
2. analyze the sample using , Spectroscopic techniques.
3. understand theory, instrumentation, and applications of surface characterization techniques

Course Outcomes:

Student will be able to

1. handle various analytical techniques
2. describe physical and chemical principles involved in instrumental analysis and practical skills
3. understand the principles of data acquisition and data analyses.
4. interpret analytical data and communicate the information about identification of different materials.
5. solve quantitative analytical problems.
6. choose the instrument for specific characterization

List of experiments

1. Demonstration of IR Spectrometer Instrument
2. IR spectral Analysis of Sample -I
3. IR spectral Analysis of Sample -II
4. IR spectral Analysis of Sample -III
5. Demonstration of UV-Visible Spectrometer
6. UV-Visible spectral Analysis of Sample -I
7. UV-Visible spectral Analysis of Sample -I
8. UV-Visible spectral Analysis of Sample -I
9. Separation of compounds using Thin Layer Chromatography of Sample -I
10. Separation of compounds using Thin Layer Chromatography of Sample -II
11. Separation of compounds using Thin Layer Chromatography of Sample -III
12. Separation of compounds using Column Chromatography -I
13. Separation of compounds using Column Chromatography -II
14. Analysis of Surface Morphology of metal oxide by Scanning Electron Microscopy - I
15. Analysis of Surface Morphology of metal oxide by Scanning Electron Microscopy - II

16. Analysis of Powder XRD Data- I
17. Analysis of Powder XRD Data- II
18. Demonstration of HPLC instrument
(Minimum 10 experiments to be completed)

Reference Book

1. Mendham J., Denny R. C., Barnes J. D. and Thomas M. J. K., "Vogel's Textbook of Quantitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, Seventh impression 2008.

20CH3016	Synthetic Organic Chemistry Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. Develop skills to prepare various organic compounds.
2. Learn the techniques in organic preparation.
3. Understand the purification techniques to get pure organic compound.

Course Outcomes:

Student will be able to

1. Design and prepare organic compounds in one step.
2. Purify the prepared organic compound and check the purity.
3. Setup the apparatus for various preparative techniques.
4. Understand the mechanism of various synthetic methods.
5. Recognize the importance of distillation, refluxing and recrystallization techniques.
6. Employ various types of reaction to prepare organic compound.

List of experiments

1. Preparation of Acetanilide from aniline
2. Preparation of acetyl salicylic acid from salicylic acid
3. Preparation of 2,4,6-tribromo aniline from aniline
4. Preparation of p-bromo acetanilide from acetanilide
5. Preparation of picric acid from phenol
6. Preparation of benzanilide from aniline
7. Preparation of Benzoic acid from benzoic acid
8. Preparation of p-nitro benzoic acid from 4-nitro toluene
9. Preparation of m-nitrophenol from m-nitroaniline
10. Preparation of fluorescein

(Minimum 10 experiments to be completed)

Reference Books:

1. A. I. Vogel – "Text book of practical organic chemistry", 5th Ed. ELBS, London, 1989
2. B. B. Dey and M.V. Sitharaman, "Laboratory manual of Organic Chemistry" Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
3. Daniel R. Palleros, "Experimental Organic Chemistry" John Wiley & Sons, Inc., New York, 2000
4. B. S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, "Text book of Practical Organic Chemistry", LBS, Singapore, 1994
5. S. M. Khopar, "Basic concepts of Analytical Chemistry", John Wiley & Sons, 1984

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1		2				3	1	2	3
CO2	2	1		3			2	3	2	1
CO3	2			3			1	2	1	3
CO4		3						3	1	1
CO5				2		3	1	3	3	3
CO6		1			2	3		3	2	3

20CH3017	Instrumental Methods of Chemical Analysis	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. develop sufficient knowledge about the physical/chemical basis of measurement
2. obtain knowledge pertaining to the appropriate selection of instruments for the successful analysis of complex mixtures
3. understand the applications and analysis of various instrumental techniques

Course Outcomes:

Student will be able to

1. understand the range and theories of instrumental methods available in analytical chemistry
2. select the appropriate instruments for analyzing complex mixtures
3. choose the proper separation technique
4. know the importance of thermal methods of analysis
5. analyze the sample using microscopic techniques
6. recognize the importance of instrumentation techniques in paint, glass, paper, water, food, body fluid analysis.

Unit 1. Data Analysis (9 Hours)

Errors in chemical analysis – Mean, Median, Mode, Accuracy and Precision –Absolute and Relative Error; Determinate errors and Indeterminate errors. Improving accuracy of analysis mean, standard deviation absolute and relative errors; Covariance and coefficient correlation; significant figures and Q-test – Modern Instrumental Techniques – Classification – Examples.

Unit 2. Analytical Chromatography (9 Hours)

Classification – techniques and applications in column, Ion exchange, Paper and Thin layer chromatography. Gas chromatography and high performance liquid chromatography (HPLC) – principle, Instrumentation and application.

Unit 3. Thermal Methods of Analysis (9 Hours)

Thermal Characterization techniques Principle and applications of Differential Thermal Analysis (DTA), Differentials Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) Thermometric titration - Theory – Instrumentation – Applications.

Unit 4. Microscopy methods of Analysis (9 Hours)

Atomic absorption Spectroscopy - Instrumentation – Applications - X-ray Methods – Instrumentation – Diffraction pattern – Applications – Crystal Tonography - Surface Characterization Techniques – SEM – TEM – instrumentation – Applications

Unit 5. Chemical analysis in Chemical Industries (9 Hours)

Paint analysis – Glass Analysis – Paper and Pulp Analysis - Water analysis - Food analysis - Body Fluid analysis – Chemical Sensors - Experiments - Process - Instruments – Application.

Reference Books:

1. Willard H, Merrit L, Dean J. A. & Settle F.A., “Instrumental methods of chemical analysis”, CBS Publishers and Distributors Pvt. Ltd, New Delhi, 7th edition, 1986.
2. Skoog D. A, West D. M, Holler F. J & Crouch S. R, “Fundamentals of Analytical Chemistry”, Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.
3. Day R. A.& Underwood A. L., “Quantitative Analysis”, 6th Edition, Printice Hall of India Pvt Ltd, New Delhi,2006.
4. G.D. Chritiain. Analytical Chemistry Wiley
5. Srivatsava A. K. & Jain P. C, “Chemical Analysis”, S. Chand Publications, New Delhi, 3rd edition, 1997.
6. Chatwal G. R &Anand S. K, “Instrumental Methods of Chemical Analysis”, Himalaya Publishing House, Mumbai, India, 5th Edition, Reprint 2011.
7. Valcarcel, Miguel, Principles of Analytical Chemistry, Springer, 2000.
8. G. Sharma, B K Chaturvedi, Richard E. Wolfe, Basic Analytical Chemistry, DK publishers, 2011
9. Zhou W, Wang Z. L, “Scanning Microscopy for Nanotechnology: Techniques and Applications”, Springer, New York, USA, 2006.
10. R.P. Braun, Introduction to Instrumental Analysis, McGraw Hill

11. Caddy; Brian Strathclyde University, Glasgow, Scotland, "Forensic Examination of Glass and Paint: Analysis and Interpretation" Journal of Forensic Science, March 2003, Vol. 48, No. 2.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	1	2	2	2	1	1	2	1	3
CO2	3	2	2	2	3	2	1	2	1	2
CO3	2	2	2	3	2	2	2	1	2	-
CO4	1	2	1	2	2	1	-	1	2	1
CO5	1	1	2	1	2	1	2	2	1	3
CO6	1	2	1	3	3	2	3	1	1	2

"3"– High; "2"– – Medium ; "1"– - Low ; "-"- No correlation

20CH3018	Chemistry of non-Transition Elements				L	T	P	C
					3	0	0	3

Course Objectives:

Enable the student to

1. summarize the chemistry of main group Compounds
2. utilize the inorganic polymers, cages and clusters for various applications
3. describe the importance of f-block elements and their applications

Course Outcomes:

Student will be able to

1. discuss the importance of alkali and alkaline earth metals
2. describe the importance of allotropy
3. summarize the importance of compounds of p-block elements
4. utilize the preparative methods of inorganic polymers
5. explain the structure and bonding in inorganic cages and clusters.
6. compare the chemistry of lanthanides and actinides and their applications

Unit 1: Chemistry of Alkali and Alkaline Earth Metals (10 Hours)

Periodic property, Synthesis of Crown ether and Cryptands, Application of Crown ethers in extraction of alkali and alkaline earth metals; Compounds of Beryllium-Aqua and hydroxo complexes, Beryllium chloride, Carbonates, Carboxylates, Dimethylberyllium, Beryllium azide, Grignard reagents and their application.

Unit 2: Polymorphism and Allotropy (8 Hours)

Allotropes of carbon-Fullerenes, Carbon nanotubes, Diamond, Graphite (synthesis, structure and applications); Allotropes of Phosphorus-Synthesis, Structure and Properties; Allotropes of Sulphur-Classification, Synthesis, Structure and Properties

Unit 3: Chemistry of Main group Elements (10 Hours)

Bonding, Preparation and Structure-Hydrides of boron, Boron oxides, Oxoacids, Borates, Aminoboranes; Chemistry of Silicates; Organometallic Compounds of B, Al, Si, Sn, Pb, and Bi-Synthesis, Structure and Reactions Oxides and oxyacids of S, Se, Te and N- Synthesis, Structures and Properties; Interhalogens, Polyhalides, Pseudohalides- Synthesis and Structure; Xenon compounds- Synthesis and Structure

Unit 4: Compounds of Cluster, Cages, Chains and Rings (10 Hours)

Hydroborane Clusters, Electron counting schemes: Effective Atomic Number (EAN) Rule – Wade–Mingos Rules, Styx numbers; P–S cages and P–O cages- Synthesis, Structure and Reactivity; Phosphazenes and Poly Phosphazenes; Borazines and Poly Borazines; S–N polymer, Boron nitrides, Polysilanes, Silicones - Carboranes, Metallacarboranes- Synthesis, Structures and bonding

Unit 5: Chemistry of f-Block Elements (7 Hours)

Abundance and Distribution - Separation of Lanthanides and Actinides – Lanthanide Contraction – Magnetic and Spectroscopic properties of Lanthanides - Transactinides - Applications

Reference Books:

1. Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.

- Greenwood N. N. & Earnshaw A, "Chemistry of the Elements", Reed Elsevier India Private Ltd, Gurgaon, India, 2nd edition, Reprinted 2010.
- Purcell K. F & Kotz J. C., "Inorganic Chemistry" Cengage Learning, New Delhi, India, Reprint, 2010.
- Shriver and Atkins, "Inorganic Chemistry", Oxford University Press, New Delhi, India, 4th edition, 2009.
- Cotton F. A & Wilkinson G, "Advanced Inorganic Chemistry", 6th edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.
- Driess M. & Nöth H, "Molecular Clusters of the Main Group Elements", Wiley-VCH Verlag GmbH & Co, Weinheim, Germany, 2004.
- Chandrasekhar V, "Inorganic and Organometallic Polymers" Springer-Verlag Berlin, Heidelberg Germany, 2005
- Henderson W, "Main Group Chemistry", Royal Society of Chemistry, United Kingdom, 2000.
- Chivers T & Manners I, "Inorganic Rings and Polymers of the p-Block Elements", Royal Society of Chemistry, United Kingdom, 2009.
- Archer R. D, "Inorganic and Organometallic Polymers", John Wiley and Sons, New York, USA, 2001.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	1	2	2	2	1	1	2	1	3
CO2	3	2	2	2	3	2	1	2	1	2
CO3	2	2	2	3	2	2	2	1	2	-
CO4	1	2	1	2	2	1	-	1	2	1
CO5	1	1	2	1	2	1	2	2	1	3
CO6	1	2	1	3	3	2	3	1	1	2

"3" – High; "2" – Medium; "1" – Low; "-" – No correlation

20CH3019	Nuclear Chemistry and Solid State Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

- summarize the applications of radioisotopes
- outline the importance of solid state chemistry
- utilize the nanomaterials for various applications

Course Outcomes:

Student will be able to

- Describe the basic concepts of nuclear chemistry
- Summarize the applications of radioisotopes
- Outline the band theory of solids
- Classify the various types of solid state reactions
- Categorize the nanomaterials
- Demonstrate the applications of coordination polymers

Unit 1- Nuclear Chemistry - I (9 Hours)

Nuclear Stability – Nuclear Fission – Nuclear Fusion – fission products and fission yields; Nuclear models – Shell model – Liquid drop model - Types of radioactive decay –Alpha decay – Theory of alpha decay - The tunnel effect - Beta decay – Types of beta decay - Electron capture - Dirac's theory - Nuclear deexcitation – Artificial radioactivity. Nuclear reactions: Bathe's notation – Types of nuclear reactions - Elastic and inelastic scattering –Cross section - Q value – Transuraniens - Photonuclear reaction - Radioactive capture - Evaporation and spallation – Buckshot hypothesis - Thermonuclear reactions

Unit 2 - Nuclear Chemistry -II (9 Hours)

Breeder reactor – Counting techniques: G.M., Ionization and Proportional counter - use of radio isotope in analytical chemistry, isotopic distribution analysis, neutron activation analysis, dating methods, applications of radio isotopes in agriculture industry and medicine. – Esterification – Friedal Craft's

reaction - Solubility of sparingly soluble substance – Isotope dilution analysis – Carbon dating – Thyroiditis - Assessing the volume of blood in a patient - Brain tumor location - bone fracture healing- Optimum use of fertilizers - Control of predatory insects - Prospecting of water and petroleum.

Unit 3: Solid State Chemistry - I (9 Hours)

Conductivity in ionic solids - Band theory of solids -metals and their properties; semiconductors - extrinsic and intrinsic, - Hall effect; thermoelectric effects (Thomson, Peltier and Seebeck); insulators – dielectric, ferroelectric, pyroelectric and piezoelectric properties, multiferroics – Superconductivity - Magnetic properties: Dia, para, ferro, ferri, and antiferro magnetic types; soft and hard magnetic materials; select magnetic materials - spinels, garnets and perovskites, hexaferrites and lanthanide-transition metal compounds; magnetoresistance.

Unit 4: Solid State Chemistry - II (9 Hours)

Preparative methods: Solid state reactions, Chemical Precursor methods, co-precipitation, sol-gel metathesis, self-propagating high temperature synthesis, ion exchange reactions, intercalation/deintercalation reactions; hydrothermal and template synthesis, high pressure synthesis. Types of solid-state reactions - Powder x-ray diffraction, indexing the powder XRD patterns, Systematic absences, Structure factor.

Unit 5: Nanomaterials and Coordination Polymers (9 Hours)

Nanomaterials – Classification based on dimension - Types –methods of synthesis of inorganic nanomaterials -Top down – High energy Ball milling – microfabrication – Bottom up –CVD – Sol-Gel Method – Synthesis of Metal nanoparticles - Self assembled monolayers - Characterization of nanomaterials – Introduction to XRD, SEM and TEM – Applications – Coordination polymers – classification - examples-Applications.

Text Books:

1. Arnikar H. J, “Essentials of Nuclear Chemistry”, New Age International Publishers Ltd., New Delhi, India, 4th edition, 2007.
2. G. Freindlander, J. W. Kennedy, E.S. Macias, and J. M. Miller, Nuclear and Radiochemistry, John Wiley and Sons, New York, 1991.
3. West R, “Solid State Chemistry and its Applications”, Wiley India Pvt. Ltd, New Delhi, India, 2007.
4. L. E. Smart and E. A. Moore, Solid State Chemistry - An Introduction, 4th Edition, CRC Press, 2012.
5. H. V. Keer, Principles of the Solid State, 2nd Edition, New Age International, 2017.
6. M. Weller, T. Overton, J. Rourke and F. Armstrong, Inorganic Chemistry, 6th Edition, Oxford University Press, 2014. (South Asia Edition 2015)
7. Shriver and Atkins, “ Inorganic Chemistry”, Oxford University Press, New Delhi, India, 4th edition, 2009.
8. Cotton F. A & Wilkinson G, “Advanced Inorganic Chemistry”, 6th edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.
9. C. P. Poole, F. J. Owens, “Introduction to Nanotechnology”, Wiley-Interscience; 1st edition, 2008.
10. A.K. Das, D. Mahua, “An Introduction to Nanomaterials and Nanoscience”, CBS Publishers and Distributors Pvt. Ltd, 2017.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	3	2				1	3	1	
CO2		2	3				2	3	1	
CO3	3	1	2					3		
CO4		1	3					1		
CO5		2	3			1		3	1	
CO6		2	2					2	1	

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20CH3020	Organic Spectroscopy	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. outline the basic principles of organic spectroscopic techniques
2. illustrate the various spectroscopic analysis of organic compounds
3. discuss the structural elucidation of unknown organic compounds using various spectroscopic analysis

Course Outcomes:

Student will be able to

1. recognize the principles and applications of UV-Visible spectroscopy and ORD in elucidating the structure of organic compounds
2. illustrate the principle and applications of IR spectroscopy in elucidating the structure of organic compounds
3. describe the basic principle and applications of NMR spectroscopy in elucidating the structure of organic compounds
4. interpret proton decoupled NMR spectra, DEPT, 2D NMR and multi nuclear NMR spectroscopic analysis
5. analyze the basic principle and applications of mass spectroscopy in elucidating the structure of organic compounds.
6. apply the combined spectroscopic data in elucidating the structure of unknown organic compounds.

Unit 1: UV Visible spectroscopy and ORD (9 Hours)

The nature of electronic excitations, Origin of UV band structure, Principle of UV-Visible spectroscopy, Instrumentation- UV Visible spectrophotometer Solvents, Chromophore, Auxochrome, red shift and blue shift- hypo and hyper chromic shift- The Woodward-Fischer rules for dienes, trienes, α,β -unsaturated carbonyl compounds, aromatic compounds, Problems on calculating absorption maximum using Woodward-Fischer rules. Principles of ORD, Instrumentation – CD, Cotton effect, Octant rule, Axial halo ketone rule

Unit 2: FTIR spectroscopy (9 Hours)

Principle of IR spectroscopy, Infrared Absorption Process, Modes of Stretching and Bending, Bond Properties and Absorption Trends, Instrumentation- Fourier Transform IR Spectrophotometer, Preparation of Samples for Infrared Spectroscopy, Finger print region correlation chart and tables, concept of combination bands and overtones, Factors Influencing vibrational frequencies, IR spectrum of Alkanes, Alkenes, and Alkynes, Aromatic Rings, Alcohols, Phenols, Ethers, Carbonyl Compounds, Amines, Nitriles, Isocyanates, Isothiocyanates, Imines, Nitro Compounds, Carboxylate Salts, Sulfur Compounds, Phosphorous compounds-Problems in IR spectroscopy-Applications of IR

Unit 3: ^1H and ^{13}C NMR spectroscopy (9 Hours)

Absorption of energy, Mechanism of Absorption (Resonance), Chemical Shift and Shielding, The NMR Spectrophotometer-instrumentation, Chemical Environment and Chemical Shift, The Origin of Spin-Spin Splitting, Spin-Spin Splitting ($n+1$) Rule, Factors influencing chemical shift, Spin-spin relaxation, spin-lattice relaxation, NMR Solvents, The Coupling Constant, ^1H NMR absorptions by alkanes, alkenes, alkynes, alkyl halides, alcohols, ethers, aromatic compounds, amines, nitriles, aldehydes, ketones, esters, carboxylic acids, amides, nitro alkanes and related problems. Carbon-13 NMR spectroscopy, Chemical Shifts, Proton-Coupled ^{13}C NMR Spectra, Proton-Decoupled ^{13}C NMR Spectra, Off-Resonance Decoupling, Nuclear Overhauser Enhancement (NOE), DEPT spectra, Carbon-13 NMR Solvents and related problems

Unit 4: Second order spectra and 2DNMR spectroscopy (9 Hours)

Second order spectra, The A_2 , AB , and AX Spin Systems, The $AB_2 \dots AX_2$ and $A_2B_2 \dots A_2X_2$ Spin Systems, Chiral Resolving Agents, Two-Dimensional Spectroscopic Methods- ^1H - ^1H COSY spectroscopy, HETCOR spectroscopy, NOESY, ROSEY- definition—Hetero nuclear Coupling of Carbon to Deuterium, Hetero nuclear Coupling of Carbon-13 to Fluorine-19, Hetero nuclear Coupling of Carbon-13 to Phosphorus-31.

Unit 5: Mass spectroscopy (9 Hours)

Principle of mass spectroscopy, Instrumentation, Ionization Methods, Electron Ionization (EI), Chemical Ionization (CI), Desorption Ionization Techniques (SIMS, FAB, and MALDI), Electrospray Ionization (ESI), Molecular ion peak – Base peak, Metastable ions, Nitrogen rule, odd even rule, Isotopic effect, Structural Analysis and Fragmentation Patterns, - McLafferty rearrangement, Other Cleavage Types, Alkanes, Cycloalkanes, Alkenes, Alkynes, Aromatic Hydrocarbons, Alcohols and Phenols, Ethers, Aldehydes, Ketones, Esters, Carboxylic Acids, Amines, Selected Nitrogen and Sulfur Compounds, Alkyl Chlorides and Alkyl Bromides -Problems, Structure elucidation of unknown compounds based on UV, IR, NMR and Mass spectroscopic data

Reference Books:

1. D. L. Pavia and G. M. Lampman Spectroscopy 4th Edition, Brooks Cole, 2012.
2. R. M. Silverstein, F. X. Webster, D. J. Kiemle, Spectrometric identification of organic compounds, 7th edition, John Wiley, 2005.
3. W. Kemp, Organic Spectroscopy, 3rd edition, Macmillan, 2011.
4. D. H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, Mcgraw Hill, 6th edition 2007.
5. P. S. Kalsi, Spectroscopy of Organic Compounds, 6th edition, New age international, 2004.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1				3				2	2	1
CO2				3				2	2	1
CO3		2		3			1	2	3	2
CO4		2		3				2	3	2
CO5				3			1	2	3	3
CO6		2		3			1	2	3	3

“3”– High; “2”– Medium; “1”– Low; “-”– No correlation

20CH3021	Supramolecular Chemistry and Green Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn the supromolecular constructs of current importance.
2. understand the principles of formation of various types of supramolecular architecture
3. describe the importance of solid state supramolecular chemistry and green chemistry

Course Outcomes :

Student will be able to

1. understand the various types of bonding in supramolecular chemistry
2. recognize the selectivity in formation of supramolecular chemistry and catalysis.
3. synthesize and assemble molecular structures of different shapes and dimensions.
4. construct supramolecular architecture based on of crystal engineering concepts
5. identify the application of supramolecular chemistry in appropriate fields
6. understand the importance of green chemical pathways in reactions and their applications.

Unit 1: Fundamentals of Supramolecular Chemistry (9 Hours)

Terminology and definitions – Selectivity – Lock and key principle and induced fit model – complementarity – Co-operativity and chelate effect – Pre-organization – Non-covalent interactions – Ion-Dipole Interactions – van der Waals Interactions – Hydrogen bonding – cation-pi, anion-pi, pi-pi interactions – hydrophobic effects – Kinetic and thermodynamic selectivity – Binding Constant – Guests in solution – Macrocyclic vs. acyclic hosts – High -dilution synthesis – Template synthesis.

Unit 2: Molecular Recognition – Solution State (9 Hours)

Introduction -Cation binding – Podands – Crown ethers and cryptands – Spherands – Heterocrowns – Biological ligands: ion channels – Anion binding – Charged receptors – Neutral receptors – Lewis acid receptors – Neutral molecule binding – Calixarenes, cyclodextrins and dendrimers as catalysts.

Unit 3: Supramolecular Materials (9 Hours)

Self-assembly using metal templates – Racks, ladders, and grids – Helicates – Mechanically interlocked molecules- Molecular polygons – Rotaxanes, catenanes, and knots – Borromean rings – Knotaxanes (structure and function of the above species). Self-assembling capsules – Molecular containers – Metal directed capsules – Hydrogen bonded capsules. Application of Supramolecular Materials - molecular devices.

Unit 4: Crystal Engineering – Solid State (9 Hours)

Introduction – Zeolites: structure – composition – catalysis. Clathrates – Urea/thiourea clathrates – Trimesic acid clathrates – Hydroquinone and Dianin's compound – Clathrate hydrates (structure and function of the above species) – applications. Crystal engineering - Role of hydrogen bonds – Solid state reactivity – Metal organic frameworks – Guest properties of metal – organic frameworks.

Unit 5: Green Methodologies (9 Hours)

Basic principles of Green Chemistry - Atom Economy - Selection of starting materials - Designing biodegradable products - Green reaction conditions - Ionic liquids - Supercritical fluids - Fluorous phase reactions - Microwave and Ultrasound assisted reactions - Heterogeneous catalysis - applications of Green chemistry.

Reference Books :

- Jonathan Steed, David Turner, Carl Wallace, Core Concepts in Supramolecular and Nanochemistry, John Wiley & Sons, 2007.
- V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, Second Edition, CRC Press, 2012.
- I. Chorkendorff, J. W. Niemantsverdriet, Concepts of Modern Catalysis and Kinetics, Second Edition, Wiley-VCH Publishers, 2007
- P.T. Anastas and J.C. Warner, Green Chemistry, Theory and Practice, Oxford University Press, 2000.
- Crystal engineering using multiple hydrogen bonds, In Structure and Bonding, Ed: Andrew D. Burrows, Vol. 108, 55-96, 2004.
- Supramolecular Chemistry: From Biological Inspiration to Biomedical Applications, Peter. J. Cragg, Springer Publishers, 2010.
- Supramolecular Chemistry – Fundamentals and Applications. Advanced Textbook by T. Kunitake, K. Ariga, Berlin: Springer-Verlag Heidelberg, 2006. 208p. ISBN 978-3-540-01298-

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1		1	2					1	
CO2		2						2	1	1
CO3	2		1	3	3			1	3	
CO4		1	2	2	3			2	2	
CO5						1	2			2
CO6	1	2	1	1	2	1	3	2	1	3

“3” – High; “2” – Medium ; “1” – Low ; “-” – No correlation

20CH3022	Applied Electrochemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

- understand the basics of electrochemical techniques
- get the knowledge about electrochemical synthesis and electroplating procedures
- know about electrochemical cells and corrosion control techniques

Course Outcomes:

Student will be able to

- understand the fundamentals of electroanalytical techniques
- know about electrochemical synthetic routes
- understand the concept of electrometallurgy and electroplating procedures
- classify the batteries based on their application
- know about different types of corrosion

6. choose the methods to resist corrosion

Unit 1: Electrochemical Techniques (9 Hours)

Current-voltage relationships - mass transfer - diffusion limited currents - kinetic currents - adsorption currents, voltammetry, amperometry, coulometry, Polarography, impedance spectroscopy, cyclic voltammetry, rotating disc electrodes, chronoamperometry, chronopotentiometry, chronocoulometry, conductometric and potentiometric titrations (basic principles and applications only in all the above methods).

Unit 2: Electrochemical Cells (9 Hours)

Electrochemical cells - components of electrochemical cells- Types of cells - divided and undivided cells - chlor-alkali cells mercury, diaphragm and membrane cells - electro-inorganic chemicals - chlorates, perchlorates - electrosynthesis of fluorine - electro-organic chemicals - electro-reduction of nitro and carbonyl groups - Kolbe synthesis - electro-dimerisation - adiponitrile.

Unit 3: Electrometallurgy and Electroplating (9 Hours)

Electro winning and electro refining of Cu and Ni, production of aluminium - Hall-Heroult process - Electrolytic production of magnesium and sodium - Electroplating operations - preplating operations - electroplating of nickel and chromium - zinc electroplating - Gold plating - anodizing of Al - electroforming

Unit 4: Electrochemical Power Sources (9 Hours)

Thermodynamic reversibility - Classification of batteries – primary batteries: Dry Leclanche cells, alkaline primary batteries - Secondary batteries: Lead acid, Nickel cadmium, Lithium batteries – High temperature batteries - sodium-sulphur system - Fuel cells – Use of batteries in electric vehicles

Unit 5: Corrosion and Corrosion Control (9 Hours)

Pourbaix diagrams - kinetics of corrosion - Evans diagram - Corrosion current and corrosion potential - Theories of corrosion – Mechanism of corrosion – Dry corrosion – Electrochemical corrosion - atmospheric corrosion - crevice corrosion - bimetallic corrosion - stress corrosion - cracking - corrosion control and corrosion inhibitors - painting for corrosion control - cathodic protection - protection by sacrificial anodes.

Text Books:

1. Vijay G. Singh, “Applied Electrochemistry”, Nova Science Publishers, 2010.
2. M. M. Baizer, “Organic electrochemistry”, Dekker Inc. New York, 1983.
3. Schlesinger, “Modern Electroplating”, John Wiley, 2002.
4. Raj Narayan, “An Introduction to metallic corrosion and its prevention”, Oxford & IBH, 1983.
5. Thomas Reddy, “Linden’s Handbook of Batteries”, 4th Edition, McGraw-Hill, 2010.

Reference Books:

1. John O’M Bockris, Amulya K. N. Reddy, Maria E. Gamboa-Adeco, “Modern Electrochemistry”, Vol.2 Part 1, Springer Science & Business Media, 2000
2. Allen J.Bard, Larry R.Faulkner, “Electrochemical Methods: Fundamentals and Applications”, Second Edition, John Wiley & Sons, 2001.
3. Fritz Scholz, “Electroanalytical Methods - Guide to Experiments and Applications”, 2nd Ed, Springer-Verlag Berlin Heidelberg, 2010.
4. Joseph Wang, “Analytical Electrochemistry”, Third Edition, John Wiley & Sons, 2006.
5. Jock Lipkowski and Phil N. Ross, “Electrocatalysis”, John Wiley & Sons, 1998.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	1	1	2	3
CO2	-	-	-	1	-	-	1	1	1	1
CO3	1	-	1	1	-	1	1	1	2	2
CO4	1	1	1	1	1	1	1	1	2	3
CO5	-	-	1	1	1	1	1	1	1	1
CO6	-	-	1	-	-	-	-	1	1	2

“3”– High; “2”– Medium ; “1”– Low ; “-”– No correlation

20CH3023	Research Methodology and IPR	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. make the student conversant with Chemical Databases for their Literature collections
2. encourage students to develop curiosity towards commercial Chemistry softwares for their research
3. acquire knowledge about chemical reaction set-up and its scientific relevance.

Course Outcomes:

Student will be able to

1. describe a research problem using the available chemistry literature.
2. analyze the components of rating like impact factor, citation index
3. realize the potential applications of chemical softwares
4. formulate the chemical reaction design and set-ups
5. create a research problem/proposal/manuscript with the awareness of plagiarism
6. learn the procedure for IPR

Unit 1: Chemical Literature Databases(9 Hours)

Chemical/Beilstein abstracts, CAS Number, DOI, Citation Index, Impact Factors, *h*-index, Scifinder/Reaxys design, Keyword Text Search, Identification of Research Problems, Scopus and Web of Sciences.

Unit 2: Chemistry Softwares(9 Hours)

Structure Tools, Chemical drawings and Chiral representations, Chems sketch, BioRad, Chemoffice, Chemdraw, 3D representation, Energy Minimization process, Substructure identifications, Chemical Structures for manuscript (ACS, RSC, Elsevier), Chemical compounds and Suppliers identification.

Unit 3: Chemical Reaction Design: (9 Hours)

Dean Stork Reaction set-up, Soxhlet extraction set-up, Barr hydrogenation Apparatus, Karl-Fisher Titrations for moisture content Concept of Rotary evaporator, Distillations, Auto Titrator, Reaction monitoring- dry/wet reaction set-up, Handling hygroscopic compounds. Low Temperature bath (freezing mixture), Anhydrous conditions.

Unit 4: Research Ethics and Technical writing (9 Hours)

Research ethics – Plagiarism, Effective literature studies approaches and analysis, Effective technical writing, how to write report, Paper - Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 5: Intellectual Property Rights (9 Hours)

Nature of Intellectual Property: Patents, Designs, Trade and Copyright - Process of Patenting and Development: technological research, innovation - patenting, development. International Scenario: International cooperation WIPO, on Intellectual Property. Procedure for grants of patents, Patenting under PCT- Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Text Books:

1. R. Burns, "Introduction to Research Methods", Addison Wesley Longman, Third Edition, 1997
2. C. R. Kothari, "Research Methodology: Methods and Techniques", New- Age International, 2008
3. S. Usharani, "Analytical Chemistry", first edition, Mcmillan, India Ltd, 2000.
4. Vogel's Text Book of Practical Organic Chemistry by Furiniss, Harnaford, Smith, Talchall, VII Edition 2010

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1			3		1			3		2
CO2			2					1	3	
CO3	1			3				2	2	
CO4			2		3			2		3
CO5			2			3			1	3
CO6	1			2			2	1	3	

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20CH3024	Applied Polymer Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. know the classification and mechanism of polymer formation
2. understand the characterization techniques used in polymer chemistry
3. know concepts of polymer Nanocomposites.

Course Outcomes:

Student will be able to

1. acquire the basic knowledge about polymers.
2. know the Synthesis of various polymers, properties and choose the methods for characterizing the polymer.
3. understand the thermal and mechanical properties of various polymers.
4. develop various fabrication techniques.
5. understand the filler-matrix interaction .
6. recognize the importance and applications of nanofillers.

Unit 1: Fundamental Concepts of Polymers (9 Hours)

Polymers - Classification of polymers - functionality- polymers tacticity – interpenetrating network - structure property relationships – naturally occurring polymers – polysaccharides – cellulose and proteins – polymerization reactions – Bio polymers – introduction. Calculation based on functionality and Tacticity.

Unit 2: Principles and Mechanisms of Polymerization(9 Hours)

Principles and mechanisms of polymerization - Addition, step growth polymerization and coordination polymerization (Zeigler-Natta)- reactivity of functional groups – Carothers equation – Characteristics of step growth polymerization – examples – mechanisms – co-polymerization – monomer reactivity – composition - types.

Unit 3: Number Average and Molecular Weight Determination methods (9 Hours)

Polymer stereochemistry – amorphous, crystalline Glass transition temperature – viscosity – thermal behaviour of polymers – T_g , T_m and their relationship – elastic effect of polymers - Calculation of Molecular weight and number average in polymers.

Unit 4: Polymerization Process (9 Hours)

Bulk, solution, emulsion and suspension – industrially important polymers and their processes – polyethylene – polystyrene – Nylon 6,6 – PET – Inorganic polymers – polyphosphazenes, sulphur based inorganic polymers – Elastomers – GRA, GRM, GRP, hypalon, Natural Rubber Vulcanization of rubber– Moulding processes – Injection, compression – Preparation of simple polymers in Lab scale.

Unit 5: Fabrication of Nanopolymers (9 Hours)

Introduction – Casting of films – Calendaring – hand lay-up and filament winding techniques - Polymer additives –Ablazing - Spinning – Melt, Dry, Wet and Cold Drawing - Introduction to polymer Nano composites – Clay, CNT Advantages and limitations of nanofillers– Applications of polymer Nanocomposites – packaging, automotive, mechanical components.

Reference Books:

1. V.R. Gowariker, N.V. Viswanathan, N.V.JayadevSreedhar, “Polymer Science”, I edition, New Age International Publishers Pvt. Ltd., New Delhi, 2008.
2. G.S. Misra, “Introductory Polymer chemistry”, New Age International Pvt. Ltd., 2008
3. Anil Kumar and Rakesh K. Gupta, “Fundamentals of polymer engineering” Tata McGraw Hill Publication Ltd., New Delhi, 2003 (revised and expanded edition)
4. R.J. Young, P.A. Lovell, “Introduction to polymers” Stanley Thomas Publishers, London, 2000
5. P. Bahadur, “Principles of polymer science”, Alpha Science International Ltd., 2nd Edition, 2005.
6. G. Odian, “Principles of Polymerisation”, IV Edition, Wiley Student Edition, New Delhi, 2007.
7. M.G. Arora, M. Singh and M.S. Yadav, “Polymer Chemistry” II revised Edition, Anmol Publications Pvt. Ltd., 2003

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	2	2	1	-	-	2	2	1	2
CO2	3	3	2	2	1	1	1	3	2	1
CO3	-	1	1	1	1	2	3	1	2	3
CO4	1	2	2	3	3	3	2	2	2	1
CO5	1	1	1	2	2	1	1	2	1	2
CO6	1	1	2	2	1	3	3	1	3	3

“3”– High; “2”– – Medium ; “1”– - Low ; “-”– No correlation

20CH3025	Laboratory Chemistry for the daily life	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. make the student familiar with ayurvedic products in daily life
2. encourage students to develop curiosity towards the preparation of lab scale cosmetics, household chemicals etc.,
3. acquire knowledge about glass science like blowing, etching and engraving.

Course Outcomes:

Student will be able to

1. formulate ayurveda tooth paste/powder, mouth wash
2. prepare instant natural head ache relief bam and dish wash powders/bath bombs
3. lip balm from vegetable extracts and preparation of phenyl, hand sanitizer & disinfectants
4. glass blowing/fusion, engraving and itching techniques in day today chemistry labs.
5. learn the procedures for preparing natural insect repellent spray/ointment /oil
6. learn the techniques involved in preparation of homemade.

List of Experiments

1. Preparation of phenyl & washing powder.
2. Preparation of Natural Mosquito repellent oil
3. Preparation of Soap
4. Preparation of Head ache Bam
5. Preparation of Ayurvedic tooth powder
6. Preparation of natural lip Bam
7. Preparation of Alcohol based Hand sanitizer (Liquid/Gel)
8. Preparation of Bath bombs
9. Glass Welding technology (Glass fusion/Pending/Etching/Engraving)
10. Preparation of Ayurvedic Mouth Wash.
11. Preparation of Candle (Natural Essential Oil)
12. Identification of Adulterants in Food stuffs – simple experiments.

(Minimum 10 experiments to be completed)

References:

1. Surfactants, Disinfectants, Cleaners, Toiletries, Personal Care Products Manufacturing and Formulations by NPCS Board of Consultants & Engineers, NIIR Project Consultancy Services, 2016
2. Modern Technology of Soaps, Detergents & Toiletries (with Formulae & Project Profiles) 4th Revised Edition, P. K. Chattopadhyay, NIIR Project Consultancy Services, 2016

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	2	3	3	3	2	2	2	2	3
CO2	2	2	3	3	2	3	2	2	2	3
CO3	3	2	2	3	2	3	1	3	3	3
CO4	2	2	1	2	2	3	2	2	2	2
CO5	1	2	2	2	1	2	3	2	2	3
CO6	1	1	2	2	1	1	2	1	1	2

“3” – High; “2” – Medium; “1” – Low; “-” – No correlation

20CH3026	Forensic Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. know the methods of analyzing trace amounts of petroleum products in crime scene evidence.
2. get the knowledge about cases involving arson and chemistry of explosives
3. know about the classification and characteristics of the narcotics, drugs, psychotropic substances and alcoholic beverages

Course Outcomes:

Student will be able to

1. understand the types of petroleum products and their analysis
2. know about conditions for fire and scientific concept of evaluation of clue materials
3. understand the classification and composition of important explosive substances
4. learn the characteristics of narcotics, drugs, psychotropic substances and alcoholic beverages
5. know about testing of narcotics, drugs and psychotropic substances
6. learn the importance of analyzing narcotics, drugs and psychotropic substances.

Unit 1: Petroleum and Petroleum Products (9 Hours)

Petroleum products: types, by products, uses and importance - Examination of petroleum products: distillation and fractionation-Commercial uses of petroleum - Standard methods of analysis of petroleum products for adulteration -Scope, importance and forensic importance of analysis for the adulterants in petroleum products.

Unit 2 : Cases Involving Arson (9 Hours)

Chemistry of fire - Conditions for fire - Fire scene patterns. Location of point of ignition - Recognition of type of fire - Searching the fire scene - Collection and preservation of arson evidence - Analysis of fire debris - Analysis of ignitable liquid residue - Post-flashover burning - Scientific investigation and evaluation of clue materials - Information from smoke staining

Unit 3: Explosives (9 Hours)

Introduction, classification, composition and characteristics - Synthesis and actions of explosives (TNT, PETN and RDX, IED) - Explosion process and affect types of explosions, post blast residue collection - Examination of explosion residues in laboratory (chemical and instrumental).

Unit 4: Narcotics, Drugs, Psychotropic Substances and Alcoholic Beverages – I (9 Hours)

Definition of narcotics, drugs and psychotropic substances - Broad classification – Narcotics, stimulants, depressants and hallucinogens - General characteristics and common example of each classification - Natural, synthetic and semi-synthetic narcotics, drugs and psychotropic substances - Designer drugs - Tolerance, addiction and withdrawal symptoms of narcotics, drugs and psychotropic substances - Crime scene search for narcotics, searching a vehicle.Clandestine drug laboratories - Collection and preservation of drug evidence.

Unit 5: Narcotics, Drugs, Psychotropic Substances and Alcoholic Beverages – II (9 Hours)

Testing of narcotics, drugs and psychotropic substances- thin layer chromatography, gas – liquid chromatography and high performance liquid chromatography - Presumptive and screening tests for narcotics, drugs and psychotropic substances in breast milk, saliva, urine, hair and antemortem blood - Drugs and driving - Dope tests - Analysis of narcotics, drugs and psychotropic substances in postmortem blood - Postmortem changes affecting the analysis of narcotics, drugs and psychotropic substances.

Text Books:

1. A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, Scientific Evidence in Civil and Criminal Cases, 4th Edition. The Foundation Press, Inc., New York, 1995.
2. B.R. Puri, L.R. Sharma and K.C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi, 2007.
3. J R Almirall, K G Furton, Fire scene evidence, CRC Press, 2004.
4. Fred Smith, Jay A. Siegel, Handbook of Forensic Drug Analysis, Elsevier Academic Press, 2004.
5. F.G. Hofmann, A Handbook on Drug and Alcohol abuse, 2nd Edition, Oxford University Press, New York, 1983.

Reference Books:

1. W.J. Tilstone, M.L. Hastrup, C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton, 2013.
2. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey, 2004.
3. S. Ballou, M. Houck, J.A. Siegel, C.A. Crouse, J.J. Lentini, S. Palenik, Forensic Science, D.H. Ubelaker (Ed.), Wiley-Blackwell, Chichester, 2013.
4. J.D. DeHaan, Kirk's Fire Investigation, 3rd Edition, Prentice Hall, New Jersey, 1991.
5. S.B. Karch, The Pathology of Drug Abuse, CRC Press, Boca Raton, 1996.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1	1	1	-	-	1	1	2	3
CO2	-	-	-	1	-	1	1	1	1	1
CO3	1	-	1	1	-	1	1	1	2	1
CO4	1	1	-	1	-	-	-	1	1	2
CO5	1	1	-	1	-	-	-	1	1	2
CO6	1	1	-	1	-	1	1	1	1	2

"3" – High; "2" – Medium; "1" – Low; "-" – No correlation

20CH3027	Advanced Photo and Electrocatalysis	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basics of photochemistry
2. get the knowledge about organocatalysis and organometallic-photocatalysis.
3. know about electrocatalysis and its application

Course Outcomes:

Student will be able to

1. understand the fundamentals of photochemistry and photocatalysis
2. describe organo-photocatalysis
3. illustrate organometallic photocatalysis
4. understand the fundamentals of electrocatalysis
5. apply electrocatalysis in various fields
6. illustrate the applications of photo-electrocatalysis

Unit 1: Photochemistry and Photocatalysis-Fundamentals (9 Hours)

Photochemical energy-Excited states, modes and dissipation of energy-Energy Transfer-Inter- and intramolecular energy transfer-Photo induced electron transfer-Quenching process-Oxidative and Reductive quenching-Quantum Efficiency and Excited State Lifetime.

Unit 2: Organo-Photocatalysis (8 Hours)

Organic Photosensitizer-Photo-redox catalysis-examples-Rose Bengal, Eosin Y, Mes-acridinium mediated photocatalytic organic transformations-Photocatalytic aerobic oxidation-Photoinduced radical chain polymerizations.

Unit 3: Organometallic-Photocatalysis (10 Hours)

Various transition metal-based complexes as photosensitizers and photocatalysts-Photocatalytic CO₂ reduction and water splitting-Photocatalytic C-C, C-N and C-O bond formations.

Unit 4: Electrocatalysis-Fundamentals (9 Hours)

Electrode materials-Standard hydrogen electrode, glassy carbon electrode-Hg and Pt electrodes-Various factor influencing electrolysis-Solvent Effect-Catalyst Effect-Electrolytes-Calculation of Current efficiency and current density-Overpotentials.

Unit 5: Electrocatalysis-Advanced Applications (9 Hours)

Homogeneous electrocatalysis-Various transition metal-based complexes as homogeneous electrocatalysts-Heterogeneous electrocatalysis-Modified Electrodes-Electrocatalytic CO₂ reduction and water splitting-Electrocatalytic carbonyl and imine reductions-Photo-electrocatalysis-Applications.

Text books:

1. B. König, Science of Synthesis: Photocatalysis in Organic Synthesis, Thieme, 2019, Verlagsgruppe, Stuttgart, New York, Delhi, Rio.
2. H. Ishida, "Electrochemical/Photochemical CO₂ Reduction Catalyzed by Transition Metal Complexes", Chapter 2, IntechOpen, 2018, DOI: 10.5772/intechopen.75199.
3. R. Ameta, S. C. Ameta, "Photocatalysis: Principles and Applications", CRC Press, Taylor & Francis Group, 2017.
4. N. Chouhan, R.-Shi Liu, J. Zhang, "Photochemical Water Splitting: Materials and Applications", CRC Press, Taylor & Francis Group, 2017.
5. M. M. Mukherji, S.P. Singh, "Reaction Mechanism in Organic Chemistry", Macmillan Publishers, 3rd Edition, Reprinted, 2010.
6. M. Aresta, "Carbon Dioxide as Chemical Feedstock", Wiley-VCH Verlag GmbH & Co. KGaA, 2010.
7. K. K. Rohatgi Mukherjee "Fundamentals of photochemistry", New Age International Pvt. Ltd., New Delhi, 2009.
8. S. Glasstone, "An introduction to Electrochemistry", East-West Press Private Limited, New Delhi, Reprint 2017.
9. M. M. Baizer, "Organic electrochemistry", Dekker Inc. New York, 2016.
10. John O'M. Bockris, Amulya K. N. Reddy, "Modern Electrochemistry Vol. I and II", Plenum Publishing, 2008.
11. B. Viswanathan, M. Aulice Scibioh, "Photoelectrochemistry: Principles and Practices", Alpha Science International Ltd, 2014.

20CH3028	Medicinal Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn the principles of drug design and metabolism of current importance.
2. elucidate the enzyme structure and comprehend DNA-drug interactions
3. describe and apply the importance of antibiotics and cardiovascular diseases

Course Outcomes:

Student will be able to

1. comprehend the basic principles of drug metabolism and pharmacokinetics
2. understand the biochemical and physiological effects of drugs through pharmacodynamics.
3. build knowledge on the drug design with their classification and their recent developments
4. acquire the importance of various enzyme structure elucidation & dna-drug interactions
5. describe the classification of various antibiotics and their mode of action
6. discuss various cardiovascular diseases, mode of action of cardiovascular drugs and their side effects.

Unit 1: Introduction (9 Hours)

History of medicinal chemistry, general mechanism of drug action on lipids, carbohydrates, proteins and nucleic acids, drug metabolism and inactivation, receptor structure and sites, drug discovery development, design and delivery systems, gene therapy and drug resistance.

Unit 2 - Drug Metabolism (9 Hours)

Introduction, oxidation, reduction, hydrolysis, conjugation, Pharmacokinetics: Drug Absorption, drug distribution, drug elimination, drug disposition, pharmacokinetic parameters, uses of pharmacokinetics in drug development process, Pharmacodynamics: Enzyme stimulation, inhibition, sulphonamides, membrane active drug, biotransformation, xenobiotics.

Unit 3 - Drug Design (9 Hours)

Development of new drugs, Procedures followed in drug design, Concepts of lead compound and lead modification, Concepts of pro-drugs and soft-drugs, Factors affecting bioactivity, Resonance, Inductive effect, Isosterism, Bio-isosterism, Spatial considerations. Clinical testing and synthesis of drugs - Various phases in preclinical testing and clinical trials –Theories of drug activity: Occupancy theory, Rate theory,

Induced fit theory. Quantitative structure activity relationship (QSAR) - testing drugs in vivo – therapeutic index and therapeutic ratio

Unit 4-Elucidation of enzyme structure& Interactions (9 Hours)

Mechanism, kinetic, spectroscopic, isotopic and stereochemical studies. Chemical models and mimics for enzymes, design, synthesis and evaluation of enzyme inhibitors. DNA-protein interaction and DNA-drug interaction. Concepts of drug receptors. Elementary treatment of drug receptor interactions. Physico-chemical parameters: Lipophilicity, Partition coefficient, electronic ionization constants. LD-50, ED-50

Unit 5 - Antibiotics and Cardiovascular drugs(9 Hours)

Introduction and classification, synthesis uses and side effects of antibiotics (a) penicillin-V (b) penicilline–G (c) cephalosporin - mode of action of penicillin and cephalosporin. Cardiovascular diseases, arteriolar dilators, diuretics, adrenergic receptor blockers, synthesis mode of action, uses and side effects of cardiovascular drugs,

Reference Books

1. D.J.Abraham. Burgers medicinal chemistry and drug discovery, Wiley, 6th edition, 2003.
2. R. B. Silverman. The organic chemistry drug design and drug action, Academic Press, 3rd edition, 2014.
3. A.Gringuage. Introduction to medicinal chemistry-how drugs act and why, Wiley-VCH, 1934.
4. William O. Foye. Thomas L. Lemice and David A.Williams, Principles of Medicinal Chemistry, Wiley-VCH, 7th edition, 2002.
5. Graham L. Patrick. An Introduction to Medicinal Chemistry, Oxford, 6th edition, 2017.
6. AshutoshKar. Medicinal Chemistry, New Age International, 3rd edition, 2005.
7. Pandeya, S.N., and Dimmock, J.R., An Introduction to Drug Design, New Age International (2008).
8. Abraham, D.J., and Rotella, D.P., Burger's Medicinal Chemistry and Drug Discovery, Vol-1, Ed. John Wiley & Sons (2010) 7thed.
9. I. Wilson, Giswald and F. Doerge, Text Book of Organic Medicinal and Pharmaceutical Chemistry, J.B. Lippincott Company, Philadelphia, 1971.

20CH3029	Photophysical Chemistry	L	T	P	C
		3	0	0	3

Course Objectives :

Enable the student to

1. acquire knowledge of photochemistry and photophysical principles
2. learn the importance of theory of photoreactions and kinetics of reactive intermediates
3. describe and apply the importance of photophysical principles on simple and macromolecules

Course Outcomes :

Student will be able to

1. comprehend the photochemistry and photophysical principles
2. explain the mechanisms of electronically excited states molecules through various concepts
3. build knowledge on the identification and characterization of transient intermediates by ultrafast modern techniques
4. acquire the importance of the theory of photoreactions
5. describe the kinetics of reactive intermediates
6. apply the photochemistry and photophysical principles on simple and macromolecules

Unit 1 - Principles and Concepts (9 Hours)

Laws of photochemistry, Atomic and molecular term symbols, Electronic transitions, Jablonski diagram and photophysical processes, Radiative transitions, Absorption and emission, Absorption coefficient, Phosphorescence, Intersystem crossing, Mechanisms of singlet-triplet conversion (spin-orbit coupling), Spin rephasing, Spin flip, Importance of electron jump between perpendicular orbital's, heavy atom effect, Examples of ISC between states of different configurations, Radiative rates, Radiationless transitions, Internal conversion, Energy gap law, Deuterium effect.

Unit 2 - Electronically Excited States (9 Hours)

Electronic, Vibrational and spin configurations, Excited state lifetime, Steady state and time resolved emission, Factors affecting excited state energy, Solvent effect, TICT, Origin of energy difference

between singlet and triplet states, Excited state kinetics, Quantum yield expressions, Excimer and exciplex, Kinetics of luminescence quenching, Static and dynamic, Stern-Volmer analysis, Deviation from Stern-Volmer kinetics, Photoinduced electron transfer rates, Free energy dependence of electron transfer on rate, Photoinduced energy transfer, FRET, ESPIT, TBET, Rate and efficiency calculation of FRET. Fluorescence sensing of Analytes

Unit 3 - Theory of Photoreactions (9 Hours)

Visualization of reactions on excited state surfaces, Minima, Funnels and conical intersections.

Unit 4 - Identification of Minima on Excited State Surfaces (9 Hours)

Surface touching, Cleavage of s and p bonds, Diradicals, Salem diagrams, Photochemical generation and excited state reactions of reactive intermediates (carbenes, nitrenes, radicals, diradicals, and carbocations).

Unit 5 - Applications of Photochemistry and Photophysical principles (9 Hours)

Measurement of fluorescence and phosphorescence and lifetimes, Introduction to time-resolved techniques for absorption and emission measurements, Detection and kinetics of reactive intermediates, Photochromic reactions and memory devices, Sensors, Switches and molecular machines, TiO₂ photocatalysis, Photosynthesis (plants), Intermediates in photoreactions, Identification and characterization through modern techniques, Flash photolysis, CIDNP, Photoacoustic, Stepscan IR.

References

1. Lakowicz, J. R., Principles of Fluorescence Spectroscopy, Springer, New York (2006), 3rd ed.
2. Kavarnos, G. J., Fundamentals of Photoinduced Electron Transfer, VCH publishers Inc., New York (1993).
3. Valeur, B., Molecular Fluorescence: Principles and Applications, Wiley-VCH Verlag GmbH, Weinheim (2002).
4. Turro, N. J., Ramamurthy, V., and Scaiano, J. C., Modern Molecular Photochemistry of Organic Molecules, University Science, Books, CA (2010).
5. Ninomiya, I., and Naito, T., Photochemical Synthesis, Academic Press, New York (1989)

20CH3030	Bioanalytical Chemistry and Biosensors	L	T	P	C
		3	0	0	3

Course Objectives :

Enable the student to

1. learn the structure and functions of biomolecules.
2. study the principle and application of electrophoresis and centrifugation
3. describe and apply immunological methods and biosensors for identification and determination

Course Outcomes :

Student will be able to

1. Comprehend the basic structure and functions of certain biomolecules
2. Understand the principle and application of electrophoresis
3. Build knowledge on the principles of centrifugation and types
4. Operate flow cytometry and apply for practical samples
5. Acquire the importance of various immunological methods and their applications
6. Able to construct biosensor for various biological molecules

Unit 1 - General principle (9 Hours)

Introduction - Sampling in biosystems, Biomolecules - lipids, proteins, amino acids, Nucleic acids, enzymes, carbohydrates – structure and functions with specific Examples

Unit 2 - Principle and application of electrophoresis (9 Hours)

principle of electro separation, types of electrophoreses, Instrumental electrophoresis applications of both charged and uncharged species. Protein purification and sequencing methods. Mass spectrometric methods for quantification of biomolecules of high molecular weights.

Unit 3 - Centrifugation and separation (9 Hours)

Isolation of biomolecules, basic principles of centrifugation, types of centrifugation methods for biomolecules, Microcentrifuges, High-speed centrifuges, Fractionation process, Ultracentrifugations, Density Gradient Centrifugation, Differential Centrifugation Flow cytometry, principles and applications.

Unit 4 - Immunological methods (9 Hours)

Immunoassays types, enzyme assay methods - fluorescence immune-labeling; enzyme-linked immunosorbent assays (ELISA); immunomagnetic assays; Western immunoblotting assays; immunoaffinity chromatographic assays; immunocytological assays; immunoprecipitation assays; and lateral flow immunoassays and Radioimmuno methods (RIA) - biological tracers and biomarkers - immunosensors. Current applications of immunological methods

Unit 5 - Sensors for identification and determinations (9 Hours)

Biosensors - enzyme, immunochemistry, nucleic acids, biomimetic receptors, construction of biosensors, nanotechnology, biosensor detection systems, characteristics and analytical applications of biosensors.

References

- 1 Understanding Bioanalytical chemistry-principle and applications, Victor A Gault, Neville H McClenaghan, Wiley Blackwell, 2009.
- 2 Bioanalytical Chemistry, David J Holme, Hazel Peck, Prentice hall, 3rd Edn., 2000
- 3 Analytical Biochemistry, Andreas Manz, Petrus Dittrich, Nicole Pamme, Dimitrios Iossifiedis, Imperial College Press, 2nd Edn., 2015.
- 4 Bioanalytical chemistry, Susan R Mikkelsen and Eduard Corton, Wiley, 2004.

20CH3031	Nanomaterials Synthesis and Characterization	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the chemistry behind the nanomaterials synthesis
2. learn the characterization techniques for nanomaterials
3. get thorough knowledge about the application based nano-sized materials

Course Outcomes:

Student will be able to

1. recognize major classes of nanomaterials and chemistry behind.
2. describe relationships among structure & composition, physical & chemical properties.
3. analyze the sustainability of nanomaterials processing and applications.
4. apply appropriate laboratory techniques to process nanomaterials, determine their properties.
5. synthesis dimension-based nanomaterials and characterization
6. create the application based innovative nanomaterials

Unit 1: Introduction of Nanomaterials: (9 Hours)

Introduction: Nanoscale Science and Technology-Implications for Physics, Chemistry, Biology and Engineering; Classifications of Nanostructured materials, nano particles; Zero-dimensional, one-dimensional and two-dimensional nanostructures, size dependent properties – quantum confinement – optical properties - specific heat and melting point- mechanical properties – super plasticity - plastic deformation of ceramics - nanoceramics - catalytic properties.

Unit 2: Synthesis of Nanomaterials: (9 Hours)

Synthesis of nanomaterials - bottom-up and top-down approaches - nanoparticles - colloidal technique - homogeneous and heterogeneous nucleation - synthesis of metallic and semiconductor nanoparticles - stabilization of nanoparticles - sonochemical method-synthesis and properties of core-shell nanoparticles. Nanowires and nanorods - spontaneous growth - vapor-liquid-solid growth – template-based synthesis – nanostructured films - self-assembly - molecular self-assembly in solutions – self assembly of nanoparticles - Langmuir-Blodgett films - electrochemical deposition. Synthesis of bulk nano structured materials - Sol Gel processing- bulk and nano composite materials - Grinding - high energy ball milling – injection moulding - extrusion - melt quenching and annealing. Preparation methods: Bottom-up Synthesis-Top-down Approach: Precipitation, Mechanical Milling, Colloidal routes, Self-assembly, Vapor phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

Unit 3: One dimensional and Two dimensional nanostructures: (10 Hours)

Nanowires and Nanotubes: Evaporation-condensation - Vapor- liquid - solid (VLS) - surface and bulk diffusion – kinetics – growth of various nanowires –control of size –precursors and catalysts - single- and multi- wall CNT - Si nanowires – density and diameter – doping in nanowires - Carbon nanotube (CNT)

and its Applications: Carbon nanotube (CNT), structure of CNT, synthesis and functionalization of CNT, electronic, vibrational, mechanical and optical properties of CNT; applications of CNT and Fullerenes. - Graphene and its Functionalization: Graphene, structure of Graphene, synthesis and functionalization of Graphene, electronic application of Graphene, Electrochemical deposition, Graphene Oxide. Fullerenes - graphene - carbon nanotubes (CNTs) - SWCNT- MWCNT – synthesis - methods of opening, filling and purifying carbon nanotubes – geometrical structure of CNTs – electronic structure of CNTs – metallic and semiconducting CNTs – CNTFETs – CNT circuits - prospects of all-CNT nanoelectronics.

Unit 4: Advanced Characterization of Nanomaterials: (9 Hours)

Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy, Optical Absorption and Emission Spectroscopy, Thermogravimetric Analysis, Differential Scanning Calorimetry, Thermo mechanical Analysis, X-Ray, neutron diffraction. interpretation of results of – XRD – XPS - AES – EDS - SEM - STM – AFM – TEM - HRTEM - BET surface area and porosimetry - UV-Vis - FTIR and Raman spectroscopy - Thermal analysis – TGA, DTA and DSC. Self assembly-Self Assembled Monolayers (SAM) - Vapour Liquid Solid (VLS) approach - Chemical Vapour Deposition (CVD) - Langmuir-Blodgett (LB) films - Spin coating - Templated self assembly Electrochemical approaches: Thin films -Epitaxy –Lithography - Working Principles.

Unit 5: Applications of Nanomaterials: (8 Hours)

Dimension, Size and Shape based Applications –Energy materials – Biological and Environmental Applications – Nanomaterials in Healthcare - Nanomaterials for Day-to-day applications.

References:

1. W. Gaddand, D. Brenner, S. Lysherski and G. J. Infrate (Eds), Handbook of nanoscience, Engg. and Technology, CRC Press, 2002.
2. G. Cao, Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperial College Press, 2004.
3. J. George, Preparation of thin films, Marcel Dekker, Inc., New York, 2005.
4. C. N. R. Rao, A. Muller, A. K. Cheetham (Eds), The chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag GmbH & Co, Weinheim, 2004.
5. Physical properties of Carbon Nanotube-R Satio
6. Applied Physics of Carbon Nanotubes : Fundamentals of Theory, Optics And Transport Devices - S. Subramony & S.V. Rotkins
7. Nanotubes and Nanowires- CNR Rao and A Govindaraj RCS Publishing 10. Nanoscale materials -Liz Marzan and Kamat
8. Carbon Nanomaterials for Environmental and Biological Applications, Bergmann and Machado., Springer.
9. Introduction to Nanotechnology- Charles P Poole & Frank J. Ownes.

20CH3032	Stereoselective Synthesis	L	T	P	C
		3	0	0	3

Course objectives:

Enable the student to

1. classify the types of asymmetric synthesis
2. emphasize the substrate and reagent control of stereoselectivity in an asymmetric reaction
3. design asymmetric reactions of synthesizing new chiral compounds

Course outcomes:

The students will be able to

1. compare the types of asymmetric synthesis
2. predict the substrate and reagent control of stereo selectivity in an asymmetric reaction
3. summarize the types of chiral reagents
4. acquire knowledge on asymmetric synthesis using chiral pool methodology
5. apply the methodology of utilizing chiral auxiliaries in asymmetric synthesis
6. analyze the methods and merits of various types of chiral catalysis

Unit 1: Introduction to asymmetric synthesis (9 Hours)

Enantioselectivity and diastereoselectivity, importance of asymmetric synthesis, conditions for an efficient asymmetric synthesis, Types and strategies in asymmetric synthesis- advantages and limitations of each

strategy, enantioconvergent Synthesis, resolving agents and resolution of common functional groups, analytical methods for determining enantiomeric excess.

Unit 2: Substrate and reagent control of stereoselectivity (9 Hours)

Asymmetric synthesis with chiral substrates: Nucleophilic addition to α –chiral carbonyl compounds, Electrophilic addition to α – chiral olefins - epoxidation, cyclopropanation, hydroboration – oxidation, alkylation of enolates of β -chiral carbonyl compounds. Asymmetric synthesis using chiral reagents: Chiral organo boranes, - application in hydroboration, reduction and allylation reactions, Chiral lithium aluminium hydride application in reduction of prochiral ketones, Michael addition to α , β – unsaturated carbonyl compounds, chiral lithium amides.

Unit 3: Asymmetric synthesis using chiral pool methodology (9 Hours)

Types of chiral pools, Amino acid and sugar derived asymmetric syntheses, enantiomeric scaffolding, Double stereo differentiation Matched pair and mismatched pair example from aldol reaction and hydroboration reactions, enantioselective and diastereoselective additions.

Unit 4: Asymmetric synthesis using chiral auxiliary (9 Hours)

Champhor derived auxiliaries, menthol derived auxiliaries chiral pyrrolidines, oxithiane, oxazolidine-2-one, oxazoline, 2-phenylcyclohexanols, 8-phenylmenthol, *chiral* (S)-1-amino-2-methoxymethylpyrrolidine (SAMP), chiral (R)-1-amino-2-methoxymethylpyrrolidine (RAMP), hydrazones- selected examples.

Unit 5: Asymmetric synthesis using chiral catalyst (9 Hours)

Organometallic catalysts, Hydrogenation catalyst, Sharpless epoxidation catalyst, semicorin catalyst, Jacobson catalyst, selected reactions. Organo catalysts: Chiral amino acid derived compounds, tertiary amines, phosphanes, phosphoramides, ureas amidines, imines, diols, sulphides in asymmetric reactions – selected examples.

Text books:

1. Stereochemistry of Organic Compounds by Ernest L. Eliel, Samuel H. Wilen, Lewis N Mander, Wiley student edition 2010, New Delhi: Wiley India
2. Catalytic Asymmetric Synthesis: Iwao Ojima, 3rd edition 2010, Wiley.

Reference books:

1. Robert Gawley and Jeffry Aube, Principles of Asymmetric Synthesis, 2nd edition, Elsevier 2012.
2. B. List, Benjamin (Ed.) Asymmetric Organocatalysis, Topics in Current Chemistry book series Springer 2009
3. E. N, Jacobsen, A. Pfaltz, H. Yamamoto, Comprehensive Asymmetric Catalysis Eds. Springer 2004.
4. H. B. Kagan, Aymmetric Synthesis, Thieme Medical Publishers, Ist Edition., 2003.
5. G. Q. Lin, Y. Li and A. S. Cchan Principles and applications of asymmetric synthesis, Wiley-Interscience 2001.
6. Daniel J. O'Leary, Methods for the Asymmetric Synthesis of Complex Organic Molecules, Lecture Notes 2001.

20CH3033	Chemistry of Biofuels	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the students to

1. learn the types of biodiesel sources
2. understand the processes to convert biodiesel from various sources.
3. describe about the physical and chemical properties of biodiesel and engine performance.

Course Outcomes:

The student will be able to

1. understand the various alternative fuels available.
2. prepare biodiesel and analyze its performance.
3. analyze the biodiesel based on physical and chemical parameter.
4. develop new catalyst and method for biodiesel preparation
5. understand the current research scenario in biodiesel.
6. design a biodiesel plant.

Unit 1: Energy Demand: (9 Hours)

Energy crisis – conventional – non conventional energy - crude oil production – importance of Biodiesel – chemical structure - Biomass feedstock - Bio-ethanol – Biodiesel - Classification of waste as fuel – Conversion devices – pyrolysis, gasifiers, digestors.

Unit 2: Biodiesel and its production (9 Hours)

Various vegetable oils and their important properties - waste vegetable oil and animal fat characteristics – fatty acid composition – oil extraction – oil refining process – types of Transesterification – Acid - Base catalysis mechanism – Application.

Unit 3: Biodiesel Characterization (9 Hours)

Free fatty acid – Kinematic Viscosity – Acid Value – Cloud and Pour Point – moisture content – peroxide value – carbon residue – saponification value – Gas chromatography – Fatty acid methyl ester value – Rancidity.

Unit 4: Green Methodologies for Biodiesel Production (9 Hours)

Catalysts - Preparation of heterogeneous nano based catalyst – Layered Double Hydroxide (LDH) – Metal oxides – Nano composites - waste materials as catalyst – Enzyme catalyst - characterization – XRD – SEM - Properties – Microwave assisted synthesis of biodiesel – different parameter - Frequency – Time – concentration – catalyst ratio - Ultrasound assisted synthesis of biodiesel – Pulse mode – Continuous mode – different parameter.

Unit 5: Biodiesel storage and stability (9 Hours)

Advantages – disadvantages – oxidation of biodiesel – Antioxidants – Natural antioxidants – Storage stability – ASTM methods – oxidation stability – induction time - Performance in engines – Emission characteristics in diesel engines.

References:

1. R. Navanetha krishnaraj, Jong- sung Yu, Bio Energy – Opportunities and Challenges, pp. 241-276, CRC Press, Taylor & Francis Group. ISBN – 13: 978-1-4987-2205-6. 2014
2. Ayhan Demirbas, Biodiesel A Realistic Fuel Alternative for Diesel Engines, Springer-Verlag London Limited 2008, ISBN-13: 9781846289941
3. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, The Biodiesel Handbook, AOCS Press Champaign, Illinois 2005.
4. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers, 1997. ISBN 0-76-80-0052-1.
5. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
6. Introduction to Biomass Energy Conversions, Sergio C. Capareda, CRC press, Taylor & Francis, 2014.
7. Non Conventional Energy Resources, G.D. Rai, 8th reprint, Khanna Publisher, 2013.

20CH3034	Glass Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn the composition of glass and techniques to determine the glass fractures
2. learn the techniques to match glass fragments and various techniques in determining the composition of Glass
3. examine the quality of the glass in practical studies and future glasses.

Course outcomes:

Student will be able to

1. understand the history of glasses in forensic field.
2. know the glass fracture examination.
3. investigate glass densities and recovery of glass pieces.
4. select appropriate instruments for analyzing the glass and complex mixture
5. analyze various studies of glass by using spectroscopic techniques.
6. choose special type of glasses for different applications.

Unit 1: Fundamental of Glass and its history(9 Hours)

Glass – introduction – composition – types – history of glass – Properties of glass (optical and Non Optical) – Physical, Chemical, Optical properties - Glass and its heat response – Laboratory glass – Distillation (Ancient (Greek & Arabic) – present – Future) – Forensic Glass and its various tests.

Unit 2: Glass Fractures and its Analysis (9 Hours)

Glass Fractures – Types (Compressive, Tensile, Shear) – Characteristic of Glass Fractures - Industrial (Tempered – Windshield Glass- Laminated) – Laboratory (Borosilicate – Soda- Lead) – Analysis of various Hardness of Glass – Forensic Examination of Glass fractures with simple case studies.

Unit 3: Glass Evidence and investigation (9 Hours)

Glass density tests (Window, Pyrex, Leaded) – Gun Shot – Windshield Glass fragments – Glass (Evidence) collection of glass evidence (Recovery from Dry and Wet cloths) - Analysis of fragments – Direction of Force - 3R Rules (Radial Fracture, Right Angle, Reverse side of force) – Case studies.

Unit 4: Spectroscopic Studies on Glass (9 Hours)

Refractive index – Becke Line – Color – Elemental Analysis (Semi Quantitative Techniques – Xray Fluorescence, Scanning Electron Microscopy – Quantitative Techniques – Flameless atomic Absorption spectroscopy) – Oil Immersion Method – Emmons.

Unit 5: Special types of Glass in Forensic Medical Field (9 Hours)

Application and properties of Bullet Proof glasses – Swap Test Glasses (Polymeric) – Glass ceramic – Glass fibre – Chromatic Glasses – Optical glass – Float glass (Gorilla Glass) – Case studies based on bullet proof glasses and Swap test glasses.

Reference Books

- 1 The Forensic Analysis of Glass Evidence: Past, Present, and Future, Brooke Weinger Kammrath , Andrew C. Koutrakos , Meghan E. McMahon, John A. Reffner, Wiley - VCH Verlag GmbH & Co. KGaA , 2016.
- 2 Forensic science – Fundamentals and applications -Jay. A. Seigel, Wiley Blackwell, Academic press., edition 2012
- 3 Basic Principles of Forensic Chemistry - Khan, JaVed, Kennedy Thomas, Springer 2012.,
- 4 Forensic Examination of Glass and Paint: Analysis and Interpretation (Taylor & Francis Forensic Science Series) Edited by Brian caddy 2012
- 5 The third edition of Forensic science – basics -Jay. A. Seigel, KarthyMirokovits – Wiley Blackwell, third edition 2016, CRC press.
- 6 Forensic Interpretation of Glass Evidence- James michale Curran – Tacha Natalie – John S. Buckleton, Taylor and Francis, 2014
- 7 Materials Analysis in Forensic Science, Ist Edition, Max M. Hock, 2016, Academic Press.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2	2	1	-	-	1	2	2	2
CO2	2	1	2	2	1	2	1	2	1	1
CO3	1	2	2	3	1	2	1	3	2	2
CO4	2	2	2	1	2	1	2	2	1	1
CO5	1	2	1	2	2	2	-	2	2	1
CO6	2	1	2	1	2	2	1	3	2	1

“3”– High; “2”– – Medium ; “1”– - Low; “-”– No correlation

20CH3035	Applied Chemical Crystallography	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. discuss the bravais lattices and crystal systems
2. explain the principle and application x-ray diffraction
3. relate the principle and application of database and chemical crystallography

Course Outcomes:

Student will be able to

1. discuss the bravais lattices
2. relate the principle and application of x-ray diffraction

3. understand the different crystal growth methods
4. examine the principle and application of crystal systems
5. examine the principle and application of crystal symmetry
6. discuss the application and database of chemical crystallography

Unit 1: Bravais Lattices and Crystal Systems (9 Hours)

Introduction, fourteen space lattices, symmetry of the fourteen Bravais lattices, coordination or environments of Bravais lattice, Unit cell, Seven crystal systems, points, Lattice and Unit Cell Parameters

Unit 2: Crystal Symmetry (9 Hours)

Introduction, 1D symmetry, Concept of 2D symmetry and lattices, notations of symmetry elements, space groups in 2D, 3D lattices, 32 point groups and their notations. Diffraction and symmetry, symmetry operations, symmetry elements, proper rotations and improper rotations. Crystal symmetry and properties

Unit 3: X-ray Diffraction (9 Hours)

What are X-rays, generation and classification of X-ray, X-ray sources, diffraction of X-rays, Bragg's law. X-ray scattering from electrons, X-ray scattering from atoms, X-ray scattering from a unit cell, Laue's analysis of X-ray diffraction, Ewald's synthesis.

Unit 4: Crystal Growth and Evaluation (9 Hours)

Methods of crystal growth, identification of phases and morphologies, in-situ cryo crystallization, crystal growth under external stimuli, Protect your crystals, Solution methods, Sublimation, Fluid-phase growth, Solid-state synthesis. Evaluation- Microscopy, X-ray photography, Diffractometry. Crystal mounting- Standard procedures, Air-sensitive crystals, Crystal alignment.

Unit 5: Application and Database (9 Hours)

Intermolecular interactions, Molecular recognition, Self-assembly, Crystal engineering, Supramolecular synthon, Hydrogen-bond directed assembly, polymorphs, applications in pharmaceutical industry, Crystallographic databases.

Reference books:

1. Clegg, W.; Blake, A.J.; Gould, R.O.; Main, P. Crystal structure analysis: principles and practice, 2nd edition, Edited by William Clegg, Oxford University Press/International Union of Crystallography, 2002.
2. Wai-Kee Li, Gong-Du Zhou and Thomas C. W. Mak. Advanced Structural Inorganic Chemistry, Oxford University Press/International Union of Crystallography, 2008.
3. The Basics of Crystallography and Diffraction. Fourth Edition. By Christopher Hammond. IUCr Texts on Crystallography, IUCr/Oxford Science Publications, 2015.
4. Fundamentals of Crystallography (2nd Ed.) by C. Giacovazzo, Oxford University Press, USA, 2002

20CH3036	Chemistry of Carbenes	L	T	P	C
		3	0	0	3

Course Objectives

Enable the student to

1. learn the various methods to generate carbene intermediates
2. understand the reactions of metal carbenoids
3. realize the applications of inorganic carbenes in organic transformations

Course outcomes

The students will be able to

1. outline the preparation of carbene intermediate
2. explain the use of diazo compounds as precursor for metal carbenoids
3. demonstrate the reactions of metal carbenoids in insertion reactions
4. understand the cycloaddition and sigmatropic reactions of metal carbenes
5. explain the synthesis of nhc and its application in organic transformations
6. realize the application of organometallic carbene in organic transformations

Unit 1: Introduction to carbenes and carbenoids(9 Hours)

History, structure of carbene, 1,2-elimination, singlet and triplet, Reimer-Tiemann reaction, diazomethane preparation, from diazald, Esterification and methylation with CH_2N_2 , Reaction of carbene

with pyrrole, Ethyl diazoacetate from glycine ester, Regitz synthesis of diazo compound, Bamford Steven reaction. Wolf rearrangement and Arndt-Eistert reaction.

Unit-2: Reactions of metal carbenoids -I (9 Hours)

Insertion reactions of metal carbenoids, C-H insertion, intramolecular C-H insertion, mechanism, O-H insertion, N-H insertion, S-H insertion, Si-H insertion, cyclopropanation, cyclopropenation, reaction with aromatic ring

Unit 3: Reaction of metal carbenoids-II (9 Hours)

1,2 sigmatropic rearrangement and 2,3 sigmatropic rearrangement, intramolecular sigmatropic rearrangement, reaction of metal carbenoids with ketone, carbonyl ylide, 1,3-dipolar cycloaddition, intramolecular 1,3-dipolar cycloaddition, applications in synthesis of complex molecules

Unit 4: N-Heterocyclic carbenes (9 Hours)

Preparation and reactions – Imidazole based NHC, Thiazole based NHC preparation, Benzoin reaction, Stetter reaction applications and advantages over KCN, Intramolecular Stetter reaction. NHC based metal catalyst and their applications in organic transformations

Unit-5: Metal carbenes (9 Hours)

Grubb's catalyst-first and second generation catalyst, structure, ene metathesis, enyne metathesis and applications in macrolide synthesis- Tebbe reagent- Reaction with ester and amide, enol ether and enamine synthesis, Fischer carbene and Schrock carbenes, synthesis and reactions, metal carbynes from Fischer carbene

Reference Books

1. J. March. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 4th edn., Wiley Student Edition, John Wiley & Sons Asia Pvt. Ltd., 2005
2. Carey, F.A., and Sundberg. R. J, "Advanced Organic Chemistry Part – B: Reactions and Synthesis", Plenum Press, 2008
3. Clayden, J; Greeves, N; Warren, S. Organic Chemistry, 2nd edition, Oxford University press, 2012
4. Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.

20CH3037	Metal-Organic Framework Materials	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the students to

1. learn the theoretical and practical knowledge in the field of metal-organic framework materials.
2. Synthesize and characterize the metal-organic framework materials
3. Understand the potential use for environmental and energy applications.

Course Outcomes:

The students will be able to

1. understand the necessary competences for the preparation and implementation of MOF
2. predict the correct choice of characterization methods of the prepared materials,
3. determine the quantitative analysis of the measurements and interpretation of the results.
4. identify the correct MOF characterization and its functional groups
5. Apply knowledge to actual MOF applications in normal life
6. To Demonstrate an understanding of the MOFs with other porous and non-porous materials

Unit-1: Classification of Metal Organic Frameworks (9 Hours)

Introduction, Background and Ongoing Chemistry of Porous, Coordination Polymers, Frameworks with High Surface Area, Secondary Building Units (SBUs): The Design Principles of MOFs, Lewis Acidic Frameworks, Soft Porous Crystals, Multifunctional Frameworks, Porosity and Magnetism, Classification of metal-organic framework materials (MOFs) and large scale MOF Suppliers.

Unit-2: Synthesis of Metal Organic Frameworks (9 Hours)

Synthesis methods of MOFs-Preparation of Multifunctional Frameworks, Mixed Ligands and Mixed Metals, Types of Synthesis: Hydrothermal, Solvothermal, and Ionothermal Routes, Types of Linkers: Carboxylate, Phosphonate, and N-based Ligands, General Synthetic Strategy for Extended Organic linkers, Designing Linker Synthesis.

Unit-3: Properties of Metal Organic Frameworks (9 Hours)

The properties of MOFs (crystallinity, porosity, chemical and thermal stability) Mechanical Properties, Analysis of Their Acidic Behavior, Stability Issues, Redox Properties, Catalytic Properties, Inclusion, Adsorption/Separation, Gas Storage, Fluid Separation.

Unit-4: Characterization of Metal Organic Frameworks (9 Hours)

Methods for structure characterization of MOFs (XRD, SEM/EDX, porosity (DFT), surface area (BET), thermal analysis, Particle analysis, Solid State NMR, crystallography, Electron Paramagnetic Resonance, IR and Raman Spectroscopies Probing MOFs Structure etc.)

Unit-5: Applications of Metal Organic Frameworks (9 Hours)

Design and use of MOFs for capture, separation and storage of gases. Design and use of MOFs for heat storage. Design and use of MOFs for use in catalysis. Other uses of MOFs (sensors, (semi)conductors, drug-delivery systems, etc.)

Reference Books:

1. MacGillivray, L.R., Metal-organic frameworks: design and application, Hoboken : John Wiley & Sons, cop. 2010, ISBN 978-0-470-19556-7.
2. Furukawa, H., Cordova, K. E., O'Keeffe, M. & Yaghi, O. M. The chemistry and applications of metal-organic frameworks. Science 341, 1230444 (2013).
3. Helal, A., Al-Maythaly, B.A., Yamani, Z.H., Cordova, K.E., Yaghi, O.M., The chemistry of metal-organic frameworks for CO₂ capture, regeneration and conversion. Nature Reviews Materials 2, 17045 (2017).
4. Mazaj, M., Kaučič, V., Zabukovec Logar, N., Chemistry of metal-organic frameworks monitored by advanced X-ray diffraction and scattering techniques. Acta chimica slovenica, 63, 440-458 (2016).
5. Stefan Kaskel, The Chemistry of Metal–Organic Frameworks, 2016, Wiley-VCH Verlag GmbH & Co. KGaA, Boschstr. 12, 69469 Weinheim, Germany ISBN: 978-3-527-33874-0.

20CH3038	Advanced Main Group Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the students to

1. conversant with the applied main group chemistry
2. understand the importance of main group chemistry in catalysis.
3. impart knowledge about biological applications of main group chemistry.

Course outcomes:

The Student will be able to

1. learn synthetic methodologies involved in main group chemistry
2. describe the mechanism of ring opening polymerization
3. understand the effect of main group element on polymeric materials
4. realize catalytic applications and cost reduction
5. understand the importance of main group molecules in developing modern technologies
6. analyse applications in toxicology and biology

Unit 1: Synthesis and classification of main group compounds (12 Hours)

Classifications, synthesis, characterisations and properties of Organoboranes, Organosilicons, Organophosphorous, Organoantimony, Organobismuth, Organogermanium, Organoarsenic, Organostannane, Organoselenium, Organotellurium compounds.

Unit 2: Main group polymers (10 Hours)

Synthesis, characterisation and properties of polysilanes-polygermanes-polystannenes-polyphosphazenes-polyphospholes-B, S, As (Arsole), Se and Te containing conjugated polymers.

Unit 3: Catalytic applications (8 Hours)

Frustrated Lewis Acid Pairs (FLP)-Low valence main group compounds-classifications-applications in small molecules activation-catalysis- Advantages.

Unit 4: Optoelectronic Applications (7 Hours)

Solid state luminescence-theory- π conjugated molecules containing main group elements-applications in OLED, solar cell and forensic science.

Unit 5: Medicinal chemistry applications (8Hours)

Chemical sensing-fluoride and cyanide-bio imaging (cancer cells and mitochondria)-photodynamic therapeutic applications-boron and antimony based anion transporters.

References:

1. Thomas Baumgartner and Frieder Jackle, Main Group Strategies towards Functional Hybrid Materials, First edition, John Wiley & Sons, 2018.
2. Ali Morsali, Lida Hashemi, Main Group Metal Coordination Polymers, John Wiley & Sons, 2017
3. Kin-Ya Akiba, Organo Main Group Chemistry, John Wiley & Sons, 2011
4. James E. Mark, Harry R. Allcock, Robert West, Inorganic Polymers, Oxford University Press, 2005
5. Ronald D. Archer, Inorganic and Organometallic polymers, John Wiley & Sons, 2001
6. A. G. Massey, Main Group Chemistry, 2nd Edition, John Wiley & Sons, 2000
7. Das, Kumar V.G, Main Group Elements and their Compounds, Springer-Verlag Berlin Heidelberg, 1999.

20CH3039	Chromatography	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. recognize the importance of various chromatographic techniques in chemistry
2. understand the principles of different separation techniques for various molecules
3. acquire the knowledge on principles and instrumentation of sophisticated chromatographic equipments for compound purification

Course Outcomes:

Student will be able to

1. understand the principles of chromatographic techniques
2. distinguish between different chromatographic techniques
3. apply the appropriate technique for separation in gc
4. attain the knowledge on purification of any prepared compound
5. utilize the proper separation technique for the purity check
6. interpret the chromatogram obtained from various techniques

Unit 1: Column Chromatography (9 Hours)

Polarity, Functional groups related polarity- Thin Layer Chromatography – Column chromatography – Silica gel Mesh- TLC applicator - Column Volume - repopole applications in chemical analysis- Applications of Column Chromatography.

Unit 2: Gas Chromatography (9 Hours)

Introduction to gas Chromatography- Theory –Working Principles — Instrumentations- Detectors- Columns- Components of GC- GC for volatile substances – Applications of GC.

Unit 3: Liquid Chromatography (9 Hours)

Introduction to HPLC Chromatography- Theory –Working Principles Pumps, Injection portal, Column chemistry- Method developments–Detectors– Instrumentations- – Applications of HPLC. UHPLC and UPLC

Unit 4: Super Critical Fluid Chromatography (9 Hours)

Introduction of SFC- Theory- Principles of SFC, Instrumentations- CO₂ as carrier Phase- Preparative approach- Method development and cost estimation-Components of SFC-Application of SFC.

Unit 5: Flash Chromatography (9 Hours)

Introduction of Flash Chromatography- Semi-Preparative Approach- Theory- Principles of FC, Instrumentations- Four Solvent Systems- Detector-ELSD- Method development and translations – Fractional Collector- Flash Cartridges – Solvent and Time benefits -Components of FC-Application of FC.

Reference Books:

1. Chatwal G. R & Anand S. K, "Instrumental Methods of Chemical Analysis", Himalaya Publishing House, Mumbai, India, 5th Edition, Reprint 2011.
2. G. Sharma, B K Chaturvedi, Richard E. Wolfe, Basic Analytical Chemistry, DK publishers, 2011
3. Skoog D. A, West D. M, Holler F. J & Crouch S. R, "Fundamentals of Analytical Chemistry", Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.
4. Srivatsava A. K. & Jain P. C, "Chemical Analysis", S. Chand Publications, New Delhi, 3rd edition, 1997.
5. Willard H, Merrit L, Dean J. A. & Settle F.A., "Instrumental methods of chemical analysis", CBS Publishers and Distributors Pvt. Ltd, New Delhi, 7th edition, 1986.
6. Valcarcel, Miguel, Principles of Analytical Chemistry, Springer, 2000.

20CH3040	Water Treatment Technologies	L	T	P	C
		3	0	0	3

Course objectives:

Enable the students to

1. gain the knowledge on sources of water, importance of water quality and its standards for usage.
2. understand about objectives of water treatment.
3. understand about the purification process like, sedimentation, coagulation, filtration and softening methodologies involved before supplying to public.

Course outcomes:

Student will be able to

1. understand the roll and importance of drinking water quality and control of water borne diseases.
2. understand the need of purity of water to reduce the transmission of various diseases in urban and rural community.
3. judge the standards of water before supplying to a community.
4. Apply the type of treatment required with respect to water quality.
5. gain the knowledge on water softening methods and utilization of water
6. explore the need of new technology in water purification

Unit 1: Water Quality Standard and Industrial waste water (9 Hours)

Introduction – Sources of water, Importance of water quality and standards. Objectives of Water treatment– Uses of Water by industry – Sources and types of industrial wastewater – Water Pollution: Sources of water and their contamination, Types of pollutants, Industrial effluents- pulp and paper mills, Sugar, Distillery, Domestic wastes, Effluents from water treatment plants. Eutrophication – causes, effects and control measures. Industrial wastewater disposal and environmental impacts – Reasons for treatment of industrial wastewater – Regulatory requirements – Industrial waste survey – Industrial wastewater generation rates, characterization and variables

Unit 2: Industrial Water Pollution Control and Treatment (9 Hours)

Sources and characteristics of industrial wastewater, effects on environment. Standards related to industrial wastewater. Waste volume reduction, waste strength reduction, neutralization, equalization and proportioning. Advanced wastewater treatment. Industry specific wastewater treatment for chloro- alkali, electroplating, distillery, tannery, pulp and paper, fertilizer, etc. Treatment technology of coal washery and coke oven effluents. Equalization – Neutralization – Oil separation – Flotation – Precipitation – Heavy metal Removal – Refractory organics separation by adsorption – Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors. Chemical oxidation – Ozonation – Photocatalysis – Wet Air Oxidation

Unit 3: Determination of water quality parameters (8 Hours)

Chemistry of water and waste water – water pollution, pollutants in water, water quality requirement, potable water standards, wastewater effluent standards principles of determination of water quality parameters like pH, alkalinity, BOD, COD, hardness, lethal doses of pollutants – sulphides, chlorides, Ca, Mg, and analysis of minerals Fe, Mn, Ca, Mg in water.

Unit 4: Methods of treating waste water (9 Hours)

Primary, secondary and tertiary methods of treating- Chemical- Coagulation and Flocculation- Theory of Coagulation. Types of Coagulants, reactions, Coagulant Aids, Determination of Optimum dose of Coagulants. Design Criteria and numerical problems on estimation of coagulants- Water Softening - Ions causing Hardness, Degree of Hardness, and Removal techniques, Problems associated with hardness. Fluoridation and De-fluoridation techniques. Special requirements of Industrial water supply.-Physical - adsorption-

Unit 5: Advanced Treatment Technologies (10 Hours)

Electrochemical – electrocoagulation, electro dialysis- - reverse osmosis-Biological methods- Microbial Treatment - Degradation of high concentrated toxic pollutants, non-halogenated, halogenated petroleum hydrocarbons metals. Rural wastewater systems – Septic tanks, two-pit latrines, Ecotoilet, soak pits. advantages and limitations-Need for the advanced technologies in waste water treatments- nanomaterials in wastewater treatments -TiO₂, ZnO- composite materials TiO₂/CNT, TiO₂/GO- composite immobilized on polymers-challenges in these technologies.

Text Books:

1. Waste Treatment and Disposal 2nd edition Paul T Williams, Wiley, 2005
2. "Wastewater Treatment", Rao M.N., Datta A.K., (2008), 3rd edition, Oxford & IBH Publishing Co. New Delhi.
3. CPHEEO Manual, (1991), "Water Supply and Treatment", GO Publications.
4. Water Treatment Grade 1 WSO: AWWA Water System Operations WSO (2016), American Water Works Association

Reference Books:

1. Peavy, H.S., Rowe and Tchobonoglous, G., (1985), "Environmental Engineering", McGraw Hill
2. Viessman Jr, Hammer J. M, Perez, E.M, and Chadik, P. A, Water Supply and Pollution Control, PHI Learning, New Delhi, 2009
3. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, (1984), Environmental Engineering, McGraw Hill., 1984
4. Joshua Armstrong, Introduction To Water Treatment: Handbook Edition, (2019), Independently published

20CH3041	Bioorganometallic Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. summarize the importance of bioorganometallic chemistry
2. describe the structure and function of bioorganometallic systems
3. discuss the importance of bioorganometallics in medicinal chemistry

Course Outcomes:

Student will be able to

1. define the bioorganometallic complexes
2. discuss the role of organometallic compounds in catalysis
3. analyse the factors affecting the catalysis
4. recognize the importance of hydrogen energy
5. synthesize the compounds for specific application
6. summarize the role of bioorganometallic complexes in medicinal chemistry

Unit 1: Introduction (9 Hours)

Bioorganometallic chemistry – Definition – Examples - Proteins – Aminoacids – Vitamin B12 and its coenzymes – Structure - Coenzyme B12 dependent enzymes – Methyl cobalamin – catalysis – Mechanism – Homolysis – Heterolysis - Electrochemistry

Unit 2: Model complexes of vitamin B12 based enzymes (10 Hours)

Model complexes – Vitamin B12 model complexes – Cobaloximes and other model complexes – Preparation – Characterization - Cis influence – trans influence – Catalysis - Applications – Tuning the catalyst – Organic transformation - Hydrogen production – Chain transfer catalyst

Unit 3: The Bioorganometallic Chemistry of Hydrogenase (9 Hours)

Hydrogenase – Significance Types – [FeFe] Hydrogenase – [FeNi] Hydrogenase – [Fe] Hydrogenase – Active sites - Mechanism – Model complexes - Dihydrogen metal complexes

Unit 4: Bio-Organometallic Systems for the Hydrogen Economy (9 Hours)

Introduction – Electrocatalysis - Electrode Materials for Hydrogen Evolution and Uptake – covalent attachment of catalyst to the electrode surface – Non-covalent attachment of a catalyst – Photocatalysis – Photocatalysts - Light driven system for hydrogen economy – Photoelectrodes - Examples – Iron based catalysts – Nickel based catalysts – Molecular based photocatalysts

Unit 5: Medicinal properties of organometallic compounds (8 Hours)

Organometallic pharmaceuticals - Anticancer and antimalarial drugs - Ruthenium complexes – Metallocene complexes – Half sandwich complexes - Tuning the activity of the catalyst

Reference Books:

- Advances in Bioorganometallic chemistry – Edited by Toshikazu Hirao and Toshiyuki Moriuchi, Elsevier 2019
- Topics in Organometallic Chemistry, Vol-17- Bioorganometallic chemistry, Edited by G. Simonneaux, Springer-Verlag Berlin Heidelberg 2006
- Bioorganometallic Chemistry- Applications in Drug Discovery, Biocatalysis, and Imaging, Edited by G. Jaouen and M. Salmain, Wiley-VCH-2015
- Bioorganometallics: Biomolecules, Labeling, Medicine, Edited by G. Jaouen, Wiley-VCH Verlag GmbH & Co, 2005
- Designing organometallic compounds for catalysis and therapy, A. L. Noffke, A. Habtemariam, A. M. Pizarro and P. J. Sadler, Chem. Commun., 2012, 48, 5219-5246, Royal Society of Chemistry, 2012

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	1						3	1	-
CO2	2	2	2					2	2	-
CO3	3	1		3				2	3	1
CO4	3	1						3	-	2
CO5	2				2			1	2	-
CO6	1			1				1	-	-

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20CH3042	Supramolecular Chemistry						L	T	P	C
							3	0	0	3

Course Objectives:

Enable the student to

- learn the supramolecular constructs of current importance.
- understand the principles of formation of various types of supramolecular architecture
- describe the importance of solid state supramolecular chemistry and crystal engineering

Course Outcomes :

Student will be able to

- understand the various types of bonding in supramolecular chemistry
- recognize the selectivity in formation of supramolecular chemistry and catalysis.
- Identify and design receptors for cations, anions and neutral molecules.
- synthesize and assemble molecular structures of different shapes and dimensions.
- construct supramolecular architecture based on of crystal engineering concepts
- identify the application of supramolecular chemistry in appropriate fields

Unit 1: Fundamentals of Supramolecular Chemistry (9 Hours)

Terminology and definitions – Selectivity – Lock and key principle and induced fit model – complementarity – Co-operativity and chelate effect – Pre-organization – Non-covalent interactions - Ion-Dipole Interactions - van der Waals Interactions - Hydrogen bonding - cation- π , anion- π , π - π interactions – hydrophobic effects – Kinetic and thermodynamic selectivity – Binding Constant - Guests in solution – Macrocyclic vs. acyclic hosts – High -dilution synthesis – Template synthesis.

Unit 2 : Molecular Recognition – Solution State (9 Hours)

Introduction -Cation binding – Podands - Crown ethers and cryptands – Spherands – Heterocrowns – Biological ligands: ion channels – Anion binding – Charged receptors – Neutral receptors – Lewis acid receptors – Neutral molecule binding – Calixarenes, cyclodextrins and dendrimers as catalysts.

Unit 3: Supramolecular Materials (9 Hours)

Self-assembly using metal templates – Racks, ladders, and grids – Helicates – Mechanically interlocked molecules- Molecular polygons – Rotaxanes, catenanes, and knots – Borromean rings – Knotaxanes (structure and function of the above species). Self-assembling capsules – Molecular containers – Metal directed capsules – Hydrogen bonded capsules.

Unit 4: Crystal Engineering – Solid State (9 Hours)

Introduction – Zeolites: structure – composition – catalysis. Clathrates – Urea/thiourea clathrates – Trimesic acid clathrates – Hydroquinone and Dianin's compound – Clathrate hydrates - Crystal engineering - Role of hydrogen bonds – Solid state reactivity – Metal organic frameworks – Guest properties of metal - organic frameworks.

Unit 5: Applications of Supramolecular Chemistry (9 Hours)

Application of Supramolecular Materials - molecular devices - molecular wires, molecular rectifiers, molecular switches, molecular logic gates - Supramolecular catalysis – Supramolecular Chemistry in Nanotechnology - examples of recent developments in supramolecular chemistry – Applications of Supramolecular chemistry in medicine.

Reference Books:

- Jonathan Steed, David Turner, Carl Wallace, Core Concepts in Supramolecular and Nanochemistry, John Wiley & Sons, 2007.
- I. Chorkendorff, J. W. Niemantsverdriet, Concepts of Modern Catalysis and Kinetics, Second Edition, Wiley-VCH Publishers, 2007
- Crystal engineering using multiple hydrogen bonds, In Structure and Bonding, Ed: Andrew D. Burrows, Vol. 108, 55-96, 2004.
- Supramolecular Chemistry: From Biological Inspiration to Biomedical Applications, Peter. J. Cragg, Springer Publishers, 2010.
- Supramolecular Chemistry – Fundamentals and Applications. Advanced Textbook by T. Kunitake, K. Ariga, Berlin: Springer-Verlag Heidelberg, 2006. 208p. ISBN 978-3-540-01298-

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		2		2	1				1	1
CO2				2	3			2	2	
CO3		2		3		1		1		
CO4				1	2	2			3	
CO5										1
CO6	1	2		2	2	2	2	1		2

“3” – High; “2” – Medium; “1” – Low; “-” – No correlation

20CH3043	Analytical Chemistry				L	T	P	C
					3	0	0	3

Course Objectives:

Enable the student to

- recognize the importance of various analytical techniques used in chemistry
- understand the principles of different chromatographic separation techniques
- acquire the knowledge on principles and applications of spectroscopic techniques and thermal methods

Course Outcomes:

Student will be able to

- distinguish between different chromatographic techniques
- apply the appropriate technique for analysis
- attain the knowledge on analysis of any prepared compound
- utilize the proper spectroscopic technique for the characterization

5. interpret the spectra obtained from various techniques
6. demonstrate the thermal methods and x-ray diffraction methods of analysis.

Unit 1: Chromatography (9 Hours)

Theory - Principle, instrumentation and applications of the following – Column, thin layer, and ion-exchange chromatography – Gas chromatography - High performance liquid chromatography - applications in chemical analysis.

Unit 2: Infrared Spectroscopy (9 Hours)

Introduction to electromagnetic radiation wave length – Wave ratio - Regions of the spectrum, characterization of electromagnetic radiation - The vibrating diatomic molecule – Selection rule - - harmonic oscillator - Vibrations of polyatomic molecules – Fundamental vibrations and overtones – Basic Principle - Instrumentation –Sampling techniques - Factors affecting vibrational frequencies - Application to chemical compounds (organic and inorganic compounds) - Finger print region - Identification of functional groups - Simple problems in functional group identification using IR spectrum.

Unit 3: Electronic Spectra (9 Hours)

Electronic spectra of diatomic molecules – physical properties – laws of absorption – absorption transitions – Jablonski diagram – auxochromes - chromophores – effects of conjugation – Woodward-Fieser rules for α,β -unsaturated carbonyl compounds and dienes – aromatic systems with extended conjugation – application to organic and inorganic compounds – instrumentation of absorption spectroscopy.

Unit 4: Nuclear Magnetic Resonance Spectroscopy (9 Hours)

Nuclear spin theory - Interaction between spin and magnetic field - Population of energy levels - Larmor precession frequency - Relaxation processes – Instrumentation – Continuous wave and FT NMR - Proton NMR - Chemical shifts and its measurement – TMS - Reference compound – Factors affecting Chemical Shifts – Solvents in NMR -Spin-spin coupling – spin spin splitting - Theory - Magnitude and factors affecting coupling constant - Long Range coupling – Second order spectra – AX, AMX, and ABX systems- Simplification of complex spectra - Applications of ^1H NMR to determine the structure of simple organic compounds - Introduction to Two Dimensional NMR (^1H - ^1H COSY) spectroscopy.

Unit 5: Thermal Methods of Analysis and X-ray Diffraction method (9 Hours)

Thermal Analysis techniques Principle and applications of Differential Thermal Analysis (DTA) - Differentials Scanning Calorimetry (DSC) - Thermogravimetric Analysis (TGA) Thermometric titration - Theory – Instrumentation of DTA, DSC and TGA – Factors affecting TG, DTA and DSC Curves – Principles of X-ray diffraction Methods – Instrumentation — Diffraction pattern – Bragg's Law – Structure factor – Reliability factor - Applications

Reference Books:

1. Chatwal G. R & Anand S. K, "Instrumental Methods of Chemical Analysis", Himalaya Publishing House, Mumbai, India, 5th Edition, Reprint 2011.
2. Kalsi P. S, "Spectroscopy of Organic Compounds", New Age International Publishers, New Delhi, 6th Edition, 2004.
3. Skoog D. A, West D. M, Holler F. J & Crouch S. R, "Fundamentals of Analytical Chemistry", Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.
4. Srivatsava A. K. & Jain P. C, "Chemical Analysis", S. Chand Publications, New Delhi, 3rd edition, 1997.
5. Willard H, Merrit L, Dean J. A. & Settle F.A., "Instrumental methods of chemical analysis", CBS Publishers and Distributors Pvt. Ltd, New Delhi, 7th edition, 1986.
6. Valcarcel, Miguel, Principles of Analytical Chemistry, Springer, 2000.
7. G. Sharma, B K Chaturvedi, Richard E. Wolfe, Basic Analytical Chemistry, DK publishers, 2011

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	1	2	1	-	2	-	2	3	1
CO2	3	2	3	2	1	2	-	1	2	1
CO3	1	1	2	2	-	1	-	-	2	-
CO4	2	3	2	1	1	2	-	1	2	1
CO5	3	2	3	2	1	2	-	2	3	-

CO6	2	2	1	2	-	2	-	1	2	1

“3” – High; “2” – Medium; “1” – Low; “-” – No correlation

20CH3044	Essentials of Forensic Chemistry					L	T	P	C
						3	0	0	3

Course Objectives:

Enable the student to

1. Understand the various fields of forensic chemistry
2. learn the methods of searching and analyzing arson and post-fire evidence
3. understand the classification of explosives and bomb scene management

Course Outcomes:

The student will be able to

1. understand the methods involved in forensic chemistry
2. realize their significance of forensic chemistry in various fields
3. analyze the various types of petroleum products.
4. realize the classification of beverages
5. apply the techniques of locating hidden explosives
6. characterize and analyze arson evidence and post-fire analysis.

Unit 1: Significance of Forensic Chemistry (9 Hours)

Forensic Chemistry - Introduction - branches - Preliminary screening - presumptive tests (colour and spot tests) - Examinations procedures involving standard methods and instrumental Techniques - Qualitative and quantitative forensic analysis of inorganic and organic material - Chemical fertilizers - (N,P,K) - Insecticides (Endosulfan, Malathion, Carbaryl) - Metallurgical analysis (Fe, Cu, Zn, Au, Ag) - Natural products (tobacco, tea, sugars, rubber) – Industrial chemicals - Cosmetics of forensic interest and their role in crime investigation, General Chemistry of Colorants, Dyes, Pigments & Polymers - Physical and chemical examination of adulterated and non-adulterated oils and fats, Analysis of chemical fertilizers

Unit 2: Petroleum Products (9 Hours)

Petroleum Products, Properties and Testing -adulteration of petroleum products -Analysis of common petroleum products including, Petrol, Kerosene, Diesel, Lubricating Oil, Furnace Oil and Grease as per BIS specifications. Analysis of Dyes used in petroleum products, Chemical fingerprinting of petroleum products - Standard method of analysis of petroleum products

Unit 3: Alcoholic Beverages (9 Hours)

Composition and analysis of alcoholic and non-alcoholic beverages, country made liquor, illicit liquor and medicinal preparations containing alcohol –Characteristics of Beer, wines and Whisky, Congeners in alcoholic beverages, Laws and penalties as per Excise/ Act -Forensic analysis of distilled and fermented liquors including illicit liquors - Common adulterants and toxic substances in alcoholic beverages – Analysis of Narcotic Drugs and Psychotropic Substances - classification of NDPS -Forensic examination of NDPS –Clandestine laboratories

Unit 4: Explosives (9 Hours)

Definition - Chemistry of explosives - Deflagration and Detonation phenomenon - Characteristics of high and low explosives - Dust explosion, Gas/vapour explosion, BLEVE, Effect of blast wave on structures & human and Pyrotechnics - Improvised Explosive Device: Definition and Components- Explosives Initiation -Detection of Hidden Explosives -Approach to scene of explosion - post-blast -explosion residue collection - Systematic analysis of explosives and explosion residues in the laboratory using chemical and instrumental techniques- Examples- Profiling and tagging of explosives- Interpretation of results, Explosives Act and Explosive Substances Act.

Unit-V: Fire & Arson (9 Hours)

Light and Flame, Chemistry of Fire, Combustion reaction, Fire Triangle, Fire Tetrahedron; Backdraft, Thermo-chemistry of Fire, Heat Capacity and Phase changes, Accelerants & types of accelerants, Combustible and Flammable liquids, Flash point, Fire point, Ignition point, Auto Ignition point, vapour density, vapour pressure, Fire extinguisher. Analysis of arson residues by conventional and instrumental methods- Documenting the fire or crime scene - Scheme of analysis - Extraction of samples from debris -Clean-up -, Analysis - Interpretation of GC-MS spectra -Report Writing & Court Room Testimony - Components of Forensic Reports

Text Books:

- James, S. H., Nordby, J. J. and Bell, S “Forensic Science: An Introduction to Scientific and Investigative Techniques”, 4th Edition, CRC Press, USA, 2015 ISBN-10: 9781439853832, ISBN-13: 978-1439853832,
- Paul Worsfold, Alan Townshend and C. F. Poole, “Encyclopedia of Analytical Science”, 2nd Edition, Elsevier Academic Press, 2005, ISBN:0127641009, 9780127641003
- Beveridge, A, “Forensic Investigation of Explosions 2nd Edition, CRC Press, 2011, ISBN: 1420087258, 9781420087253
- Yallop, H. J, ‘Explosion Investigation’, Forensic Science Society &, S. S. Kind, 1980, 0950242551, 9780950242552
- Narayanan, T. V: Modern Techniques of Bomb Detection and Disposal, R. A. Security System, 1995.
- Yinon, J. and Zitrin, S, “Modern Methods and Applications in Analysis of Explosives”, John Wiley & Sons, 1996, ISBN: 04719656nm26, 9780471965626
- Clarke, “Clarke’s Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids and Postmortem Material” Edited by Moffat, A. C., Osselton, M. D., Widdop, B. and Clarke, E.G.C: 3rd edition, Pharmaceutical Press, 2004, ISBN: 0853694737, 9780853694731
- Almirall, J. R. and Furton, K. G, “Analysis and Interpretation of Fire Scene Evidence”, CRC Press, 2004, ISBN: 0203492722, 9780203492727
- Bogusz, M. J, “Forensic Science Volume 2 of Handbook of Analytical Separation”, Elsevier Science, 2000, ISBN: 0444829989, 9780444829986
- Detlean, J. D and Icove, J. D, “ Kirk’s Fire Investigation”, 7th Edition, Pearson, 2011, ISBN-10: 0135082633, ISBN-13: 978-0135082638
- Gough, T. A, “The Analysis of Drugs of Abuse” John Wiley, 1991. ISBN: 0471922676, 9780471922674
- Saferstein, R and Hall, A. B, “Forensic Science Hand Book, Vol. I, II and III,” 3rd Edition, Taylor & Francis Group, 2020, ISBN: 1498720196, 9781498720199
- N. D. P. S. Act, 1985 with amendments
- Explosive Act with amendments
- Explosive Substances Act with amendments
- Bureau of Indian Standards: Specifications and Methods of Analysis for Alcoholic Beverages.
- Bureau of Indian Standards: Specifications and Methods of Analysis for Petroleum Products.
- Working Procedure Manual: Chemistry, Explosives & Narcotics, B.P. R & D, 2000
- DEA Manual: Analysis of Controlled Substances
- Saferstein, R., “Criminalistics: An Introduction to Forensic Science”, 11th Edition, Pearson, 2015, ISBN-139780133458824
- Sarkar, S: Fuels and Combustion, Orient Blackswan, 1989, ISBN: 8125003967, 9788125003960
- Standard Methods of Chemical Analysis
- AOAC: Official Methods of Analysis
- Indian, British & U. S. Pharmacopeias

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	1						1	2	1
CO2	1	2		1	2		1	2	1	
CO3	2	1	2		2		1	2	1	1
CO4	3		2	2		2	1	2	2	2
CO5	2	3		1			2	2		
CO6	2	2	1	2			1			

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20CH3045	Forensic Tools and Techniques				L	T	P	C
					3	0	0	3

Course Objectives:

Enable the student to

- Understand the various fields of analytical chemistry

2. learn the methods of qualitative methods of analysis
3. understand the principles of quantitative methods of analysis

Course Outcomes:

The student will be able to

1. understand the methods involved in analytical chemistry
2. understand the terms used in analytical chemistry
3. realize the significance qualitative analysis
4. realize the importance of volumetric analysis
5. understand the importance of gravimetric analysis
6. apply the various types of separation methods

Unit 1: Significance of Analytical Chemistry (12 Hours)

Nature and scope of analytical chemistry in Forensic chemical analysis -Concept of Mole, Molecular Mass and Molecular Weight,- Classification of analytical methods - Conventional and instrumental methods of analysis - Theoretical principles of analytical chemistry – Law of mass action and its application – Le Chatelier and Braun principle –Dissociation theory – Electrolytes and non-electrolytes – Classification of acids, bases and salts according to their degree of dissociation – Dissociation of acids, bases and salts – Dissociation constants – Common ion effect – Solubility product – Ionization of water – pH value – pOH value – Relation between pOH & pH scale – pH scale - Buffer solutions - Buffer action – Preparation of buffer solutions –Methods of sample preparation in organic and inorganic analytical chemistry- Scientific Calculations: Scientific volume and weight measurements, Density, Specific Gravity, Specific Volume, Percentage, Ratio Strength, and other Expressions of Concentration

Unit 2: Qualitative analysis (9 Hours)

Organic reagents in detection of inorganic ions – Oxidizing and reducing agents in organic chemistry – Inorganic and organic spot tests – Micro chemical tests – Physical tests – Qualitative inorganic analysis –Colour spot tests in Forensic Biological, Chemical and Physical analysis, Microcrystalline test - Centrifugation Techniques, Basic principles of sedimentation, types of centrifuges - Group separations for cations and anions – Interfering radicals - Elemental analysis of organic compounds– Functional group analysis – Schemes of identification of unknown solids, liquids and gases (inorganic and organic) – Confirmation tests and their importance – Sensitivity and limit of detection

Unit 3: Volumetric Method of Analysis (9 Hours)

Titrimetric methods of analysis – General principle – Equivalence point and end point –Fundamental requirement of a titrimetric method – Standard solution – Detection of end point – Indirect titrations– Calculations in titrimetry – Aqueous acid-base titrimetry –Preparation of standard solutions – Primary standards – Indicators – Theory of indicators –Acid-base titrimetry in nonaqueous solvents – Redox titrimetry – Oxidation and reduction – Oxidant and reductant – Iodimetry and iodometry – Permanganometry – Dichromatometry – Precipitation methods –Argentometry – Complexometry – EDTA methods

Unit 4: Gravimetric Method of Analysis (9 Hours)

Gravimetric methods of analysis – Basic Digestion of precipitates – Washing of precipitates – Drying and ignition of precipitates – Thermal decomposition of precipitates – Organic precipitants – examples - Factors affecting gravimetric analysis – Requirements of quantitative separation – The process of precipitation – Saturated and supersaturated solution – Nucleation – Crystal growth – Conditions of precipitation – Completeness of precipitation – Factors influencing solubility – Purity of a precipitate – Adsorption of ions on precipitates - Coprecipitation – Occlusion and post-precipitation

Unit 5: Chemical Separation Techniques (6 Hours)

Physical separation methods – Distillation – Extraction – Precipitation –Crystallization - Solvent extraction (Liquid-liquid extraction), Solid phase extraction, Solid phase microextraction (SPME). Phenolphthalein in trap case: Chemistry and Forensic examination of Phenolphthalein used in Bribe trap cases, and related legal issues.

Textbooks:

1. Christian G.D, “Analytical Chemistry” John Wiley & Sons, 6th Edition, 2004 ISBN-10: 0471214728, ISBN-13: 978-0471214724

- J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas “Vogel’s Quantitative Chemical Analysis”, 6th edition, 7th Impression, Dorling Kindersley limited, New Delhi, India, 2008 ISBN-10: 0582226287, ISBN-13: 978-0582226289
- Svehla, G: Vogel’s Qualitative Inorganic Analysis, 7th Edn., Longman, 1996, ISBN-10: 0582218667, ISBN-13: 978-0582218666
- Verma, R. M: Analytical Chemistry, 3rd Edn, CBS Pub, New Delhi, 2019, ISBN-10: 9788123902661 ISBN-13: 978-8123902661
- Ghoshal, A., Mahapatra, B and Nad, A. K, New Central Book Agency, Kolkata, 2000 ISBN: 9788173813023, 9788173813023
- Kasture, A. V., Mahadik, K. R., Wadodkar, S. G and More, H. N: Pharmaceutical Analysis 13th edition, NiraliPrakshan, Pune ISBN: 978-81-85790-07-7
- Alexeyev, V. N: Qualitative Chemical Semi micro Analysis, CBS Pub., New Delhi, 2004, ISBN-10: 9788123902791, ISBN-13: 978-8123902791
- Alexeyev, V: Quantitative Analysis, CBS Pub, New Delhi, 2007, ISBN-10: 812390293X, ISBN-13: 978-8123902937
- Feigl, F and Anger, V, “Spot Tests in Inorganic Analysis”, Elsevier, 1982, ISBN-10: 0444409297; ISBN-13: 978-0444409294
- F. Feigl and Anger, V, “Spot Tests in Organic Analysis”, 7th Edition, Elsevier, 1983
- Harris, D. C “Quantitative Chemical Analysis”, 9th Edition., W. H. Freeman Publishers; 2015, ISBN-13: 978-1464135385, ISBN-10: 146413538X
- Vogel, A: Qualitative Organic Analysis, 2nd Edition., reprinted 2002, CBS Pub, New Delhi,
- Connors, K. A: A Text Book of Pharmaceutical Analysis, 3rd Edn., John Wiley, 1999, Publisher: Wiley-Blackwell; 3rd Revised edition edition (27 October 1982), ISBN-10: 0471090344 ISBN-13: 978-0471090342
- Furniss, B. S., “Vogel, A. I: Text Book of Practical Organic Chemistry” Pearson Education India, 1989, ISBN: 8177589571, 9788177589573
- Skoog D. A, West D. M, Holler F. J & Crouch S. R, “Fundamentals of Analytical Chemistry”, Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2		1	1		1	2	2	
CO2	2	1		2		2	1	1	
CO3	3	1		1			2		2
CO4	3	1	1	2		2	2	2	1
CO5	2	1			2		1	1	
CO6	2			1			2	1	

“3”– High; “2”– – Medium; “1”– - Low; “-”– No correlation

20CH3046	Instrumental Methods of Analysis - I	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

- Understand the basic concepts of spectroscopy
- learn the principles of vibration and electronic spectroscopy
- understand the principles of radiochemical methods and electrochemical methods

Course Outcomes:

The student will be able to

- understand the principles of atomic spectroscopy
- realize the importance of IR and Raman Spectroscopy
- apply the principles of electronic spectroscopy
- understand the principles of NMR spectroscopy
- realize the importance of radiochemical methods in forensic science
- utilize the role of electrochemical methods in forensic science

Unit 1: Basic Concept of Atomic Spectroscopy (10 Hours)

Electromagnetic spectrum, various source of radiation their utility and limitation. Interaction of radiation with matter - Detection of radiation - Forensic application of spectroscopy - Atomic Spectrometry – General properties of Electromagnetic Radiation – Optical Atomic Spectra – Principles, instrumentation, techniques and forensic applications of Atomic Absorption and Atomic Fluorescence Spectrometry – Atomic Emission Spectrometry – Atomic Mass Spectrometry - Atomic X-Ray Spectrometry

Unit 2: Principles of UV-Visible Spectroscopy (9 Hours)

Molecular Spectroscopy – Introduction to UV-Visible Spectroscopy – Measurement of Transmittance and Absorbance – Beer’s Law – Instrumentation – Molar Absorptivities – Absorbing Species – Application to Qualitative Analysis – Quantitative Analysis – Photometric Titrations – Photoacoustic Spectroscopy – Molecular Luminescence Spectroscopy – Theory of Fluorescence and Phosphorescence – Instrumentation – Applications of Photoluminescence methods – Chemiluminescence

Unit 3: Principles of IR and Raman Spectroscopy (9 Hours)

Infrared Spectroscopy – Theory – Infrared Sources and Transducers – Instrumentation – Dispersive and FT instruments - Techniques and Applications – Mid IR Absorption, Mid IR Reflection and Photoacoustic IR Spectroscopy – Near and Far IR Spectroscopy – IR Micro Spectroscopy – Forensic Applications of IR Spectroscopic methods- Raman Spectroscopy – Principles – Instrumentation – Techniques - Applications

Unit 4: Principles of NMR Spectroscopy (8 Hours)

Nuclear Magnetic Resonance Spectrometry – Principles, Instrumentation, Techniques (Proton NMR, Carbon-13 NMR, FT-NMR, Magnetic Resonance Imaging) and Forensic Applications

Unit 5: Radiochemical methods and Thermal methods (9 Hours)

Radiochemical Methods – Radioactive Isotopes - Principles, Instrumentation, Techniques and Application of Neutron Activation Analysis and Isotope Dilution Methods - Application of radiochemical techniques in forensic science - Electrochemical techniques: General principles Electron transport process, Principles, instrumentation, techniques and applications of Conductometry, potentiometry, coulometry, polarography and ion selective electrodes

Text Books:

1. P.W. Atkins, “Physical Chemistry”, 8th edition, Oxford University Press, 2006
2. Barrow, G. M, “Introduction to Molecular Spectroscopy”, McGraw-Hill Inc., USA, 1988 ISBN-10: 0070038708, ISBN-13: 978-0070038707
3. Haswell, S. J. “Atomic Absorption Spectrometry”, Elsevier, 1991. ISBN: 9780444882172
4. R. M. Silverstein, F. X. Webster, D. J. Kiemle, “Spectrometric identification of organic compounds”, 7th edition, John Wiley, 2005.
5. Skoog D. A, West D. M, Holler F. J & Crouch S. R, “Fundamentals of Analytical Chemistry”, Cengage Learning India Pvt. Ltd”, New Delhi, India, 8th Edition, 2004.
6. Day R. A. & Underwood A. L., “Quantitative Analysis”, 6th Edition, Printice Hall of India Pvt Ltd, New Delhi, 2006.
7. James W. Robinson, “Atomic Spectroscopy, 2nd Edn. Revised & Expanded, Marcel Dekkar, Inc, NY. (1996)
8. K.C. Thompson & R.J. Renolds, “Atomic Absorption Fluorescence & Flame Emission Spectroscopy, A Practical Approach, 2nd Edn. Charles Griffin & Co. (178)
9. Willard H, Merrit L, Dean J. A. & Settle F.A., “Instrumental methods of chemical analysis”, CBS Publishers and Distributors Pvt. Ltd, New Delhi, 7th edition, 1998
10. Alexeyev, V: Quantitative Analysis, CBS Pub, New Delhi, 2007, ISBN-10: 812390293X, ISBN-13: 978-8123902937
11. Christian G.D, “Analytical Chemistry” John Wiley & Sons, 6th Edition, 2004
12. U.N. Dash, “Analytical Chemistry: Theory and Practice”. Sultan Chand and sons Educational Publishers, New Delhi, 2013, ISBN-10: 8180549534 ISBN-13: 978-8180549533
13. Fifield, F. W. and Kealy, D. “Principles and practice of Analytical Chemistry”, 5th Edition, Blackwell Science Ltd, 2000, ISBN 0-632-05384-4
14. Subramanian P.S. Gopalan R., Rangarajan K. “Elements of Analytical Chemistry”, S. Chand and Co., New Delhi, 2003. ISBN-10: 8180547655; ISBN-13: 978-8180547652

15. Gurdeep R. Chatwal and Sham K. Anand, “Instrumental Methods of Chemical Analysis”, 5th edition, Himalaya Publishing House, 2018.
16. Gowenlock, A. H.: Varleys, “Practical Clinical Biochemistry”, 6th Edition, CBC, 2006, ISBN-10: 9788123904276; ISBN-13: 978-8123904276
17. Kealey, D. and Haines, P. J.: BIOS Instant Notes in Analytical Chemistry”, Taylor & Francis, 2002, ISBN-10: 1859961894; ISBN-13: 978-18599618962002.
18. Lajunan, L. H. J. “Spectrochemical Analysis by Atomic Absorption and Emission”, Royal Society of Chemistry; 2005, ISBN-10: 0854046240 ISBN-13: 978-0854046249
19. Lundquist & Curry (1963) Methods of Forensic Science.
20. Moonesens A.A. (1979) Scientific Evidence in Criminal Cases.
21. Nad, A. K., Mahapatra, B. and Ghoshal, A., “An Advanced Course in Practical Chemistry”, New Central Book Agency, 2000.
22. Sane, R.T. and Joshi, A.P., “Electroanalytical Chemistry: Theory and Applications”, Quest Publications. 1999
23. F.A. Settle, “Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, 1997.
24. Sharma, B. K. “Instrumental Methods of Chemical Analysis”, Krishna Prakashan Media p Ltd; 2011, ISBN-10: 8182830990; ISBN-13: 978-8182830998
25. Verma, R. M. “Analytical Chemistry, Theory and Practice, 3rd edn, CBS, 1994
26. Paul Worsfold Alan Townshend Colin Poole Manuel Miró, “Encyclopedia of Analytical Science” 3rd Edition, Elsevier, 2019, ISBN: 9780081019832

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1		1	2				1	1	
CO2	2	1		1	2		1	2		1
CO3	1		2			1		2	1	
CO4	2	2	1		3		2	1	2	
CO5	1			2	1		2	2		1
CO6	2		1		2	1	1		2	

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20CH3047	Advanced Forensic Toxicology and Pharmacology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand the basic concepts of toxicology
2. Learn the methods involved in toxicological analysis
3. Understand the pathways of drug metabolism

Course Outcomes:

The student will be able to

1. understand the various types of poisoning
2. understand the principles of toxicology
3. summarize the methods involved in toxicological analysis
4. understand the methods involved in elimination of poisons
5. know the pathways of drug metabolism
6. summarize the types of vegetable poison

Unit 1: Introduction to Toxicology (9 Hours)

Toxicology- Introduction- History- Scope- Areas of Toxicology- Role of forensic toxicologist- Poisons- Classification of poisons- Types of poisoning- Sample collection and preservation of toxicological exhibits in fatal and survival cases- Storage of samples- Signs and symptoms of poisoning- Toxicological investigation of poisoned death- Interpretation of toxicological data- Courtroom testimony in toxicological cases. Case Histories

Unit 2: Principles to Toxicology (9 Hours)

Introduction – Pharmacokinetics - Methods of transportation of toxicant-Absorption- Distribution- Storage of toxicants- Redistribution - Metabolism-Oxidation – Reduction –Hydrolysis – Conjugation - Excretion- Other routes of elimination- Toxicokinetics- one and two compartmental model – Toxicodynamics- Spectrum of undesired (toxic) effects- Interaction of chemicals-Tolerance- Dose response relationship- Developmental and reproductive toxicity- Mutagenicity- Toxicity testing

Unit 3: Toxicological Analysis (9 Hours)

Introduction- Sample preparation – Deproteinization – Deconjugation - Liquid–liquid, solid phase, supercritical fluid extraction methods, Isolation and Clean-up procedures into toxicological analysis- Identification and quantitation of poisons by physical, chemical, chromatographic, spectrophotometric, electrophoretic, immunoassay- and other methods (Metals, anions, volatile poisons, gases, drugs, pesticides and miscellaneous poisons) - Field testing in toxicological work – Therapeutic drug monitoring – Emergency hospital toxicology

Unit 4: Management of acute poisoning (9 Hours)

Introduction- Maintenance of vital functions- Measures to enhance elimination of poisons- Removal of unabsorbed poisons- Antidotes- Classification of antidotes-Mechanism of action of antidote – Examples - Identifying route of administration of poison- Estimation of time and dose after administration of poison- Recovery and after care of patients- Poison Information/Control Centre.

Unit 5: Forensic Pharmacological studies (9 Hours)

Absorption, Distribution, Metabolism, Pathways of drug metabolism -General studies and Analysis of some vegetable poisons, Opium, Abrus, Cyanogenetic glycosides, Dhatura, Marking nuts, Nux-vomica, Oleander and Aconite

Textbooks:

1. Klaassen, C. D., Casarett and Doull's Toxicology: The Basic Science of Poisons, 5th edition, McGraw-Hill, 1995.
2. Moffat, A.C. : Osselton, D. M. Widdop, B. : Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, body fluids and postmortem material, 3rd ed., Pharmaceutical Press, 2004.
3. Bogusz, M. J., Hand Book of Analytical Separations, Vol. 2: Forensic Science, 1st ed., Elsevier Science, 2000.
4. Siegel, J.A., Saukko, P. J., Knupfer, G., Encyclopedia of Forensic Sciences (Vol3), Academic Press, 2000.
5. Rang, P.H., Dale, M.M., Ritter, M.J.: Pharmacology, 4th ed., Harcourt/Churchill Livingstone, 2000.
6. Paranjape, H.M., Bothara, G.K., Jain, M.M.: Fundamentals of Pharmacology, 1st ed., Nirali Prakashan, 1990.
7. Budhiraja, R.D.: Elementary Pharmacology and Toxicology, Popular Prakashan, 2nd ed., 1999.
8. Wiseman, H and Henry J.: Management Of Poisoning, A Handbook for Healthcare workers, 1st ed., M.A.I.T.B.S, 2002
9. Hardman, J. G. and Limbird, L. E., Goodman and Gilman's The Pharmacological basis of Therapeutics, 9th edn., McGraw-Hill, 1996
10. Laboratory procedure Manual, Forensic Toxicology: DFS, 2005
11. Sunshine, I ; Methods for Analytical Toxicology, CRC Press USA (1975)
12. Cravey, R.H; Baselt, R.C.: Introduction to Forensic Toxicology , Biochemical Publications, Davis, C.A. (1981)
13. Stolmen, A.; Progress in Chemical Toxicology: Academic Press, New York (1963)
14. Modi, Jaisingh, P.; Textbook of Medical Jurisprudence & Toxicology, M.M. Tripathi Publication (2001)
15. Eckert; An Introduction to Forensic Science, CRC Press
16. Pillay, V. V.; Handbook of Forensic Medicine and Toxicology, Paras Pub., 2001
17. Curry, A. S: Poison Detection in Human Organs
18. Levine Barry, Principles of Forensic Toxicology, 2nd Edn., (2006)
19. Hodgeon Emeet, A Text Book of Modern Toxicology, 3rd Edn. (2004)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	1	2		2	1		1	2	1
CO2	3	2		1			1	2		2
CO3	2	1			2			2	1	
CO4	2		2	2		1	1	1	2	
CO5	2	1					1	1	2	
CO6	1		1		2	1		2	1	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3048	Instrumental Methods of Analysis - II	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand the basic principles of chromatography
2. learn the principles of mass spectrometry and hyphenated techniques
3. understand the use of microscopic techniques and thermal methods

Course Outcomes:

The student will be able to

1. summarize the types of chromatographic techniques
2. realize the importance of High Performance Liquid Chromatography
3. apply the principles of mass spectrometry in forensic science
4. realize the importance of hyphenated techniques
5. realize the use of microscopic techniques in forensic science
6. utilize the role of X-ray diffraction techniques in forensic science

Unit 1: Principles of Chromatography (9 Hours)

Chromatographic Techniques – Introduction - Theoretical principles– Classification of– Adsorption and Partition Chromatography - Principles, instrumentation, techniques and applications of Thin Layer Chromatography - Method Development in Planar Chromatography – Gas Chromatography – Instrumentation – Detectors - Adsorption, Partition, Gas-Solid, Gas-Liquid, Isothermal, Linear Temperature Programming, Chiral, Pyrolysis and Derivatization Chromatography -Columns and Stationary Phases – Column Efficiency – Method Development - Forensic Applications of Gas Chromatography.

Unit 2: High Performance Liquid Chromatography (9 Hours)

High Performance Liquid Chromatography – Instrumentation - Detectors – Columns and Stationary Phases - Isocratic, Gradient, Adsorption, Partition, Ion and Derivatization Chromatography – Method Development – Applications of Liquid Chromatography - Super Critical Fluid Chromatography – Properties of Super Critical Fluids – Instrumentation – Columns – Detectors – Applications – Capillary electrophoresis – Principles, instrumentation, technique and applications

Unit 3: Mass Spectrometry (8 Hours)

Principle and Instrumentation - Correlation of MS with molecular structure -Interpretation of mass spectra – Applications of mass spectrometry – Atomic mass spectrometry – Mass spectrometers – Inductively coupled plasma-Mass spectrometry. Application of MS in Forensic Science

Unit 4: Hyphenated techniques (8 Hours)

Unit Measurements, signals and data – Introduction – Signal to noise ratio – Sensitivity and detection limit, sources of noise – Evaluation and measurement – Accuracy and instrument calibration Hyphenated techniques – Principle, instrumentation, techniques and applications of GC-FTIR, GC-MS, LC-MS, CE-MS and MS-MS.

Unit 5: Other Techniques (10 Hours)

Microscopy: Theory and basic principles, setup and Forensic applications of Compound, Comparison, Fluorescence, Polarized, Stereo-zoom microscope. Electron Microscopy- Theory and basic principles of Electron Microscopy, Structure and Forensic applications of Scanning Electron microscope (SEM), Transmission Electron Microscope (TEM). -X-Ray diffractometry – Principle, instrumentation, techniques and applications -Thermal Methods – Principles, Instrumentation, Techniques and

Applications of: Thermo gravimetric methods – Differential Thermal Analysis – Differential Scanning Calorimetry

Textbooks:

1. Skoog D. A, West D. M, Holler F. J & Crouch S. R, "Fundamentals of Analytical Chemistry", Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.
2. Willard H, Merrit L, Dean J. A. & Settle F.A., "Instrumental methods of chemical analysis", CBS Publishers and Distributors Pvt. Ltd, New Delhi, 7th edition, 1998
3. Kealey, D. and Haines, P. J.: BIOS Instant Notes in Analytical Chemistry, Taylor & Francis, 2002, ISBN-10: 1859961894; ISBN-13: 978-18599618962002.
4. Settle, F. A.: Hand Book of Instrumental Techniques for Analytical Chemistry, Prentice Hall, 1997.
5. Harris, D. C.: Quantitative Chemical Analysis, 5th edn., Freeman, 1999
6. Sane, R. T and Ghadge, J. K: Thermal Analysis, Theory and Applications, Quest Pub., Mumbai, 1997
7. Christian, G. D.: Analytical Chemistry, Theory and Applications, John Wiley, 2004
8. Sharma, B. K.: Instrumental Methods of Chemical Analysis, Krishna Prakashan Media (P) Ltd, India, 2014
9. Townsends Allen (ed.): Encyclopedia of Analytical Science, Academic Press, 1995
10. Goldsby, R. A., Kindt, T. J., Osborne, B. A and Kuby, J: Immunology, 5th Edn., Freeman, 2003.
11. Mukherjee, K. L (Ch. Ed): Medical Laboratory Technology, Vol I & II, Tata McGraw-Hill, 1988.
12. Gerstein, A.S (Ed): Molecular Biology - Problem Solver – A Laboratory Guide, Wiley- Liss, 2001
13. Jarris, K.E., A.L. Gray & R.S. Hock, EDS; handbook of Inductively Coupled Plasma Mass Spectrometry; Glasgow Blockie, (1992)
14. MacLafferty, F.W. & F. Turecek; Interpretation of Mass spectra; 4th ed Mill Valley, C A Univ. Science Books, (1993)
15. Chapmen, J.R.; Practical Organic Mass spectrometry, A Guide for Chemical and Biochemical Analysis, Wiley, New York, (1993)
16. Lindsay, S.; High Performance Liquid Chromatography, New York, Wiley (1992)
17. Gurdeep R. Chatwal and Sham K. Anand, *Instrumental Methods of Chemical Analysis*, 5th edition, Himalaya Publishing House, 2018.
18. Egon Stahl, Thin-Layer Chromatography: A Laboratory Handbook, CBS Publishers and distributors, 2005
19. Fried Bernard, Thin-Layer Chromatography, Revised And Expanded, Taylor & Francis Inc
20. V. K. Srivastava, K. K. Srivastava, "Introduction To Chromatography Theory & Practice", 4th Edition S. Chand & Company Pvt Ltd, 1991
21. Robert M. Silverstein & Francis X Webster; Spectrometric Identification of Organic Compounds, 6th Edn., John Wiley & Sons, Inc. (1997)
22. P.S. Kalsi; Spectroscopy of Organic Compounds, 4th Edn, New Age International Pub. (2001) w.e.f. 2005-2006
23. R.S. Khandpur; handbook of Analytical Instruments, Tata McGraw Hill Pub. Co. New Delhi (2004)
24. John A. Dean; Analytical Chemistry Handbook, McGraw Hill Inc. (1995)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3		2		1	2		1	1	1
CO2	2	3		2	2			2	3	
CO3	2	2	1	2		3	1	1		2
CO4	3		2	1	1		1	1		
CO5	2	2	1		2		1		2	
CO6	2		2	1		2		2	1	

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20CH3049	Forensic Chemistry Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. detect the liquors and corrosive chemicals
2. Detect the drugs
3. Detect the explosives

Course Outcomes:

The student will be able to

1. Understand the importance of detection of drugs
2. Apply the knowledge to detect inorganic explosives
3. Apply the knowledge to detect organic explosives
4. Find the melting point of various substances
5. Analyze corrosive chemicals
6. Analyze dyes and pigments

LIST OF EXPERIMENTS

1. Detection of methanol, chloral hydrate and alprazolam in alcoholic liquors
2. Extraction and detection of inorganic explosive / explosion residues by spot tests
3. Extraction and detection of inorganic explosive / explosion residues by colour tests
4. Extraction and detection of organic explosive / explosion residues by spot tests
5. Extraction and detection of organic explosive / explosion residues by colour tests and TLC
6. Analysis of Phenolphthalein in trap cases.
7. Analysis of forensically important cosmetics
8. Analysis of Dyes, Pigments & Polymers
9. Forensic analysis of oils and fats
10. Analysis of chemical fertilizers, consumer items such as gold, silver, tobacco, tea, sugar, salts,
11. Analysis of Corrosive chemicals: Hydrochloric acid, sulphuric acid, and nitric acid and alkalis.
12. Detection of Narcotic Drugs and Psychotropic Substances (NDPS) eg. Opiates, barbiturates, benzodiazepines, amphetamines and cannabis by spot / colour tests.
13. Chemical analysis of liquors.
14. Forensic Drug Testing by Color/spot test, Microcrystalline testing
15. Melting Point determination of some substances of forensic interest.
16. Forensic investigation of arson scene of crime.
17. Forensic analysis of arson related evidences.
18. Characterization and analysis of adulteration of Petroleum products.
19. Bomb scene investigation
20. Systematic analytical approach to pre-blast and post-blast explosives
21. Examination of a bribe trap case
(Minimum 10 experiments to be completed)

Text Books:

1. Thomas Catalano, Good Laboratory Practices for Forensic Chemistry, Springer, 2014
2. Petraco, N and Kubic, T. "Forensic Science Laboratory Manual and Workbook", 3rd Edition, CRC Press, 2009
3. Frank Lundquist, Methods of Forensic Science, Vol. 1, New York, Interscience, 1962.
4. Frank A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, Upper Saddle River, 1997.

20CH3050	Forensic Tools and Techniques Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. Understand the importance of analytical chemistry
2. Realize the use of qualitative analysis
3. Realize the importance of quantitative analysis

Course Outcomes:

The student will be able to

1. Understand the importance of accuracy
2. Realize the importance of qualitative inorganic analysis
3. Apply the organic qualitative analysis
4. Practice volumetric analysis
5. Apply gravimetric method of analysis
6. Apply various separation techniques

LIST OF EXPERIMENTS

1. Work out the problems related to mean, median, mode, standard deviation, probability, Chi-square test, t-test and correlation
2. Familiarize the technique of data representation (tables, bar-diagram, histogram, pie- diagram and frequency curve, manual and using computer)
3. Qualitative analysis of Lead, Arsenic, Chromium, Zinc, Selenium, Thallium,
4. Qualitative analysis of Cyanide, Thiocyanate, Phosphate, Chlorate, Perchlorate ions in compounds
5. Detection of non nitrogenous and nitrogenous functional groups in organic compounds
6. Partition coefficient of benzoic acid between benzene and water
7. Determination of sodium carbonate and sodium bicarbonate in a mixture with standard HCl
8. Determination of purity of potassium /sodium nitrite by permanganometry
9. Estimation of ferric iron in ferric alum by dichromatometry
10. Estimation of lead by iodimetry
11. Estimation of calcium and magnesium by EDTA complexometry
12. Preparation of buffer mixtures and measurement of pH
13. Study of hydrolysis of an ester catalysed by an acid
14. To determine the concentration of a colored compound by colorimetry analysis (Minimum 10 experiments to be completed)

Text Books:

1. Petraco, N and Kubic, T. "Forensic Science Laboratory Manual and Workbook", 3rd Edition, CRC Press, 2009
2. Frank Lundquist, Methods of Forensic Science, Vol. 1, New York, Interscience, 1962.
3. Frank A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, Upper Saddle River, 1997.
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton, 2005.
5. Thomas Catalano, Good Laboratory Practices for Forensic Chemistry, Springer, 2014
6. Alexeyev, V: Quantitative Analysis, CBS Pub, New Delhi, 2007, ISBN-10: 812390293X, ISBN-13: 978-8123902937
7. J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas "Vogel's Quantitative Chemical Analysis", 6th edition, 7th Impression, Dorling Kindersley limited, New Delhi, India, 2008

20CH3051	Forensic Toxicology Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. Understand the methods of detecting poisons
2. Understand the estimation of poisonous substances
3. Extract the substances systematically

Course Outcomes:

The student will be able to

1. Understand the methods of extraction of poisons
2. Apply the methods to separate insecticides and pesticides
3. Identify the poisons microscopically
4. Analyze the poisonous substances
5. Identify various types of drugs

- Determine the amount of drug or pesticide in a specimen

LIST OF EXPERIMENTS

- Extracting poisons from viscera/blood and urine samples.
- TLC separation of pesticides/insecticides & Identification using chromomeric reagents
- Lab testing of Aluminum Phosphide (Phosphine gas)
- Identification of Gaseous Poisoning (Carbon Monoxide and HCN)
- Detection of metallic poisons using Reinsch Test.
- Extraction and analysis of different categories of poisons from viscera.
- Estimation alcohol in Blood.
- Microscopic Identification of plant poisons.
- Analysis of viscera and food material for in case of food poisoning by chemical microscopic and instrumental techniques.
- Qualitative Descriptions of Toxicity Exposure Limits Determination of LD50 and ED50, Units in Toxicology.
- Preliminary tests directly on blood / urine / vomitus / tissues for heavy metals, alkaloids, pesticides, cyanide, phenolic compounds and alcohol
- Detection and determination of ethyl alcohol in blood / urine / visceral tissue by Kozelka & Hine's method
- Detection and determination of ethyl alcohol in blood / urine / visceral tissue by gas chromatography
- Systematic extraction of basic substances from viscera
- Systematic extraction of neutral & acidic substances from viscera (Minimum 10 experiments to be completed)

Textbooks:

- Curtis D. Klaassen, "Casarett & Doull's Toxicology: The Basic Science of Poisons" 9th edition, McGraw-Hill Education, 2019
- "Clarke's isolation and identification of drugs", edited by A. C. Moffatt., 2nd Edition, Pharmaceutical Press: London. 1986.
- Curry A.S., "Analytical Methods in Human Toxicology, Part II" CRC Press, Ohio, 1986.
- Curry A. S., "Poison detection in human organs (American lecture series)", Thomas Publishers, 1976.
- CRC Handbook of Toxicology, Edited by M. J. Derelanko and M. A. Hollinger, CRC Press, 1995.
- Morgan B.J.T., "Statistics in Toxicology" Clarendon Press, Oxford. 1996
- Modi, "Text Book of Medical Jurisprudence Forensic Medicines and Toxicology" CBS Pub. New Delhi, 1999
- Saferstein, R., "Forensic Science Handbook", Volumes I, II and III, 2nd edition, Pearson, 2001
- DFS Manual of Forensic Toxicology
- Moffat, A. C., Osselson, M. D., Widdop, B and Watts, J, "Clarke's Analysis of Drugs and Poisons" Fourth edition, Pharmaceutical Press: London. 2011

20CH3052	Instrumental Analysis Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

- Understand the importance of spectroscopic techniques
- Realize the use of conductometric analysis
- Realize the importance of potentiometry

Course Outcomes:

The student will be able to

- Understand the applications of Lambert-Beer Law
- Realize the importance of spectroscopic methods of analysis
- Use spectroscopic techniques for the identification of drugs

- Analyze the sample using IR spectroscopy
- Understand the importance of conductometric titration techniques
- Apply potentiometric titration

LIST OF EXPERIMENTS

- Verification of Beer's law and calculation of molar absorption coefficients for CuSO₄
 - Verification of Beer's law and calculation of molar absorption coefficients for KMnO₄
 - To identify drug samples using UV – visible spectroscopy
 - Determination of a drug in urine by visible / UV spectrophotometry
 - IR spectroscopy of samples of forensic interest -1
 - IR spectroscopy of samples of forensic interest -2
 - Conductometric titration of weak acid vs. strong base
 - Conductometric titration of strong acid vs. strong base
 - Conductometric titration of mixture of acids vs. strong base
 - Potentiometric redox titration of potassium dichromate-ferric ammonium sulphate
 - Potentiometric titration -2
 - Potentiometric titration – 3
- (Minimum 10 experiments to be completed)

Text Books:

- Petraco, N and Kubic, T. "Forensic Science Laboratory Manual and Workbook", 3rd Edition, CRC Press, 2009
- Frank Lundquist, Methods of Forensic Science, Vol. 1, New York, Interscience, 1962.
- Frank A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, Upper Saddle River, 1997.
- S.H. James and J.J. Nordby, Forensic Science: An Introduction to scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton, 2005.
- Thomas Catalano, Good Laboratory Practices for Forensic Chemistry, Springer, 2014
- Alexeyev, V: Quantitative Analysis, CBS Pub, New Delhi, 2007, ISBN-10: 812390293X, ISBN-13: 978-8123902937
- J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas "Vogel's Quantitative Chemical Analysis", 6th edition, 7th Impression, Dorling Kindersley limited, New Delhi, India,

20CH3053	Modern Instrumental Analysis Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

- understand experiments based on chromatography
- realize the importance of chromatographic techniques for separation
- Analyze the SEM photograph

Course Outcomes:

The student will be able to

- Utilize color test for the identification of drugs
- Use TLC for the identification of drugs
- Use TLC for the identification of pesticides
- Apply GC technique for the identification of drug
- Understand the use of HPLC in forensic science
- Analyze the SEM photograph

LIST OF EXPERIMENTS

- Identification of basic drugs (from the extract) by colour tests and TLC -1
- Identification of basic drugs (from the extract) by colour tests and TLC -2
- Identification of neutral and acidic drugs (from the extract) by colour tests and TLC -1
- Identification of neutral and acidic drugs (from the extract) by colour tests and TLC -2
- Identification of pesticides (from the extract) by TLC
- Detection of (NDPS) by TLC
- Determination of a drug / pesticide in toxicological specimen by GC -1

8. Determination of a drug / pesticide in toxicological specimen by GC -2
 9. Determination of a drug / pesticide in toxicological specimen by HPLC
 10. GC-MS / LC-MS of a poison of forensic interest (Demo only)
 11. Determination of a drug of forensic interest by GC
 12. Determination of a drug / explosive of forensic interest by HPLC
 13. SEM Analysis-1(Metal fragment/Hair/Fiber/Paint/Ink)
 14. SEM Analysis-2(Metal fragment/Hair/Fiber/Paint/Ink)
- (Minimum 10 experiments to be completed)

Text Books:

1. Petraco, N and Kubic, T. "Forensic Science Laboratory Manual and Workbook", 3rd Edition, CRC Press, 2009
2. Frank Lundquist, Methods of Forensic Science, Vol. 1, New York, Interscience, 1962.
3. Frank A. Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall, Upper Saddle River, 1997.
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton, 2005.
5. Thomas Catalano, Good Laboratory Practices for Forensic Chemistry, Springer, 2014
6. Alexeyev, V: Quantitative Analysis, CBS Pub, New Delhi, 2007, ISBN-10: 812390293X, ISBN-13: 978-8123902937
7. J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas "Vogel's Quantitative Chemical Analysis", 6th edition, 7th Impression, Dorling Kindersley limited, New Delhi, India,

20CH3054	Biochemistry and Biochemical Applications	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand the basic concepts of biochemistry
2. Learn the role of biomolecules
3. Understand the importance of electrophoresis

Course Outcomes:

The student will be able to

1. understand the various types of biomolecules
2. understand the importance of Amino acids
3. summarize the composition of proteins
4. understand the enzyme action
5. know the role of nucleic acids
6. summarize the principles of electrophoresis

Unit 1: Proteins and peptides (9 Hours)

Biomolecules and cells – Biological fitness of organic compounds – Hierarchy of molecular organization of cells – Primordial biomolecules – Specialization and differentiation of biomolecules- The dimensions and shapes of biomolecules- Biomolecules supra molecular structures and cell organelles- Structural organization of cells. Proteins and peptides – Composition of proteins – Size of protein molecules – Confirmation of protein supra molecular assemblies of proteins – Denaturation – Estimation of proteins Functional diversity of proteins – Antibodies and immune response – The species specificity of proteins – Sequence isomerism in polypeptide chains – Genetic coding of amino acid sequences in proteins- Mutation – Structure of peptides – Optical and chemical properties of peptides- Steps in determination of amino acid sequence – Separation and analysis of peptides – Sequence analysis of peptide fragments.

Unit 2: Amino acids (9 Hours)

Amino acids – Common amino acids of proteins – Rare amino acids of proteins – Non protein amino acids- Physicochemical properties of amino acids – Absorption spectra of amino acids – Chemical reactions of amino acids – Analysis of amino acid mixtures – Complete hydrolysis of polypeptide chains and determination of amino acid composition – Identification of N-terminal and C-terminal residues of peptides.

Unit 3: Enzymes (9 Hours)

Enzymes – Definition, types and classification - Biological activities – Kinetics – Inhibition - Types of inhibition - Poisoning – Micheles-Mentor's equation – Enzyme polymorphism – Purification of proteins and enzymes – Enzyme assay techniques: UV-Vis, Luminescence, Radio isotope and immunochemical methods – Automated enzyme analysis – Immobilized enzymes.

Unit 4: Nucleic Acids (9 Hours)

Nucleotides – General structure of the nucleotides – Pyrimidines and purines – Nucleosides, Nucleotides – Nucleic acids – RNA and DNA - Short hand representation of nucleic acid back bones- Hydrolysis of nucleic acids by acids and bases – Enzymatic hydrolysis of nucleic acids – Analysis of nucleotide sequence in nucleic acids – Nucleic acid- Protein supra molecular complexes – DNA sequencing – PCR technique

Unit 5: Electrophoresis (9 Hours)

Electrophoretic Techniques – Overview of Electrophoresis – Principles – Classification of electrophoresis - Factors affecting migration – Instrumentation, Techniques and Applications of: Zone Electrophoresis – Cellulose Acetate Membrane Electrophoresis – Agar Gel Electrophoresis – Acryl amide Gel Electrophoresis – Capillary electrophoresis -Isoelectric Focusing – Isotachophoresis – Biochemical techniques – General principles – pH and buffers – physiological solution – Cell and tissue culture – Cell fractionation –DNAProfiling Techniques: PCR, RFLP etc. Centrifugation techniques- Forensic Application of electrophoresis,

Textbooks:

1. Nelson, D. L., and Cox, M. M., "Lehninger Principles of Biochemistry", 3rd edition., Macmillan Worth, 2000
2. Voet, D. and Voet, J.G., "Biochemistry", 2nd edition, John Wiley, 1995
3. Rao, P. Gundu, "Biochemistry", VallabhPrakashan, 1995
4. White, A., Handler, P. and Smith, E., "Principles of Biochemistry", 5th Edition, McGraw-Hill Kogakusha Ltd, 1973
5. Turner, P.C, McLennan, A. G., Bates, A. D., and White, M. R. H., "Molecular Biology", 2nd edition. BioScientific/Viva Books, 2001.
6. Rao, Rama. A. V. S. S., "A Text Book of Biochemistry", 8th editionn., L. K & S Pub, 1998
7. Henry, B. J., "Clinical Diagnosis and Management by Laboratory Methods", 19th edition., Harcourt / Thomson, 1999.
8. Gowenlock, A. H., "Practical Clinical Biochemistry", 6th edition., Butterworth / CBS, 1988
9. Plummer, D. T., "An Introduction to Practical Biochemistry", 15th edition, Tata McGraw Hill, 1988.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	2		3	1	1		2	1	2
CO2	2	1	2		2	2		2	2	
CO3	3		2	2	1	2	1	1		2
CO4	3	2	1	2			1	1	2	
CO5	2		2	1		1	2	2	2	
CO6		2	2	1		2	2	1	2	2

'3'-High, '2'- Medium, '1'-Low, '- No correlation

20CH3055	Standards, Quality Management, Laboratory Management and Safety	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand about various standards used
2. know about the laboratory management and quality management
3. apply the steps to be taken for laboratory safety

Course Outcomes:

The student will be able to

1. summarize various chemical standards

2. Summarize various biological standards
3. Understand about the quality management systems
4. Realize the importance of Laboratory Management
5. understand Laboratory Information Management system
6. apply the steps to maintain Laboratory safety

Unit 1: Standards for analysis (9 Hours)

Basic standards – Need of standards in analytical sciences – Basic chemical standards – Analytical standards – Reference materials – High purity substances – Certified reference materials – Working or secondary standards – Matrix effect in standards – Biological standards – Biochemical standards – Microbial cell lines and standards

Unit 2: Quality Management (9 Hours)

Introduction – Quality - Quality system – Quality plan – Inspection and testing – Test records – Control of inspection - Handling, storage, packaging, preservation and delivery of the material – Control of quality records – Internal quality audits – Quality assurance – Training Laboratory Accreditation – ISO 9000 - ISO 14000 and 17000 series of standards – Accreditation Boards – NABL guidelines for accreditation in India Proficiency testing system – Internal quality control – Inter and intra laboratory testing programmes – Designing and running the proficiency testing programmes – Confidentiality - Advantages of accreditation

Unit 3: Laboratory Management (9 Hours)

Administration of Laboratories – Types of laboratories – Connection between field work and laboratory – Educational requirements of laboratory personnel – Routine laboratory work – Research and development – Internal organization of a laboratory Architectural requirements – Laboratory design – Floor area - Furniture design – Auxiliary services – Receipt of reports and remnants – Record management – Requirement of equipment, glassware, chemicals and other material – Purchase procedure – Disposal of wastes – Security of the premises

Unit 4: Laboratory Information Management system (LIMS) (9 Hours)

Classification of LIMS - Functions – Sub-division by functional area – Definition of LIMS – Strategic design of LIMS – System development life cycle – Review of the laboratory – Project proposal – Definition of system requirements – Specifications – Commercial or Bespoke LIMS – Evaluation – Purchase and installation – Demonstration – Validation – User training and implementation

Unit V: Laboratory Safety (9 Hours)

Planning – Written safety plan – Safety policies – Safety resources – Operations - Hazards of chemicals, solvents, poisons and explosives – Storage facilities – Biological hazards - Pressure vessels and their handling – Electrical safety – Fume cup boards-Exhausts system – Protective equipment - Emergency care and medical facilities

Textbooks

1. Woodget, B. W. and Cooper, D., "Sample and Standards", ACOL Series, Wiley, 1987
2. Dux, J. P., "Hand Book of Quality Assurance for Analytical Chemistry Laboratory", Van Nostrand, 1986
3. Duncan, W. L and International, L.W, "Total Quality: Key Terms and Concepts" AMACOM publishers, 1995
4. Shah, D. H., "QA Manual", Business Horizons, 2000
5. Kumar, K., "Quality Management", ABD Pub., 2000
6. Ross, J., "Total Quality Management", Vanit Book, Intl., 1995
7. Seiler, J. P., "Good Laboratory practice", Springer, 2000
8. Diwan, P., "Quality in Totality, Manager's Guide to TQM and ISO 9000", Deepti&Deepti Pub., 2000
9. Gyani, G. J. "Training Manual on ISO 9000; 2000 and TQM", Raj Pub., 1999
10. Olson, M. H. and Davis, G. B., "Management Information Systems" McGraw Hill, 1998
11. Specific Guidelines for Accreditation of Forensic Science Laboratories, DST, 1998
12. "Guide for Safety in The Chemical Laboratory:", Manufacturing Chemist's Association, 2nd Edition, 1972
13. Steere N. V.(Ed.), "Hand Book of Laboratory Safety", CRC, 1967
14. Tilstone, W. J. and Lothridge, K., "Crime Laboratory Management", Taylor and Francis, 2004

15. Clair, J. S, "Crime Laboratory Management", Academic Press, 2003
16. Siegel, J. A, Saukko, P. J and Knupfer, G. C (Eds.), "Encyclopedia of Forensic Sciences", Academic Press, 2000

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3		2			2		1	2	
CO2	2	1		2	1		1	1	1	
CO3	3	2	1			2		1	2	
CO4	3	1		2	2	1	1	2	1	1
CO5	2	2	2		1	2	2	2	1	3
CO6	2	3	1		2		2	1	2	3

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3056	IPR, Ethics and Research Methodology				L	T	P	C
					3	0	0	3

Course Objectives:

Enable the student to

1. Understand about IPR
2. know about the research ethics
3. apply the steps to be taken in research methodology

Course Outcomes:

The student will be able to

1. realize the importance of IPR
2. apply the ethics to be carried out in research
3. summarize the steps in research methodology
4. differentiate basic research and applied research
5. design experiments
6. follow the research progress

Unit 1: Intellectual Property Rights (9 Hours)

Meaning,- Evolution – Classification and forms – Rationale for protection of IPRs – Importance of IPRs in the fields of science and technology – Patents – Concepts and principles of patenting – Patentable subject matter – Procedure of obtaining patents – Rights of patents — Patentability and emerging issues. Role of WIPO – PCT.

Unit 2: Ethical Issues(9 Hours)

Introduction – Causes of unethical acts – Ignorance of laws, codes, policies and procedures – Recognition – Friendship – Personal gain - Professional ethics – Professional conduct - Ethical decision making – Ethical dilemmas - Teaching ethical values to scientists – Forensic Science ethics and Personal ethics – Organizational Forensic Science Ethics – Code of ethics in Forensic Science practice – Standards for good forensic practice - Good laboratory practices (GLP) – Good manufacturing practices (GMP).

Unit 3: Research methodology(9 Hours)

Introduction – Basic research – Applied research – Need based research –Keywords and its significance- Literature search — Information sources – Library resources – Reference Books, Journals, abstracts, hand books, procedure manuals, encyclopedias, annual reports, data banks, CDROMS and online literature search – Internet access, websites and directories of information resources - Identification of the Research problem – Research project planning.

Unit 4: Design of Experiments (9 Hours)

Design of the experimental programme –Variables in the experiments – Materials and methods – Evolution of method –Application of the method – Reproducibility – Report of research findings.

Unit 5: Research Progress (9 Hours)

Progress of research – Evaluation of results – Statistical approach – Comparison with existing methodologies – Validation of findings – Research communications – Plagiarism - Research ethics- Impact factors of journals

Suggested reading:

1. American Academy of Forensic Sciences: Code of Ethics and Conduct, Colorado Springs, 1998

- Chadwick, R: Concise Encyclopedia of the Ethics of New Technologies, Academic Press, 2001
- Siegel, J. A, Saukko, P. J and Knupfer, G. C (Eds.): Encyclopedia of Forensic Sciences, Academic Press, 2000.
- IPO Intellectual property handbook, WIPO Publication no. 489 (E) ISBN 978-92-805-1291-5, WIPO 2004 Second Edition Reprinted 2008.
- Patent IPR Licensing- Technology Commercialisation – Innovation Marketing, By Indian Innovators Association, Notion Press, ISBN: 978-1-947851-43-6.

	PO 1	PO2	PO 3	PO4	PO5	PO 6	PO7	PSO1	PSO 2	PSO 3
CO1	2	1	1		2	1		1	1	
CO2	3	2		2	1		1	1	1	
CO3	3	2	2	1		2		2	2	
CO4	2		3	2	2			1	2	3
CO5	2	1	3	2		1	2		2	3
CO6	3	3	2	1	2		2	2	2	2

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20CH3057	Forensic Analysis of Drugs	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

- Learn about the drug and drug abuse
- Understand the problems of Clandestine laboratory
- Summarize the drugs used in sports

Course Outcomes:

The student will be able to

- understand about drug
- summarize the illegal drugs
- understand the chemistry of drugs
- understand the methods of analysis of drugs
- realize the problems of Clandestine laboratory
- summarize the drug abuse in sports

Unit 1: Drug (9 Hours)

Definition of Drug, Drug Use & Misuse, Drug Chemistry, Drug Dependence and chemistry of Addiction, Drug Receptors and Brain Chemistry. Drugs of Abuse: Definition, Classification based on Form and Origin, Use, Effects and Schedules, Structure of NDPS Act and the definitions of each drug classification, Drugs as Evidence, Profiling Examples of Illegal Drugs, United Nations International Drug Control Programme.

Unit 2: Chemistry and Analysis of Drugs of Abuse (9 Hours)

Origin, Pharmacology, Methods of preparation, Storage, Diluents and Adulterants, Sample Handling, Optimization of Experimental Conditions, Presumptive/Screening and Confirmatory Methods - Legal Implications and Data Interpretation of Opium and Opioids analgesics, Stimulants (Cocaine, Amphetamine & other amphetamine derivatives), Depressants (Barbiturates and Benzodiazepines), Hallucinogens (Cannabis, LSD, Psilocybine and Mescaline), OTC, Inhalant and Volatile Substances, Drugs in sexual assault

Unit 3: Clandestine laboratory (9 Hours)

Meaning and Definition of Clandestine, Clandestine Laboratory, Related Problems, Factors Contributing to Clandestine Drug Labs, Harms Caused by Clandestine Drug Labs, Equipment Needs: Reflux, Distillation, Hydrogenation, Bucket Chemistry, Extractions, Chemical Needs, Cooking Methods Commonly Used in Clandestine Drug Labs, Extraction Process, Conversion Process, Synthesis Process, Tableting. Designer drugs: Definition, Analogs of Fentanyl and Meperidine (both synthetic opioids), Phencyclidine (PCP), Amphetamines and methamphetamines (which have hallucinogenic and stimulant properties).

Unit 4: Laboratory Analysis (9 Hours)

The Chemist, Extractions: Physical Extraction, Dry Wash/Extraction, Liquid/Liquid Extractions, Analysis: Chemical Color Tests, Microscopic Techniques, Infrared Spectroscopy, Thin-Layer Chromatography, Ultraviolet Spectroscopy, Gas Chromatography. Format of NDPS Report Writing & Court Room Testimony.

Unit5: Drug Abuse in Sports (9 Hours)

Introduction, International Olympic Committee (IOC), World Anti-Doping Agency (WADA), classification of commonly prohibited substances and Performance enhancing Drugs, Steroids, Stack and Pyramid methods, Dope test and Blood Doping, Sampling techniques, analytical approaches.

Textbooks:

1. Moffat, A.C. : Osselton, D. M. Widdop, B. : Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, body fluids and postmortem material, 3rd ed., Pharmaceutical Press, 2004.
2. "Clarke's isolation and identification of drugs", edited by A. C. Moffatt., 2nd Edition, Pharmaceutical Press: London. 1986.
3. Modi, "Text Book of Medical Jurisprudence Forensic Medicines and Toxicology" CBS Pub. New Delhi, 1999
4. Saferstein. R, "Forensic Science Handbook", Volumes I, II and III, 2nd edition, Pearson, 2001
5. DFS -Working Procedure Manual- Narcotics
6. Stahl, E., "Thin-Layer Chromatography: A Laboratory Handbook", CBS Publishers and distributors, 2005
7. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1		2	2		1		2	1	
CO2	1	1		2	2			1	2	
CO3	2		2	3		2	2		2	2
CO4	3	2	1	2			1	1	1	2
CO5	2	2			1	2	2	1	2	3
CO6	1	1	2	2	1	1	2	1		3

'3'-High, '2'- Medium, '1'-Low, '- ' No correlation

20CH3058	Advanced Pharmaceutical Toxicology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. know the chemical mediators and mechanisms by which the drugs act
2. know the drug therapy of certain disorders
3. understand different types of toxicities understand gene therapy

Course Outcomes:

The student will be able to

1. understand signaling molecules and receptors
2. summarize about signal transduction
3. understand the chemistry of mediators
4. understand about the pharmacotherapy
5. summarize about reproductive toxicology
6. summarize about carcinogenicity

Unit1: Molecular Mechanisms in Cell regulation (9 Hours)

Cell Regulation-. Signaling molecules and their receptors -Molecules: Nitric oxide, carbon monoxide, neurotransmitters, cytokines, peptide hormones, growth factors and eicosanoids - Receptors - Cell surface Receptors: Ion channels, G-protein coupled receptors, tyrosine kinase receptors, cytokine receptors, non-receptor protein tyrosine kinases - Nuclear receptors: Steroid hormone receptors, thyroxine receptors, other nuclear receptor families - Signal transduction - Intracellular signal transduction: cAMP, cGMP, IP3-DAG, calcium pathway, PI3K/Akt, m-TOR, MAPK, JAK/STAT, TGF β /Smad, NFB signaling, Hedgehog-Wnt, Notch pathways including Adrenergic and cholinergic transmissions. Other peripheral

mediators: 5-HT and Purines, Cannabinoids, Peptides and proteins - Cytoskeleton signal transduction: Integrins and signal transduction, regulation of actin cytoskeleton

Unit 2: Chemical Mediators (9 Hours)

Biosynthesis, pathophysiological roles, receptors and drugs affecting the receptors for following - Mediators of inflammation and allergy: Histamine, Bradykinin, PAF, Eicosanoids: prostaglandins, thromboxanes, leukotrienes and related compounds, EDRF and vascular substances, oxygen free radicals, Cytokines, Cox-1 and Cox-2.

Unit 3: Pharmacotherapy-1 (9 Hours)

Pathophysiology, Pharmacotherapy and critical analysis of rational use of drugs in the following disorders - Introduction to Pharmacotherapeutics - CVS: Hypertension, Ischaemic heart disease, CCF, Cardiac arrhythmias and dyslipidaemia. - Respiratory: Asthma and COPD -CNS: Parkinson's disease, Alzheimer's disease, Schizophrenia, Affective disorders, Epilepsy, insomnia, anxiety and pain management - Musculoskeletal: Rheumatoid & Osteoarthritis, hyperuricaemia, Myasthenia gravis.

Unit 4: Pharmacotherapy-II (9 Hours)

GIT: Peptic ulcer, GERD, Inflammatory bowel diseases, constipation, diarrhea - Endocrine: Obesity, Diabetes mellitus, Osteoporosis, Thyroid and parathyroid disorders - Infectious: UT infections, RT infections, GI infections (Bacterial and protozoal), Malaria, Tuberculosis, AIDS, Malignant: Leukaemia, Lymphomas and solid tumours.

Unit 5: Toxicity studies (9 Hours)

Acute, sub-acute and chronic studies: Protocols, objectives, methods of execution and regulatory requirements - Reproductive toxicology assessment: Male reproductive toxicity, spermatogenesis, risk assessment in male reproductive toxicity, female reproductive toxicity, oocyte toxicity, alterations in reproductive endocrinology, relationship between maternal and developmental toxicity - Mutagenicity: In vitro tests for gene mutations in bacteria, chromosome damage, gene mutations in vivo (micronucleus tests and metaphase analysis) in rodents - Carcinogenicity studies: In vivo and In vitro studies - Toxicological requirements for biological and bio-tech products: Safety analysis, concept of safety Pharmacology, antibodies, transmission of viral infections, residual DNA

Text Books:

1. Brunton, L.L., Hilal-Dandan, R and Knollmann, B.C., "Goodman and Gilman's The Pharmacological Basis of Therapeutics" 13th Edition. McGraw Hill, New York, 2018.
2. Rang, H.P, Dale, M.M., and Ritter, J.M, "Pharmacology", 6th Edition, Churchill Livingstone, London, 1999.
3. Katzung, B. G, "Basic and Clinical Pharmacology", 8th Edition, Lange Medical Book/McGraw-Hill, U.S.A., 2001)
4. D.R. Laurence, D. R, Bennett, P. Nand Brown, M., "Clinical Pharmacy" 8th Edition, Churchill Livingstone, 1997.
5. Herfindal, E. T and Hirschman, "Clinical pharmacy and therapeutics" 3rd edition, Williams and Wilkins Publications 1984
6. Walker, R and Whittlesea, C, "Clinical pharmacy and therapeutics", 5th Edition, Churchill Livingstone Publication, 2012
7. Waynforth, H.B, and Flecknell, P, "Experimental and Surgical Techniques in the Rat", 2nd Edition, Academic Press, 1992.

Reference Books:

1. Jameson, J. L, Fauci, A. S, (Author), Kasper, D. L, Hauser, S. L, Longo, D. L and Loscalzo, J, "Harrison's Principles of Internal Medicine" 20th Edition, Volume I & Volume II, McGraw Hill Education, 2018 Pharmacotherapy; A pathophysiologic approach-Joseph T. Dipiro et.al Appleton and Lange
2. Ballantyne, B., Marrs, T and Syversen, T (eds). "General and Applied Toxicology", 2nd Edition, 3 Vols, Macmillan Press, 2000

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1		1	2	2	1		2	1	
CO2	1	2		2		2	1	1	2	
CO3	3	2	1	2		1	1	1	1	

CO4	2		1	3	1	2	1	1	2	3
CO5	3	2	2	1	2		1	2	1	3
CO6	1	3	2		2		2	2	2	2

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20CH3059	Analytical Forensic Toxicology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand the basic steps involved in sample collection
2. Learn the methods involved in analysis of alcohol intoxicification
3. Summarize various types of poisons

Course Outcomes:

The student will be able to

1. Apply the methods of sample collection
2. Understand the steps involved in alcohol intoxicification
3. Summarize the types of animal poisons
4. Summarize the types of plant poisons
5. Summarize the types of gaseous poisons
6. Summarize the types of food poisons

Unit 1: Samples required in Toxicological analysis (9 Hours)

Selection of Post-mortem samples and reference to particular class of poison, Classes of samples (Biological and Non-biological), Methods of sample collection (Living and Dead person), Classification of matrices, choice of preservatives, containers and storage conditions. Alternative specimens: Hair analysis, Drugs in oral fluid, Detection of drugs in sweat etc. Analysis of Exhumed and decomposed bodies.

Unit 2: Alcohol Intoxication & analysis (9 Hours)

Related cases, Properties and types of Alcohols, Pharmacology, Toxic properties and effects of alcohol. Chemical tests for alcohol in blood and urine including Breath Alcohol Screening devices, Method of analysis of some alcoholic beverages in biological materials by chemical methods (Kozelka- Hine) and instrumental methods (GC), Legal context to drinking and driving. Format of Report Writing & Court Room Testimony: Information required by the Forensic toxicologist, Presenting findings in a Report format.

Unit 3: Animal and Plant Poisons (9 Hours)

Insects and animal toxins and their examination, Composition of Snake venoms, Sites and mode of action, Effect on the body as a whole, and tests for identifications. Plant poisons: Classification and characteristics, method of extraction and stripping of plant poisons in matrices and analysis by chemical and instrumental techniques.

Unit 4: Gaseous Poisoning (9 Hours)

Carbon Monoxide, Hydrogen Cyanide and Phosphine gas, significance, signs and symptoms, methods of diagnosis, tests for identification.

Unit 5: Food Poisoning (9 Hours)

What is food poisoning, Food poisoning due to chemical and bacterial, Sign and symptoms of food poisoning, collection and preservation of evidence material, extraction and isolation, from food material, Biological material, detection and identification by colour test and Instrumental techniques.

Suggested books:

1. Moffat, A. C, Osselton, M. D, Widdop, B and Watts, J, "Clarke's Analysis of Drugs and Poisons" Fourth edition, Pharmaceutical Press: London. 2011,
2. Curtis D. Klaassen, "Casarett & Doull's Toxicology: The Basic Science of Poisons" 9th edition, McGraw-Hill Education, 2019
3. Curry A.S, "Analytical Methods in Human Toxicology, Part II" CRC Press, Ohio, 1986.
4. Curry A. S., "Poison detection in human organs (American lecture series)", Thomas Publishers, 1976.

5. CRC Handbook of Toxicology, Edited by M. J. Derelanko and M. A. Hollinger, CRC Press, 1995.
6. Morgan B.J.T, "Statistics in Toxicology" Clarendon Press, Oxford.1996
7. Modi,"Text Book of Medical Jurisprudence Forensic Medicines and Toxicology" CBS Pub. New Delhi, 1999
8. Saferstein. R, "Forensic Science Handbook", Volumes I, II and III, 2nd edition, Pearson, 2001
9. DFS Manual of Forensic Toxicology

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	1		2	2	1		1	1	
CO2	1		2	2	1	1	1	1	1	
CO3	2	3	1	2		2	1	2	1	
CO4	2	1	2		2	1	2	1	2	3
CO5	2	3	1	2		2	2	2	2	2
CO6	3	2	2		1	1	2		2	2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3060	Electrochemical Devices for Electric Vehicles				L	T	P	C
					3	0	0	3

Course Objectives:

Enable the student to

1. learn the basics of electrochemical devices
2. learn the fundamentals of energy storage and testing procedures
3. learn about the future of electric vehicles

Course Outcomes:

The student will be able to

1. understand the fundamental concepts of electrochemical devices
2. understand the principle, design and application of storage batteries
3. understand the evaluating procedures of electrochemical devices
4. know the principles of electrochemical capacitors
5. know concepts of operation of fuel cell systems
6. understand about basics of hybrid electric vehicle

Unit 1: Basics of electrochemical devices (9 hours)

EMF, reversible and irreversible cells, free energy, effect of cell temperature, thermodynamic calculation of the capacity of a battery, calculations of energy density of cells - Factors affecting battery capacity, voltage level, current drain of discharge, types of discharge: continuous, intermittent, constant current, constant load, constant power, service life, voltage regulation, charging methods, battery age & storage condition.

Unit 2: Storage batteries (9 Hours)

Principle, design, construction, performance characteristics, advantage and disadvantages - Primary batteries - Zn-MnO₂ carbon-zinc, carbon-zinc chlorides, and zinc-silver oxide- Secondary batteries – lead-acid, nickel-cadmium, nickel-metal hydride, silver oxide-zincsystem, lithium-ion, lithium- polymer battery systems - Battery maintenance and safety precautions - Application of phase-change materials for energy conservation - Batteries for electric vehicle applications.

Unit 3: Testing & evaluation of electrochemical devices (9 Hours)

Evaluation of active mass, surface area measurement - BET method - Internal resistance of cells - A.C. impedance method - Testing of capacity, retention of charge, vibration, life, efficiency, leakage for sealed cells, high rate discharge, testing of separators.

Unit 4: Fuel cells & super capacitors (9 Hours)

Introduction to super capacitors, types of super capacitors - Introduction to fuel cells, types of fuel cells and technology development - Polymer electrolyte, direct methanol, phosphoric acid, molten carbonate and solid oxide fuel cells – Material related challenges - Stack engineering - Microbial fuel cells

Unit 5: Future of Electric vehicles (9 Hours)

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles - Laboratory Test of Electric Vehicle Batteries, Vehicle tests with Electric Vehicle Batteries, Safety of electric vehicle, Charging station and Fast Charging of Li-ion battery - Future of Electric Vehicles.

Text Books:

1. Linden, D., Reddy, T.B., "Hand book of batteries and Fuels", 3rd Edition, McGraw Hill Book Company, 2002.
2. McNiol B.D., Rand, D.A.J., "Power Sources for Electric Vehicles", Elsevier Publications, 1998.
3. Nazri, G.A., "Lithium batteries – Science and Technology", Springer, New York, 2009.
4. Emadi, A. (Ed.), Miller, J., Ehsani, M., "Vehicular Electric Power Systems", Boca Raton, CRC Press, 2003.
5. Husain, I., "Electric and Hybrid Vehicles", Boca Raton, CRC Press, 2010.

Reference Books:

1. Pavlov, D., "Lead – Acid Batteries: Science and Technology", Elsevier, Amsterdam, 2011.
2. Conway B. E., "Electrochemical Supercapacitors: Scientific Fundamentals and Technological Applications", Kluwer Academic / Plenum publishers, New York, 1999.
3. Mench, M., "Fuel Cell Engines", John Wiley, New York, 2008.
4. Viswanathan, B., Scibioh, Aulice, M., "Fuel Cells, Principles and Applications", Universities Press, 2006.
5. Williamson, S.S., "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2						3	2	2
CO2		3		3	3			3	2	3
CO3					3				2	
CO4	3	3						3	2	2
CO5		3							2	
CO6			3			3		3	3	1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20CH3061	Entrepreneurship and Business Plan	L	T	P	C
		2	0	0	2

Course Objectives:

Enable the student to

1. Understand about various standards used
2. know about the laboratory management and quality management
3. understand the basics of Entrepreneurship skills

Course Outcomes:

The student will be able to

1. summarize various chemical standards
2. Summarize various biological standards
3. Understand about the quality management systems
4. Realize the importance of various accreditation
5. understand the basics of entrepreneurship
6. apply the steps used for project management

Unit 1: Standards for analysis (6 Hours)

Basic standards – Need of standards in analytical sciences – Basic chemical standards – Analytical standards – Reference materials – High purity substances – Certified reference materials – Working or secondary standards – Matrix effect in standards – Biological standards – Biochemical standards – Microbial cell lines and standards

Unit 2: Quality Management-I (6 Hours)

Introduction – Quality - Quality system – Quality plan – Inspection and testing – Test records – Control of inspection - Handling, storage, packaging, preservation and delivery of the material – Control of quality records – Internal quality audits – Quality assurance –

Unit 3: Quality Management – II (6 Hours)

Training Laboratory Accreditation – ISO 9000 - ISO 14000 and 17000 series of standards – Accreditation Boards – NABL guidelines for accreditation in India Proficiency testing system – Internal quality control – Inter and intra laboratory testing programmes – Designing and running the proficiency testing programmes – Confidentiality - Advantages of accreditation

Unit 4: Basics of Entrepreneurship (6 Hours)

Concept – Definition – Structure – Theories of entrepreneurship – Types of Start-ups – Types of entrepreneurs – Environment – The process of entrepreneurial development – entrepreneurial culture – Entrepreneurial leadership – Product planning and development – project Management – Search for business idea

Unit 5: Concepts of Projects (6 Hours)

Concept of projects – project identification – Formulation – Design and network analysis – Project report and project appraisal - Basis and challenges of entrepreneurship – Innovation and Entrepreneurship in technology based organizations – Technology absorption – Networking with industries and institutions

Textbooks

1. Woodget, B. W. and Cooper, D., “Sample and Standards”, ACOI Series, Wiley, 1987
2. Dux, J. P., “Hand Book of Quality Assurance for Analytical Chemistry Laboratory”, Van Nostrand, 1986
3. Duncan, W. L and International, L.W, "Total Quality: Key Terms and Concepts" AMACOM publishers, 1995
4. Shah, D. H., “QA Manual”, Business Horizons, 2000
5. Kumar, K., “Quality Management”, ABD Pub., 2000
6. Gyani, G. J. “Training Manual on ISO 9000; 2000 and TQM”, Raj Pub., 1999
7. Desai, V., “Dynamics of Entrepreneurial development and Management”, Himalaya Publishing House, 2011
8. Rao, T. K and Naidu, N.V.R., “Management and Entrepreneurship”, Dreamtech Press, 2019
9. Rao T. V and Kuratko, D. F, “Entrepreneurship A South-Asian Perspective”, Cengage, 2012

20FS3001	Forensic Science and Criminal Justice System	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn about the fundamental principles and functions of forensic science
2. understand the significance of forensic science to human society
3. know the working of the forensic establishments in india

Course Outcomes:

The student will be able to

1. understand the importance of forensic sciences
2. summarize the organizations in India related to forensic science
3. understand the importance of collecting physical evidence
4. know the problems in society and collecting the evidences
5. understand the importance of criminal justice system
6. describe the recent advancements in Forensic science

Unit 1: Introduction to Forensic Science (9 Hours)

Forensic Science – Introduction – History - - The Role of the Forensic Laboratory, History and Development of Forensic Science in India & Abroad, Pioneers in Forensic Science, Multidisciplinary nature, Forensic Technology solving crimes with advanced technology, Forensic intelligence and Interviews. Administration and Organizational Setup: DFSS, CFSL, GEQD, SFSL, RFSL, MFSL, FPB,

NICFS, CDTS, NCRB, BPR&D, Qualifications and duties of Forensic Scientists Academic centres of education and research: Indian and Academy of Forensic Science, American Board of Forensic Odontology, Interpol and FBI, Australian Academy of Forensic Sciences -Duties of Forensic Scientists –

Unit 2: Physical Evidence (9 Hours)

Physical evidence and Locard's exchange principle – Classification of physical evidence - Role of Forensic Science in crime investigation - Crime scene – Types - Processing of crime Scene - Chain of custody - Probative value of physical evidence - Reconstruction of scene of crime - Investigation of crime - Modus operandi – Court Testimony – Introduction - Admissibility of expert testimony - Expert and lay witnesses – Giving testimony as an Expert

Unit 3: Sociology (9 Hours)

Sociology – Introduction – Society - Culture and socialization – Social problems in India – Social change – Sociological causes of crime – Relation of sociology to other sciences Criminology – Introduction – cope of Criminology – Concept and definition of crime – Criminal behaviour - Types of crimes – Schools of Criminology – Causes of crime – Juvenile delinquency - Criminal profiling Penology – Theories of punishment – Types of punishments – Capital punishment – Prisons and correctional institutions – Objectives – Administration – Functioning and limitations

Unit 4: Criminal Justice System (9 Hours)

Criminal Justice system in India – Introduction – Administration of civil and criminal justice – Hierarchy of courts – Powers of courts – Types of courts – Lok Ayukta system The structure of Police organizations in India – Functions and duties of police – Investigation of crimes and prosecution – Cognizable and Non- cognizable offences - Powers of police to search, seize and arrest – Role and responsibilities of prosecution – Third degree methods - Human rights – Scientific methods of investigation Introduction to constitution of India – Indian penal Code - Introduction – Sections 171B, 171E, 291, 292, 293, 299, 300, 302, 304B, 308, 309, 362, 375, 376, 390, 391, 415, 420, 463, 465 - Criminal Procedure Code Introduction – Sections 291, 292, 293, 300 – Indian Evidence Act - Introduction – Sections 45, 46, 47, 57, 58, 60, 73, 135, 136, 137 and 159

Unit 5: Recent Trends in Forensic Science (9 Hours)

Recent Trends in Forensic Science- Environmental Forensics: Definition, Legal processes involving environmental forensic science. Geo-forensics Global Positioning System; Basic principles and applications. Biometrics in Personal Identification: Introduction, Concepts of Biometric Authentication, Role in person Identification, Techniques and Technologies (Finger Print Technology, Face Recognition, IRIS, Retina Geometry, Hand Geometry, Speaker Recognition, Signature Verification and other forensic related techniques). Bioterrorism: Definition, Concepts of Biosecurity and microbial forensics, Weapons of mass destruction (WMD), mass-casualty weapons (MCW), NBC and CBRNE, Dirty Bombs.

Textbooks:

1. James, S. H., Nordby, J. J. and Bell, S., "Forensic Science: An Introduction to Scientific and Investigative Techniques", 4th Edition, CRC Press, USA, 2015.
2. Saferstein, R., "Criminalistics: An Introduction to Forensic Science", 11th Edition, Pearson, 2015.
3. Siegel, J. A, Saukko, P. J., Knupfer, G. C., "Encyclopedia of Forensic Sciences, Vol I, II and III", Academic Press, 2000.
4. Horswell, J., "The Practice of Crime Scene Investigation (International Forensic Science and Investigation)" 1st Edition, CRC Press, 2004.
5. Sharma, B.R., "Forensic Science in Criminal Investigation & Trials", Universal Law Publishing – An imprint of LexisNexis, 5th Edition, 2014.
6. Rao C.N. Shankar, "Sociology: Principles of Sociology with an Introduction to Social Thoughts" S Chand, 6th Edition, 2006 (2019).
7. Bhushan, V., Sachdeva, D.R., "An Introduction to Sociology", Kitab Mahal, 16th Edition, 1986.
8. Shapiro, D.L., "Forensic Psychological Assessment: An Integrative Approach", Allyn & Bacon, 1990.

9. Turvey, B., "Criminal Profiling – An introduction to behavioral evidence analysis", 4th Edition, Academic Press, 2011.
10. Lal, R., Lal, D., "The *Indian Penal Code*", 28th Edition, Wadhwa&Co., 2002.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3							3	2	2
CO2							3			
CO3		3								
CO4		3					3			
CO5							3			
CO6								3	2	2

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3002	Forensic Physics and Advanced Ballistics	L	T	P	C
		3	0	0	3

Course Objectives

Enable the student to

1. understand the physics of Blood and various materials
2. describe the causes and investigation of vehicular accidents, and its legal implications.
3. understand about firearms and their classification

Course Outcomes

The students will be able to:

1. understand the examination of road accident
2. understand the physics of blood
3. analyze various types of material
4. classify the various types of fire arms
5. distinguish between, internal, external and terminal ballistics
6. summarize the procedure of writing ballistic report

Unit 1: Introduction to Forensic Physics (7 Hours)

Nature, collection, preservation & forwarding of physical evidence for scientific examinations. Forensic Engineering; Fire investigation; Industrial accidents; Traffic accident reconstruction; Transportation disaster investigation; Civil engineering investigation; Investigation report. Road Accidents- Examination of scene, Filaments examination, Examination of skid marks,

Unit 2: Physics of Blood (7 Hours)

Physics of Blood stain Pattern Analysis (BPA): Introduction, Terminologies and classification, Biological and physical properties of human blood, Droplet Directionality from bloodstain patterns, Determination of Point of Convergence and Point of Origin. Impact spatter and mechanisms. Importance and Legal aspects of BPA.

Unit 3: Glass, Soil and Paint (11 Hours)

Glass -Types of glass and their composition, Glass fracture analysis, Laboratory exercises include refractive index measurements using immersion methods and classical chemical and physical methods of analysis. Soil- Formation and types of soil, Composition and color of soil, Forensic examination of soil, Interpretation of soil evidence. Paints- Types of paint and their composition, Forensic examination of paints, Interpretation of paint evidence. Tool Marks- Types of tool marks, Class characteristics and individual characteristics - Fiber analysis: Forensic significance, Classification, characteristics, Birefringence, Colors in textile, Color Assessment, Chemical properties, Miscellaneous Clue Materials- Examination of strings/ropes, Wires/cables, Seals, Counterfeit coins, Gem Stones: Analysis of crystalline substances. Building Materials- Types of cement and their composition, Determination of adulterants, Analysis of cement mortar and cement concrete and stones. Forensic examination of electrical appliances/installations

Unit 4: Fire Arms and Internal Ballistics (11 Hours)

Firearms: Definition, Breech Loader and Muzzle loader, Smooth bore and Rifled firearms, Briefs of Indian Arms Act, Country Made/Improvised Firearms, Illegal firearms - Proof Marks of weapons - Types

of ammunition- types of cartridges, types of primers and priming composition, propellants and their compositions, velocity and pressure characteristics under different conditions, various types of bullet and compositional aspects, latest trends in their manufacturing and design projectile, Head stamp Markings. Internal Ballistics: Definition, Ignition of the propellant, Shapes of Propellants, Manner of the propellant burning, Piobert's law, Pressure space curve, Shot Start Pressure, All Burnt Point, Velocity, Le Du's formula, Muzzle velocity - factors affecting the internal ballistics - equation of motion of projectile, Measurement of strength of firearm, projectile velocity determination, theory of recoil, methods for measurement of recoil.

Unit 5: External Ballistics and Terminal Ballistics (9 Hours)

External Ballistics: Bullet Drop in the flight, Use of sight to compensate for bullet drop, Influence of Earth on Trajectory, Angle of Fall, Ballistic Coefficient and Air resistance-base drag, Sectional Density, Maximum effective range, Drift, Yaw, Precession, Nutation, Terminal velocity, Ballistics tables, measurements of trajectory parameters, Escape velocity & Ricochet. Terminal Ballistics: Definition, Effect of projectile on hitting the target: function of Bullet shape, striking velocity, striking angle and nature of target, tumbling of bullets, effect of instability of bullet, effect of intermediate targets, function of bullet shape, striking velocity, striking angle and nature of target, tumbling of bullets, Brief introduction to Cavitations -Ricochet and its effects, stopping power - Introduction to Forensic Ballistics Report Writing

Textbooks:

1. Hatcher J.S., Jury, F.J., Weller, J., "Firearms Investigation Identification and Evidence", Ray Riling Arms Books Co. Philadelphia, PA; Reprint edition (October 4, 2006)
2. Jauhri, M., "Monograph on Forensic Ballistics", Govt. of India Publication, New Delhi, 1980.
3. Sharma, B.R., "Forensic Science in Criminal Investigation & Trials", Universal Law Publishing – An imprint of LexisNexis, 5th Edition, 2014.
4. Kumar, K., "Forensic Ballistics in Criminal Justice", Eastern Book Company, Edition: 1987 Edition W/S 1990, Reprinted 2015.
5. Heard, B.J., "Handbook of Firearm and Ballistics Examination and Interpretation Forensic Evidence", Wiley, 2008.
6. Warlow, T., Warlow, T.A., "Firearms, the law and Forensic Ballistics", CRC Press, 1996.
7. Jacobson, R., Ray, S., Attridge, G.G., Axford, N., "Manual of Photography", Ninth Edition (Media Manual), 9th Edition, Focal Press, 2000.
8. Saferstein, R., "Forensic Science Handbook Volume 1", Pearson, 2nd Edition, 2001.
9. James S.H., Nordby, J.J., "Forensic Science: An introduction to scientific and investigative techniques", CRC Press, USA, 2003.
10. Working Procedure Manual - Toxicology, BPR&D Publication, 2000.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1				3				3	2	2
CO2					2			2		
CO3					3			3		
CO4		3						3		
CO5					2					
CO6					2			2		

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3003	Forensic Biology	L	T	P	C
		3	0	0	3

Course Objectives

Enable the student to

1. understand the basics of forensic biology
2. know the details of body fluids, stains and tissues
3. Understand about forensic anthropology, examination of hair and wildlife forensics

Course Outcomes

The students will be able to:

1. understand the various forms of biological evidences
2. know the chemistry of blood and semen
3. become a forensic anthropologist
4. to perform hair analysis
5. know the importance of wildlife
6. identify bacteria and viruses

Unit 1: Introduction to Forensic Biology (8 Hours)

Introduction – Scope - Various forms of biological evidences like wood, timber varieties, seeds and leaves - Their identification and matching Forensic Botany - Toxic principles of plants and their forensic significance - Identification of poisonous plants and mushrooms of India -Diatoms - Types – Morphology - Methods of isolation from tissues and bones - Forensic significance in drowning cases - Study and identification of pollen grains - Identification of starch grains, powder, stains of spices - Paper pulp identification - Isolation and identification of microbial organisms

Unit 2: Body Fluids, Stains and Tissues (8 Hours)

Blood - Composition, histology, examination of blood and blood stains, Identification of lochial and menstrual stains by various methods. Semen - Composition, St. of spermatozoa, Forensic methods of detection and identification of semen and seminal stain examination - Identification and examination of other body fluids/stains- vaginal, saliva, urine, pus, faeces, vomit, milk, sweat & tears.

Unit 3: Forensic Anthropology (9 Hours)

History - Scope and development - Role of forensic anthropologist – Collection and preservation of evidences - Human osteology - Determination of age, sex, stature- Determination of personal identity by superimposition technique - Video image analysis - Facial reconstruction – Legal provisions and tools involved in it - Pathology of bones and its importance in identification - Identification of burnt bones, skeletal remains in accidents, crimes and mass disaster Forensic Odontology: Introduction - Structure and types of teeth - Dentition and dental formula – Dental diseases - Determination of age, sex and race from teeth - Role of teeth in mass disaster – Forensic significance in identification

Unit 4: Examination of Hair (10 Hours)

Introduction - Structure of hair - Growth and chemistry of hair - Identification and comparison of hair by microscopic – Chemical - Biochemical and instrumental methods - Identification of animal hair - Assessment of age, sex, race and site of hair - Analysis of drugs and elements in hair – Hair diseases - Hair transfer, persistence and recovery - DNA typing of hair Fibre Examination – Introduction - Classification of fibres - Identification and comparison of fibres by physical - Chemical – Microscopic – Spectroscopic - Chromatographic methods - Persistence and recovery of fibres - Forensic significance Forensic Entomology: Introduction - Analyzing crime scene for entomological evidence - Collection of climatological data and specimen before body removal - Common arthropod found on the dead body - Determination of time of death - Entomological succession in case of buried, drowned and buried bodies

Unit 5: Wild life Forensics and Forensic Microbiology (10 Hours)

Wild Life Forensics: Introduction - Importance of wild life - Wild life Protection Act – Endangered species – CITES - Census of wildlife population - Wild life crime - Methods of smuggling and poaching of wild life artifacts - Crime scene search - Criminal investigation - Determination of time of death – Sexdetermination from bones - Identification of teeth, claws, Ivory, Horns, antlers, furs, skin, bite marks, pugmarks - Identification of blood, excreta and bones by biochemical and immunological methods- Forensic Microbiology: Definition, Types and identification of Bacteria and Viruses in Forensic Science, Microbial profiles as identification tools, use of microorganisms in bioterrorism, Anthrax, transmission of HIV as a criminal act, role of microbes in food poisoning

Textbooks:

1. Robertson, J., “Forensic Examination of Fibres”, Chichester, West Sussex, England: Ellis Horwood Ltd., 1992.
2. Saferstein, R., “Criminalistics. An Introduction to Forensic Science”, 11th Edition., Pearson, 2015.
3. Robertson, J.R., “Forensic Examination of Hair”, 1st Edition, CRC Press, 1999.
4. Eckert, W.G., “Introduction to Forensic Sciences”, 2nd Edition, CRC Press, 1996.
5. Kirk, P. L., “Crime Investigation”, Interscience, New York, 1953.

6. Jams, S.H., Nordby J.J., Bell, S., "Forensic Science: An Introduction to Scientific and Investigative Techniques", 4th Edition, CRC Press, 2015.
7. Wild Life (Protection) Act, 1972, Universal Law Publishing - An imprint of LexisNexis, 2016.
8. Pillay, V.V., Textbook of Forensic Medicine & Toxicology, 18th Edition, Paras Medical Publisher, 2017.
9. Byrd, J. H., "Forensic Entomology: The Utility of Arthropods in Legal Investigations", 2002.
10. Chowdhuri, S., "Forensic Biology", B P R & D, Govt. of India, 1971.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3			2			3	2	1
CO2				3						
CO3					3					
CO4					3					
CO5							2			
CO6					3					

'3'-High, '2'- Medium, '1'-Low, '-'- No correlation

20FS3004	Advanced Questioned Documents	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn examining the questioned documents using various detection apparatus
2. identify the forgery by comparing documents
3. learn to identify the forgery

Course Outcomes:

The student will be able to

1. understand the various types of documents
2. compare the questioned documents with standards
3. identify the different types of forgery in the documents
4. apply various method to analyze questioned documents
5. analyze the questioned documents of various types
6. prepare the report

Unit 1: Classification of Documents (9 Hours)

Nature and problems of document examination – Classification of documents – Procurement of standard admitted / specimen writings – Handling and marking of documents – Preliminary examination of documents- Basics of handwriting identification – Individuality of handwriting – natural variations, process of comparison – Various types of documents – Various writing features and their estimation – General characteristics of hand writing – Individual characteristics of hand writing – Basic tools for forensic document examination

Unit 2: Examination of Signatures (9 Hours)

Disguised writing and anonymous letters – Identification of writer – Examination of signatures – Characteristics of genuine and forged signatures – Examination of alterations, erasers, over writings, additions and obliterations – Decipherment of secret, indented and charred documents – Examination of seal impressions and other mechanical impressions

Unit 3: Examination of Documents (9 Hours)

Examination of black and white, colour Xeroxed copies, carbon copies, fax messages – Forgeries and their detection – Various types of forgeries and their detection – Examination of built up documents – Determination of sequence of strokes, physical matching of documents, identification of typewriter writings – Identification of typewriter – Identification of printed matter – Various types of printing of security documents, printing of currency notes – Examination of counterfeit currency notes, passports, visa, stamp papers, postal stamps etc.

Unit 4: Analysis of Documents (9 Hours)

Determination of age of documents by examination of signatures, paper, ink, writing / signatures etc.- Examination of computer print outs – dot-matrix, ink-jet and laser printers, electronic typewriters –

creditcards – e-documents – Digital signatures – Opinion writing – Reasons for opinion – Court testimony
 Analytical instrumentation used in document examination – Video spectral comparators, Microscopes, TLC, HPLC, Spectrofluorimetry and X-ray fluorimetry etc.

Unit 5: Report Writing & Court Room Testimony (9 Hours)

Evidence and testimony in court, Information required by the Forensic expert, Components of Forensic Reports, Preparation of Report, Presenting findings in a Report format.

Textbooks:

1. Morris, R., Morris, R.N., Forensic Handwriting Identification: Fundamental Concepts and Principles, Academic Press, 2000.
2. Huber, R.A., Headrick, A.M., Handwriting Identification: Facts and Fundamentals, CRC Press, 1999.
3. Osborn, A. S., "The Problem of Proof", 2nd Edition, Universal Law Publishers, 1998
4. Thomas, C.C., "I.S.Q.D. Identification System for Questioned Documents", Billy Prior Bates, Springfield, Illinois, USA, 1971.
5. Harrison, W.R., "Suspect Documents: Their Scientific Examination", Universal Law Publisher, 1997.
6. Levinson, J., "Questioned Documents: A Lawyer's Handbook", 1st Edition, Academic Press, 2000.
7. Saferstein, R., "Criminalistics: An Introduction to Forensic Science", Prentice-Hall; 5th Revised Edition, 1994.
8. Day, S. P., Ellen, D., Davies, C., "The Scientific Examination of Documents: Methods and Techniques (Taylor & Francis Forensic Science Series), Taylor & Francis; 2nd Edition, 1997.
9. Morris, R. N., "The Identification of Handwriting & Cross Examination of Expert, NM Tripathi, Allahabad, 1970.
10. Saxena, B.L., "Law and Technique Relating to Identification of Handwriting, Disputed Documents, Finger Prints, Foot Prints, and Detection of Forgeries", Central Law Agency, Allahabad, 1968.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1					2			3		
CO2						6				
CO3							2	3	2	1
CO4					3					
CO5					2					
CO6							2			

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

0FS3005	Finger Prints and other Impressions	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. learn examining the various types of finger prints
2. identify the footwear and tire impressions
3. learn to identify the lip print

Course Outcomes:

The student will be able to

1. understand the various elements of fingerprints
2. understand the types of reprints
3. Analyze footwear reprints
4. Apply various methods to analyze tire reprints
5. Analyze the Lip reprints
6. Analyze the bite marks

Unit 1: Introduction to Fingerprints (9 Hours)

Fingerprints- Introduction- History and development of fingerprints- Structure of skin- Elements of fingerprinting - Classification of fingerprint patterns- Classification of fingerprints- Identification and comparison- Poroscopy- AFIS- Introduction- History- Operation- Search technology- Palm prints – Administration and networking.

Unit 2: Types of Fingerprints (9 Hours)

Types of evidentiary fingerprints- Development of latent fingerprints- Physical and chemical methods- Visualization methods of illumination- Photography- Preservation and lifting of fingerprints- Development techniques on porous and non-porous surfaces- Development on adhesive surface- Development with blood and grease contamination-Development of latent fingerprints on dead body- Digital imaging of fingerprints- Case histories.

Unit 3: Footwear Fingerprints (9 Hours)

Footwear Impressions- Introduction- Forms of footwear impressions- Information from footwear impressions- Location and recovery of footwear impressions- Enhancement methods- Preparation of Exemplars- The examination process- Case histories

Unit 4: Tire impressions (9 Hours)

Introduction- Original equipment tires, Replacement tires and tire construction- Tread nomenclature and sidewall information- Tread wear indicators- Retreated tires- Tire reference material and databases- Tire track evidence and recovery- Known tires and exemplars- Tire impressions examination process- Case histories

Unit 5: Lip Prints (9 Hours)

Lip Prints- Introduction- History- Scope- Application in crime detection Ear Prints- Introduction- History- Morphology of ear – Ear prints location- Producing standards from suspects- Identification and comparison Bite marks- Introduction- Significance- Judicial Acceptance- Description of prototypical bite marks- Evidence collection on victim and suspects- Identification and comparison- Case histories.

Textbook:

1. Ashbaugh, D.R., “Quantitative-Qualitative Friction Ridge Analysis: An Introduction to Basic and Advanced Ridgeology (Practical Aspects of Criminal and Forensic Investigations)”, CRC Press, 1st Edition, 1999.
2. Mehta, M.K., “The Identification Of Thumb Impressions and The Cross Examination of Finger Print Experts”, 2nd Edition, N.M. Tripathi Publishers, Bombay, 1963.
3. Lee, H.C., Ramotowski, R., Gaensslen, R.E., “Advances in Fingerprint Technology, Second Edition (Forensic and Police Science Series)”, CRC Press, 2001.
4. Saferstein, R., “Criminalistics: An Introduction to Forensic Science”, Pearson Prentice Hall, 11th Edition, 2014.
5. Eckert, W.G., “Introduction to Forensic Sciences”, 2nd Edition, CRC Press, 1996.
6. James, S.H., Nordby, J.J., Bell, S., “Forensic Science: An Introduction to Scientific and Investigative Techniques”, 4th Edition, CRC Press, 2015.
7. Siegel, J. A., Sukoo, R. J, Knupfer, G. C., “Encyclopedia of Forensic Science, Vol I, II and III, Academic Press, 2000.
8. Kirk, P.L., “Crime Investigation: Physical Evidence and the Police Laboratory”, Interscience, New York, London, 1953.
9. O’Hara, C.E., Osterburg, J.W., Introduction to Criminalistics, The Macmillan Company, 1949.
10. O’Hara, C.E., “An Introduction to Criminalistics;: The Application of the Physical Sciences to the Detection of Crime”, Indiana University Press, 1972.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3						3	2	1
CO2					3			3		
CO3					3				2	1
CO4					3			2		
CO5					3				3	
CO6					3					1

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS3006	Crime Scene Management Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. learn sketching the crime scene
2. collect the physical evidences from the crime scene
3. learn to reconstruct and evaluate the crimescene

Course Outcomes:

The student will be able to

1. understand the methods of sketching the outdoor crime scene
2. understand the methods of sketching the indoor crime scene
3. collect the evidences from the crime place
4. understand the methods of packing the physical evidence
5. summarize the evaluation of indoor crime scene
6. summarize the evaluation of outdoor crime scene

List of Experiments:

1. Sketching the scene or a crime
 2. Sketching of Outdoor crime scene (murder, suicide, accident etc)
 3. Sketching of Indoor crime scene (theft, dacoity, murder, suicide etc)
 4. Photography of crime scene using manual & digital camera.
 5. Collection and packing of physical evidence at the scene of crime
 6. Searching of physical evidences at scene of crime.
 7. Collection, packing, labeling and forwarding of physical evidence from scene
 8. Reconstruction and evaluation of indoor crime scene
 9. Reconstruction and evaluation of outdoor crime scene
 10. Physical evidence and Locard's principle
 11. Polygraphy (Demonstration only)
- (Minimum 10 experiments to be completed)

Textbook:

1. Miller, M.T., "Crime Scene Investigation Laboratory Manual", Academic Press, 1st Edition, 2013.
2. Sutton, R., Trueman, K., "Crime Scene Management: Scene Specific Methods", Wiley, 2016.
3. Crime Scene Investigation, A Guide for law Enforcement, Research Report, US Department of Justice, 2000.
4. Dutelle, A.W., "An Introduction to Crime Scene Investigation", Jones and Bartlett Publishers, LLC, 2011.
5. Mozayani, A., Noziglia, C., "The Forensic Laboratory Handbook Procedures and Practice", Springer, 2011.
6. Jones, P., Williams, R.E., "Crime Scene Processing and Laboratory Workbook", CRC Press, Taylor & Francis Group, 2009.
7. Krishnamurthy, R., "Introduction to Forensic Science in Criminal Investigation", Selective & Scientific Books, 2015.
8. Houck, M.M., Crispino, F., McAdam, T., "The Science of Crime Sciences", Academic Press, 2012.
9. Saferstein, R., "Forensic Science: From the Crime Scene to the Crime Lab", 4th Edition, Pearson, 2019.
10. Mozayani, A., Noziglia, C., "The Forensic Laboratory Handbook Procedures and Practice", Springer, 2011.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1			3							
CO2			3		3			3	2	1
CO3										
CO4				3						

CO5						3		3	2	1
CO6						6			2	1

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS3007	Forensic Physics and Ballistics Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. understand the analysis of soil, paint and glass samples
2. know about tool marks
3. understand about microscopic examination of different samples

Course Outcomes:

The student will be able to

1. examine paint sample
2. analyze the soil
3. examine the bullet
4. do density gradient method
5. experiment paint samples
6. know about the methodology to collect digital evidences

LIST OF EXPERIMENTS

1. Examination of glass fractures
2. Determination of refractive indices of glass & liquids
3. Physical examination of soil for colour, moisture, organic matter, pH, presence of anthropogenic
4. material and presence of biological material
5. Determination of particle size distribution of soils
6. Soil comparison by density gradient method
7. Examination of paint samples by microscopy
8. TLC and spectrophotometric comparison of paint evidence
9. Examination of counterfeit currency
10. Comparison of tool marks
11. Restoration of erased identification marks from metal surfaces
12. Determination of density, by density gradient tube techniques.
13. Comparison of paints, Soils and glass.
14. Miscellaneous (Cloth and Bangles)
15. Bloodstain pattern analysis
16. Preparation of report of the examination.
(Minimum 10 experiments to be completed)

Textbook:

1. Robinson, J.W., “Undergraduate Instrumental Analysis, 5th Edition, Marcel Dekker, Inc., New York, 1995.
2. Redsicker, D.R., “The practical Methodology of Forensic Photography, 2nd Edition, CRC Press, Boca Raton, 2000.
3. Mirakovits, K., Londino, G., “The Basics of Investigating Forensic Science”, CRC Press, 2015.
4. Franck. H., Franck, D., “Forensic Engineering Fundamentals”, 1st Edition, CRC Press, Boca Raton, Florida, USA, 2013.
5. Saferstein, R., “Criminalistics: An Introduction to Forensic Science”, Pearson, 2017.
6. Meloan, C.E., Saferstein, R., “Lab Manual”, Pearson, 2003.
7. Hueske, E.E., “Practical Analysis and Reconstruction of Shooting Incidents”, CRC Press, 2015.
8. Erickson, E., “Criminalistics Laboratory Manual: The Basics of Forensic Investigation”, Routledge, 2017.
9. Heard, B.J., “Forensic Ballistics in Court: Interpretation and Presentation of Firearms Evidence”, Wiley – Blackwell, 2013.

10. Hueske, E.E., Bell, S., “Firearms and Fingerprints”, Facts on File Scientific Library, 2008.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1					3					
CO2					2					
CO3					3					
CO4					2					
CO5					3	3				
CO6						3		3	2	1

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS3008	Questioned Documents and Finger Print Analysis Lab	L	T	P	C
		0	0	3	2

Course Objectives:

Enable the student to

1. identify the finger prints
2. identify forgery by analyzing the handwriting
3. analyze the footprints

Course Outcomes:

Students will be able to

1. record and classify the fingerprint
2. analyze and study the fingerprint
3. analyze the fingerprint by chemical method
4. analyze the fingerprint by physical method
5. record and study footprints
6. analyze handwriting and identify forgery

LIST OF EXPERIMENTS

1. To take plain and rolled inked fingerprints and to identify patterns
2. To perform ridge tracing, ridge counting and identify the ridge characteristics
3. Comparison of fingerprints
4. To develop latent fingerprints with powder, fuming and chemical methods
5. Lifting of fingerprints
6. Footprint tracing, casting and comparison
7. Bite mark casting and comparison
8. Tire print tracing, casting and comparison
9. Identification of normal / disguise writing
10. Detection of forgeries (traced, simulated and built up)
11. Examination of rubber stamps and other mechanical impressions like seals etc.
12. Examination of type scripts and printed material
13. Examination of alterations, additions, overwriting and obliterations in documents
14. Examination of erasures (mechanical and chemical)
15. Examination of inks by TLC & spectrophotometry
(Minimum 10 experiments to be completed)

Textbooks:

1. Erickson, E., “The Basic of Forensic Investigation”, Elsevier Inc., 2014.
2. Evidence Handling & Laboratory Capabilities Guide, Virginia Department of Forensic Science, 2012.
3. Ramotowski, R., “Lee and Gaensslen's Advances in Fingerprint Technology”, 3rd Edition, CRC Press, 2013.
4. Bridges, B.C., “Practical Fingerprinting”, Funk & Wagnalls, 1963.
5. Alvarez, M.G.P., “Forensic Examination of Questioned Documents”, Chapterhouse Publishing Incorporated, Philippines, 2013.
6. Ellen, D., Day, S., Davies, C., “Scientific Examination of Documents – Methods and Techniques”, 4th Edition, CRC Press, 2018.

7. Daluz, H.M., "Fingerprint Analysis – Laboratory workbook", Second Edition, CRC Press, 2019.
8. Bleay, S.M., Croxton, R.S., de Puit, M., "Fingerprint Development Techniques", Wiley, 2017.
9. Lee, H.C., Gaensslen, R.E., "Advances in Fingerprint Technology", Second Edition, CRC Press, 2001.
10. Mirakovits, K., Londino-Smolar, G., "The Basic of Investigating Forensic Science – A Laboratory Manual", CRC Press, 2016.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3							3	2	1
CO2					3			2		
CO3					3			2		
CO4					3			2		
CO5	3							2		
CO6					3			2		

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3009	Cyber Crime					L	T	P	C
						3	0	0	3

Course Objectives:

Enable the student to

1. understand the types of various storage devices
2. know about cyber forensics
3. understand the principle of cyber crimes

Course Outcomes:

The student will be able to

1. know the principle of operation of computer hardware and accessories
2. understand the types of storage devices
3. know crimes related to computer security
4. analyze computer files
5. understand types of cyber crimes
6. understand the various investigation methods

Unit 1: Parts of the Computer and storage devices (9 Hours)

The computer system and CPU – Types of computers -Binary numbers, digital signals, Moore's law, bits & bytes, the binary code, CPU, the microprocessor, the part of progress –Memory – ROM and RAM - Virtual memory – Caches – Buffers – Machine cycle – Registers – Buses for input and output – Adapter cards and multimedia systems – Computer ports – USC and fire wire input and output devices – OCR bar codes – Speech recognition graphics – Scanners – Digitalizing photos and video pointing devices – Pixels and resolution fonts – Range of colour display screens – Image Processing -Types of resolution printers - Secondary storage devices – Storage devices and media – Storage characteristics – Tracks and sectors –Storage media – OS – Application programme user interface – OStypes - File management – Utilities – Document centric computing – Object linking and embedding (ole)- Major software issues – Network computing – Windows – Word processing – Desk top publishing – Internet browsing

Unit 2: Cyberforensics (9 Hours)

Introduction to Cyber Forensics – Storage fundamentals – File systems concepts – Data recovery – CyberForensic Investigation – Investigation tools – eDiscovery – Digital evidence collection – Evidence presentation – Nature of digital evidence, Retrieval and analysis of digital evidence, Sources of digital evidence, Computer security and its relationship to computer forensics E-mail investigation – E-mail tracking – IP tracking – E-mail recovery – Encryption and decryption methods – Search and seizure of computers – Recovering deleted evidence – Password cracking – Formatted partition recovery – Data recovery tools – Data recovery procedures and ethics - Preservation and safe handling of the original media – Chain of custody

Unit 3: Analysis of computer files (9 Hours)

Complete time line analysis of computer files based on file creation – File modification and file access – Recovery of internet usage data – Recovery of swap files / temporary files / cache files – Introduction to Encase Forensic Edition – Forensic Tool Kit

Unit 4: Cyber security (9 Hours)

Emergence of computer crime - Classification of computer crimes -Internet – Hacking – Cracking – , computer virus and types, computer worms, Trojan Horse, trap door, super zapping, logic bomb, salami logic, characteristics of computer crime and criminals.– Virus attacks - Mail Bombs – Bug Exploits – Pornography –Software piracy – Intellectual property – Legal systems of Information Technology – Cyber crime laws –IT laws - Cyber security – Implementing hardware based security – Software based Fire walls – Security standards - Assessing threat levels – Forming an incident response team – Reporting cyber crime – Operating system attacks – Application attacks – Reverse Engineering – Cracking techniques – Financial frauds – Forensic accounting

Unit 5: Investigation (9 Hours)

Investigating on various imaging methods. Lay down the image provided onto a hard disk and provide a disk map of the suspect drive. Extraction of all relevant information from a hard disk. Cell phone/mobile forensics: Introduction, Forensic toolkit, EnCase, Ilook Investigator-Digital signature and cryptography: signature in paper based society, Transfer of computer based documents, digital signature and authentication, digital signature generation and verification, certification of public keys, certification of authority-Brief introduction to Cyber space and cyber Laws, IT Act.

Text Books

1. Johnson, T.A., “Forensic Computer crime Investigation”, CRC Press, 2005.
2. Miller, M., “Absolute Beginner’s Guide to Computer Basics”, CRC Press, 2005.
3. Miller, M., “Easy Computer Basics”, Windows Vista Edition, Que, 2008.
4. Atul, J., “Cyber Crime – Issues, Threats and Management (Vol. 1 &2)”, Isha Book Publishers, 2005.
5. Britz, M.T., “Computer Forensics and Cyber Crime: An Introduction”, Pearson; 1 Edition, 2003.
6. Clark.F., Dileberto, K., “Investigating Computer Crime” CRC Press, 1996.
7. Vacca, J. R., “Computer Forensics – Computer Crime Scene Investigation”, 2nd Edition, River Media (Thomson), 2005.
8. Stephenson, P., “Investigating Computer – Related crime”, CRC Press, 2000.
9. Casey, E., “Handbook of Digital Forensics and Investigation”, Academic Press, 2009.
10. Bayuk, J., “Cyber Forensics: Understanding Information Security Investigations”, Springer, 2010.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3						3		
CO2	3							3		
CO3		3						3		
CO4					3			3	3	1
CO5		3						3		
CO6					3			3		

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS3010	Forensic Psychology						L	T	P	C
							3	0	0	3

Course Objectives:

Enable the student to

1. overview of Psychology
2. understand forensic psychology and criminal behavior.
3. learn about tools for macroanalysis

Course Outcomes:

The student will be able to

1. understand the basics of psychology
2. explain forensic psychology.
3. describe the significance of psychological assessment
4. outline the principles of polygraph
5. describe the procedure for macroanalysis
6. demonstrate brain electrical oscillation signatures.

Unit 1: Introduction to Psychology (9 Hours)

Psychology – Introduction – Scope and importance – Principles of development – Attention and perception – Process of learning – Memory and forgetting – Motivation – Attitudes – Values of emotions – Behavioural problems – Conflict and use of defense mechanisms – Various types of mental disorders – Psychology of criminal behaviour

Unit 2: Forensic Psychology (9 Hours)

Forensic Psychology and Psychiatry – Narcoanalysis – Polygraphy – Brain fingerprinting – Forensic Psychology and the Law, Ethical Issues in Forensic Psychology, Civil and criminal case assessment, Assessing mental competency, Mental disorders and Forensic Psychology, Eye witness testimony, Criminal profiling- need and types, Forensic Scientific evidence, Crime and Psychopathology, Genetics and Crime, Serial murders, Modus Operandi.

Unit 3: Psychological Assessment (9 Hours)

Psychological Assessment Tools, Detection of deception, Various methods for detection of deception, Interview, Non-verbal detection, statement assessment, Hypnosis, Psychological assessment, voice stress analyzer, Thermal imaging, Brain Electrical Oscillation Signature Profiling, Functional Magnetic Resonance study, Current research in detection of deception/truth finding mechanisms

Unit 4: Polygraph (9 Hours)

Historical aspects of Polygraph, Principles of polygraph, psycho physiological aspects, operational aspects, Question formulation techniques, Interviewing technique procedure, The Art-Polygraph, Legal and Ethical aspects, Human rights of individual.

Unit 5: Narcoanalysis (9 Hours)

Narco-Analysis - Historical aspects, Principle and Theory, General Procedure – Legal and Ethical aspects, Human rights of individual. Brain Electrical Oscillation Signature (BEOS) Profiling - Principle and Theory, General Procedure – Legal and Ethical aspects, Human rights of individual.

Textbooks:

1. Sharma, B.R., “Forensic Science in Criminal Investigation & Trials”, Universal Law Publishing – An imprint of LexisNexis, 5th Edition, 2014.
2. Weiner, I.B., Hess, A.K., “The Handbook of Forensic Psychology”, John Wiley & Sons; 3rd Revised Edition, 2005.
3. O’Donohue, W., Levensky, E., “Handbook of Forensic Psychology”, Academic Press, 2003.
4. Mukundan, C.R., “Brain Experience: Neuroexperiential Perspectives of Brain-Mind”, Atlantic; Nil Edition, 2007.
5. Turvey, B., “Criminal Profiling - An Introduction to Behavioral Evidence Analysis”, Academic Press, 2011.
6. Niehaus, J., “Investigative Forensic Hypnosis”, 1st Edition, CRC Press, 1998.
7. Matte, J.A., “Art and Science of the Polygraph Technique”, 1980.
8. Kleiner, M., “Handbook of Polygraph Testing”, Academic Press; 1st Edition, 2001.
9. Vrij, A., “Detecting Lies and Deceit: Pitfalls and Opportunities”, John Wiley & Sons; 2nd Edition, 2008.
10. Ramachandran, “Law of Narco-Analysis Right Against Self Incrimination”, Lawmann’s, New Delhi, 2017.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3									
CO2							2			
CO3							2			
CO4				2						
CO5					2			3	2	
CO6						3				2

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS3011	Forensic Serology and Molecular Genetics	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basic principle of Forensic Serology
2. understand the DNA typing
3. obtain knowledge on bioinformatics

Course Outcomes:

The student will be able to

1. recognize the basic principle of Forensic Serology
2. classify the biological stains
3. understand about serogenic markers
4. summarize about DNA typing and its forensic significance
5. interpret the DNA typing results
6. understand the basics of bioinformatics

Unit 1: Forensic Serology (9 Hours)

Introduction- The nature of blood- Blood stain pattern interpretation and significance-Age of bloodstain- Collection and preservation of blood, semen, saliva, urine, faeces, milk samples- Identification of above biological stains by chemical- Biochemical- Crystal- Chromatographic- Spectroscopic methods- Determination of origin of species by immunological methods- Methods of grouping biological stains- Secretor and non-secretor status- Identification of menstrual blood, amniotic fluid and parturition stains.

Unit 2: Serogenetic Markers (9 Hours)

Introduction of blood groups- History- Biochemistry and genetics of ABO, MN, Rh, Lewis, Lutheran, Kidd, Duffy and P systems- Serum proteins- KM-GM- HP- GC- Transferrin -Cellular proteins- PGM-AK-ADA-PepA-EsD-GLO-GPT-G6PD- Haemoglobin variants- Hbf – Hbs– Hbc – HbA - Determination of sex and race from blood- White blood group system HLA and its forensic significance.

Unit 3: DNA Typing (10 Hours)

Introduction- Forensic significance - History- Why DNA- Introduction to human genetics-Physical basis of hereditary- Alleles- Population genetics- Molecular biology of DNA- Variation-Enzymes- Collection and Preservation of physical evidence for DNA typing - Forensic DNA Analysis- Isolation of DNA - Determination of quality and quantity of DNA-RFLP analysis- PCR amplification- Types of PCR - Analysis of PCR product- Sequence polymorphism – Length polymorphism - DNA separation – Slab Gel & Capillary Electrophoresis – DNA detection – Fluorescent dyes and silver staining – Instrumentation for STR typing – STR Genotyping – Automated analysis system- Applications of DNA profiling- Legal standards for admissibility of DNA profiling- Future technologies DNA chips, SNPs, DNA cloning

Unit 4: Interpretation of DNA Typing Results (10 Hours)

Introduction to complicating factors- Multiple contributors-Degradation- Extraneous substance- System specific interpretational issues- RFLP based system - Multibanded patterns- Single banded patterns – PCR based systems - Nuclear DNA- Mitochondrial DNA -Determination of genetic concordance-Evaluation of results- Bayes theorem- Hardy Weinberg law-Frequency estimate calculations- Population sub structure- Likelihood ratios.

Unit 5: Bioinformatics(7 Hours)

Introduction to bioinformatics, Genomics and Proteomics- DNA databank and database- Certification and Accreditation - role of bioinformatics in forensic science - bioinformatic methods for forensic DNA analyses

Textbooks:

1. Tripathi, A., Dwivedi, A.K., “Forensic Serology & Blood Examination”, Selective & Scientific Books, 2012.
2. Kobilinsky, L., “Forensic Chemistry Handbook”, Wiley, 2011.
3. Judd, W.J., Rolih, S.D., “Serological Methods in Forensic Science”, American Association of Blood Banks, 1985.
4. Butler, J. M., “Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers”, Elsevier Academic Press; 2nd Edition, 2005.

5. Rudin, N., Inman, K., "An Introduction to Forensic DNA Analysis", CRC Press; 2nd Edition, 2011.
6. Kirby, L.T., "DNA Fingerprinting: An Introduction", Palgrave Macmillan, 1990.
7. Esteal, S., McLeod, N., Reed, K., "DNA Profiling: Principles, Pitfalls and Potential", Harwood Academic Publishers, 1991.
8. Burns, G.W., "The Science of Genetics: An Introduction to Heredity", Pan Macmillan; 4th Revised Edition, 1980.
9. Gardner, E.J., "Human Heredity", John Wiley & Sons, 1983.
10. Fanger, M.W., Lydyard, P.M., Whelan, A., "Instant Notes in Immunology", Taylor & Francis; 1st Edition, 1999.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3									1
CO2				3						
CO3		3								
CO4					3					
CO5						3		3		
CO6		3							2	

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3012	Forensic Phonetics, Voice Analysis and Speaker Recognition	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basic principle of Phonetics and psycholinguistics
2. understand the procedures involved in voice analysis
3. summarize the various types of speaker recognition methods

Course Outcomes:

The student will be able to

1. recognize the importance of phonetics
2. understand the basics of psycholinguistics
3. understand the methods involved in voice analysis
4. summarize the various types of speaker recognition
5. understand the methods involved in automatic speaker recognition
6. realize the application of voice analysis in forensic science

Unit 1: Introduction to Phonetics (9 Hours)

Introduction, Authentication of tape recordings- Physical examination and laboratory examination, Difficult tapes and transcripts- Enhancing speech- Speech decoding and transcripts- Decoding mechanics, Speaker identification- Ear witness identification- Aural perceptual approaches machine/computer approaches, Vocal behaviours- Stress- Alcohol speech relationships

Unit 2: Psycholinguistics (9 Hours)

Written and spoken utterances as special evidence- Psycholinguistics distinguished-Stylistics- Contribution of psycholinguistics- Identifying authorship- Inferring characteristics of author-Predicting consequence

Unit 3: Voice analysis (9 Hours)

Introduction, Human voice- Nature of voice and production of speech- Perception of voice and speech, Collection of evidence, Quality of evidence- Types of evidences - Speaker variability and simulation- Transmission channel distortion- Recording system distortion - Admissibility

Unit 4: Speaker recognition (9 Hours)

Types- Procedure and methods - Feature extraction - Feature comparison – Classification, Speaker recognition by listening - Recognition by non-experts and experts, Speaker recognition by visual comparison of spectrograms- Technology- Kersta method- Tosi study

Unit 5: Automatic speaker recognition (9 Hours)

Feature extraction – Feature comparison and normalization techniques- Interpretation of results, Speaker profiling, Intelligibility enhancement of audio recordings, Transcription & analysis of disputed utterances- Authenticity and integrity examination of audio recordings

Textbooks:

1. Ladefoged, P., Johnson, K., “A Course in Phonetics”, Wadsworth Publishing Co Inc; 7th Edition, 2014.
2. Ashby M., Maidment, J., “Introducing Phonetic Science”, Cambridge University Press, 2005.
3. Steinberg, D.D., “An Introduction to Psycholinguistics”, Addison Wesley Publishing Company, 1995.
4. Sedivy, J., “Language in Mind: An Introduction to Psycholinguistics”, Sinauer Associates (An Imprint of Oxford University), 2014.
5. Maher, R.C., “Principles of Forensic Audio Analysis”, Springer, 2018.
6. Hollien, H., “Forensic Voice Identification”, Academic Press, 2001.
7. Zhang, D., Wu, K., “Pathological Voice Analysis”, Springer; 1st Edition, 2020.
8. Beigi, H., “Fundamentals of Speaker Recognition”, Springer, 2011.
9. Li, J., Deng, L., Haeb-Umbach, R., Gong, Y., “Robust Automatic Speech Recognition – A Bridge to Practical Applications”, Elsevier, 2015.
10. Yu, D., Deng, L., “Automatic Speech Recognition: A Deep Learning Approach (Signals and Communication Technology)”, Springer, 2015.

	PO 1	PO2 2	PO 3	PO4 4	PO5 5	PO 6	PO 7	PSO 1	PSO2 2	PSO 3
CO1	3									
CO2		3								
CO3		3						3	2	
CO4		3								1
CO5							3			
CO6						3				

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS3013	Microscopy in Forensic Science	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basic principle of light microscopy
2. realize the importance of electron microscope
3. summarize the types of photomicrography

Course Outcomes:

The student will be able to

1. understand the properties of light
2. summarize the principles of microscopy
3. realize the principles of various types of light microscopy
4. understand the principles of SEM
5. understand the principles of TEM
6. understand the principles of photo micrography

Unit 1: Introduction to Microscopy (9 Hours)

Electromagnetic radiation – Properties of Light – Magnification – Resolution – Resolving Power – Depth of field – Depth of focus – Numerical aperture – Lens – Aberration of Lenses

Unit 2: Light Microscopy – I (9 Hours)

Principle of bright field and dark field microscopy – Theory, Principles and working of compound microscope – Comparison microscope – Stereomicroscope – Fluorescence Microscope – Polarizing Microscope –Phase contrast Microscope

Unit 3: Light Microscopy – II (9 Hours)

Theory, Principles and working of interference microscope – Confocal microscope – Oil immersion microscope – Ultraviolet microscope – Infra-red microscope – X-ray microscope

Unit 4: Electron Microscope (9 Hours)

Introduction-Historical view – types – Scanning Electron Microscopy – Theory and Principles – Specific feature – instrumentation – sample preparation – specimen interaction volume – signal produced by specimen and forensic applications - Transmission Electron Microscopy – Theory and Principles – instrumentation – Forensic applications – Comparison of SEM and TEM – Comparison of Light microscopy and Electron Microscopy

Unit 5: Miscellaneous Microscopy (9 Hours)

Photomicrography – Introduction, Principles and procedure of photomicrography – UV Photography – Infra red photography – Microphotography – Comparison of Light microscopy and photomicrography – Principles and applications of Magnetic Resonance Microscope – Scanning Probe Microscope – Ultrasonic microscope

Textbook:

1. Bell, S., Morris, K., “An Introduction to Microscopy”, 1st Edition, CRC Press, 2009.
2. Murphy, D.B., “Fundamentals of Light Microscopy and Electronic Imaging”, Wiley-Blackwell, 2001.
3. Chiarini-Garcia, H., Melo, R., “Light Microscopy – Methods and Protocols”, Springer, 2011.
4. Sanderson, J., “Understanding Light Microscopy”, John Wiley & Sons, 2019.
5. Egerton, R.F., “Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM”, 2nd Edition, Springer, 2016.
6. Wheeler, B., Wilson, L.J., “Practical Forensic Microscopy: A Laboratory Manual”, Wiley-Blackwell, Lab Manual Edition, 2008.
7. Encyclopedia of Analytical Chemistry, Wiley, 2006.
8. Overney, N., Overney, G., “The History of Photomicroscopy”, 3rd Edition, 2011.
9. Davies, A., “Digital Ultraviolet and Infrared Photography (Applications in Scientific Photography)” Routledge, 1st Edition, 2017.
10. Basu, S., Millette, J.R., “Electron Microscopy in Forensic, Occupational, and Environmental Health Sciences”, Plenum Press, 1986.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3								
CO2						3				
CO3		3						3	2	1
CO4		3								
CO5		3								
CO6		3								

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS3014	Biological Instrumental Methods	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand the basic principle biological analysis
2. realize the importance of centrifugation techniques
3. apply the methods for enzyme kinetics

Course Outcomes:

The student will be able to

1. understand the principle biological analysis
2. summarize the principles of centrifugation techniques
3. realize the techniques used in enzyme kinetics
4. understand the principles of immunochemical methods
5. understand the cloning procedures
6. understand the methods involved in specific nucleic acid sequences

Unit 1: General principles of Biological Analysis

physiological solution, Cell and Tissue Culture, Cell fractionation, Biological variation etc.

Unit 2: Centrifugation Techniques

Basic principles of sedimentation, Types of centrifuges, Density gradient centrifugation, Prerogative centrifugation, Analysis of sub-cellular fractions, ultracentrifuge, refrigerated centrifuges.

Unit 3: Enzyme Techniques (9 Hours)

Enzyme kinetics, purification and protein estimation, enzyme assay techniques, visible UV spectrophotometric methods, Luminescence method, Radioisotope methods, Immuno-chemical method, automated enzyme analysis, immobilized enzymes.

Unit 4: Immunochemical Techniques (9 Hours)

General principles, production of antibodies, precipitation reaction, Gel immunodiffusion, Immune-electrophoresis, complement fixation. Radio immunoassay (RIA), enzyme immunoassay, metalloimmunoassay, chemiluminiscent/fluorescence immunoassay.

Unit 5: Molecular Biology Techniques (9 Hours)

Outline of genetic manipulation enzyme, Enzymes and in genetic manipulation, cloning procedures, Isolation of specific nucleic acid sequences-complimentary DNA, Gene libraries, colony hybridization, Nick translation, oligonucleotide probes, expression of genes.

Textbooks:

- Gordon, M.H., "Instrumental Analysis in the Biological Sciences", Springer, 1987.
- Rao, D.M., Swamy, A.V.N., Reddy, D.D., "Instrumental Methods of Analysis", CBS Publication, 2012.
- Bajpai, P.K., "Biological Instrumentation & Methodology", S. Chand & Company, 2010.
- Naidoo, S., "Centrifugation Techniques", Arcler Education Incorporated, 2017.
- Rickwood, D., "Centrifugation, a practical approach", Information Retrieval, 1978.
- Khan, M.Y., Farha, K., "Principles of Enzyme Technology", PHI Learning Pvt Ltd, 1st Edition, 2015.
- Goers, J., "Immunochemical Techniques Laboratory Manual", Academic Press; Spi Edition, 1993.
- Burns, R., "Immunochemical Protocols", Humana Press, 2010.
- Suraksha, A., "Techniques in Molecular Biology", Ibdc Publishers, 2008.
- Miller, H., Witherow, D.S., Carson, S., "Molecular Biology Techniques: A Classroom Laboratory Manual", Academic Press, 3rd Edition, 2011.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3								
CO2						3				
CO3							3	3	2	1
CO4		3								
CO5		3								
CO6		3								

'3'-High, '2'- Medium, '1'-Low, '- ' No correlation

20FS3015	Statistics and Forensic Applications							L	T	P	C
								2	0	0	2

Course Objectives:

Enable the student to

- understand the basics of statistics
- realize the concept of probability
- know about statistical approach to evaluation of results

Course Outcomes:

The student will be able to

- understand the importance of statistics in interpreting forensic data
- know about concept of probability
- understand about various analytical tests

4. understand the concept of analysis of variance
5. understand the various types of databases
6. acquire knowledge about evaluation of evidence

Unit 1: Fundamentals of Statistics (6 Hours)

Statistics: Definition – Importance of statistics in interpreting forensic data in research work and quality control – Data – Population – Distribution – Location - Random experiment - Brief introduction to sampling and data collection - Frequency distribution - Concept of measures of central tendencies - Normal distribution - Arithmetic mean - Median & Mode concept of measures of dispersion – Variance -Normal distribution- Variance, Standard Deviation, Coefficient of variation.

Unit 2: Probability (6 Hours)

Definitions of probability – Discrete random variables and probability distributions -Addition, multiplication and Bayer's theorem & applications – Probability in Forensic Evidence - Concept of random variable - Discrete and continuous – Some examples, Concept of probability distribution – Binomial - Poisson - Normal distribution – Definitions, statements of properties of above distribution and examples - Simple linear regression and correlation – Concept of computational methodology – Examples - Concept of tests of hypothesis – Null and alternative hypothesis – Critical region - Types of errors & level of significance

Unit 3: Sample tests (6 Hours)

Large samples tests – Test for single mean, Difference of means, Single proportion and difference of proportion examples - Chi square test for goodness of fit and test for independence of attributes – Examples - Hypothesis testing for one or two population means - Student t-test - t-test for simple mean - Difference of means – Examples. Hypothesis testing for small sample sizes and multinomial experiments

Unit 4: Variance (6 Hours)

Fisher's exact test- Analysis of variance and multiple comparison tests - F-test for equality of variance – Examples - Concept of analysis of variance – Computational procedure for ANOVA one way and two way classification- Examples.

Unit 5: Scientific evidence and statistics (6 Hours)

Data Bases – Type and geographical factors –Statistical approach to DNA fingerprinting – Loci and alleles - Simple case genotypic frequencies – Hardy Weinberg equilibrium – Simple case of allelic frequencies – Accounting for sub-population – Paternity mother and father unrelated – Data base searches and value of evidence- Evidence evaluation examples – Blood group frequencies – Clothing fibres – Shoe types – Air weapon projectiles – Height identification from eye witnesses - Uncertainty in scientific experimentation – Determination of uncertainty

Textbooks:

1. Lucy, D., "Introduction to Statistics for Forensic Scientists", 1st Edition, Wiley, 2005.
2. Aitken, C., Taroni, F., "Statistics and the Evaluation of Evidence for Forensic Scientists", Wiley, 2nd Edition, 2004.
3. Fung, W.K., Hu, Y., "Instrumental DNA Forensics: Theory, Methods and Computation", Wiley, 1st Edition, 2008.
4. Evett, I.W., Weir, B.S., "Interpreting DNA Evidence: Statistical Genetics for Forensic Scientists", Sinauer Associates Inc., 1st Edition, 1998.
5. Miller, J.C., Miller, J.N., "Statistics for Analytical Chemistry", Ellis Horwood Ltd., Subsequent Edition, 1993.
6. Fisher, R.A., "Statistical Methods for Research Workers", Cosmo Publications, New Delhi, 2006.
7. Sokal, R.R., Rohlf, F.J., "Biometry: The Principles and Practices of Statistics in Biological Research", W. H. Freeman; 3rd Edition, 1994.
8. Rao, T.B., "Methods of Biostatistics", Paras Medical Publisher; Third Edition, 2001.
9. Ramakrishnan, P., "Biostatistics", Saras Publication, 2015.
10. Rao, K.V., "Biostatistics a Manual of Statistical Methods for Use in Health, Nutrition and Anthropology", Jaypee Brothers Medical Publishers, Second Edition, 2009.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3								
CO2						3		3	2	1

CO3		3								
CO4		3								
CO5		3								
CO6							3			

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS3016	Molecular Biology & Immunology	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand about gene expression
2. know about the organization of immune system
3. know about immune technology

Course Outcomes:

The student will be able to

1. understand the fundamental concepts of regulation of genes
2. know the role of DNA in biological systems
3. understand the concept of immunity
4. know about vaccines and types
5. understand about Antigen-Antibody interaction
6. acquire knowledge about Generation of Polyclonal antibodies

Unit 1: Regulation of gene expression (9 Hours)

– Regulation by operons in prokaryotes – lac operon – Catabolite repression – Attenuation – promoter flipping – Central dogma and levels of gene regulation by chromatin remodeling – Transcriptional regulation by transcription factors – Post transcriptional regulation by alternate splicing – Translational regulation – Post translational modifications to modulate gene product activity

Unit 2: Recombinant DNA technology(9 Hours)

Overview of cloning – History of rDNA technology – Bacterial and eukaryotic vectors – Restriction enzymes for production recombinant DNA – Polymerases, kinase and ligase for production of recombinant DNA – Preparation of cDNA and genomic DNA libraries – Screening to select clone of interest – Over expression of cloned proteins in bacteria – Production of transgenic animals – production of transgenic plants – Silencing using RNAi

Unit 3: Immunology (9 Hours)

Organization of the immune system – Haematopoiesis – Production and differentiation of the immune cells - Cells of the immune system – Primary and secondary lymphoid organs – Innate immunity – Specific acquired immunity – Active and passive immunity - Cell mediated immunity – Humoral immunity

Unit 4: Immunoglobulin (9 Hours)

Structure of a typical immunoglobulin - Classes of immunoglobulins – Genetics of Antibody production – Generation of Antibody diversity - Antigens and immunogens – Super antigens - Auto immune disorders – Blood group antigens – Vaccines and their types

Unit 5: Immunotechnology (9 Hours)

Antigen-Antibody interaction - Precipitation and agglutination of the Ag –Ab – Mancini's Radial immunodiffusion - Ouchterlony's Double diffusion – Haemagglutination – Agglutination inhibition – Passive agglutination - Immuno electrophoresis – Rocket immune electrophoresis – RIA – ELISA – Western blot – Complement fixation test – Inhibition of complement fixation – Direct and indirect Coombs' test - Immediate and delayed Hypersensitivity – Generation of Monoclonal antibodies – Generation of Polyclonal antibodies – Abzymes

Textbooks:

1. Kindt, T. J., Osborne, B.A., Goldsby, R.A., “Kuby Immunology”, W. H. Freeman & Company; 6th Edition, 2006
2. Roitt, I., “Essential Immunology”, Wiley-Blackwell; 8th Edition, 1994.
3. Nelson, D.L., Cox, M.M., “Lehninger Principles of Biochemistry”, W H Freeman & Co, 6th Edition, 2012.

4. Glick, B.J., Pasternak, J. J., Patten, C.L., “Molecular Biotechnology: Principles and Applications”, American Society for Microbiology, 4th Edition, 2010.
5. Watson, J.D., Baker, T.A., Bell, S. P., Gann, A., Levine, M., Losick, R., “Molecular Biology of the Gene”, Pearson, 7th Edition, 2013.
6. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D., “Molecular Biology of the Cell”, Garland Science, 3rd Edition, 1994.
7. Brown, T.A., “Gene Cloning and DNA Analysis: An Introduction”, 6th Edition, Wiley-Blackwell, 6th Edition, 2010.
8. Gaensslen, R.E., “Sourcebook in Forensic Serology, Immunology, and Biochemistry”, University of Michigan Library, 1983.
9. Chakravarthy, A.K., “Immunology and Immunotechnology”, Oxford University Press, 1st Edition, 2006.
10. **Rastogi, S.C.**, “Elements of Immunology”, CBS Publication, 2011.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		3						3	2	1
CO2							3			
CO3		3								
CO4							3			
CO5							3			
CO6							3			

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

20FS3017	Medical Jurisprudence	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. understand about legal procedures in Courts
2. know about personal identity
3. know about post-mortem examination

Course Outcomes:

The student will be able to

1. know about various legal procedures
2. know about the parameters contributing to personal identity
3. understand the importance of post-mortem examination
4. know about wounds
5. understand the modes of death
6. acquire knowledge to estimate time since death

Unit 1: Concept of Medical Jurisprudence (8 Hours)

Brief knowledge about legal procedures in Courts, inquest, Criminal courts and their powers, Subpoena & oath of medical expert. Recording of Medical experts evidence in courts. Types of Medical evidence. Kinds of witness and rules for giving evidence.

Unit 2: Personal Identity: (8 Hours)

Definition and importance. Parameters contributing to personal identity- Race, Sex, Age, Complexion, features & Photographs, Anthropometry, Fingerprints, Footprints, Tattoo marks, Occupational marks, Handwriting, Clothes & Ornaments, Voice & Speech, DNA, Superimposition techniques for skull. Disputed paternity.

Unit 3: Post-Mortem Examination: (9 Hours)

Importance, post-mortem report format, external & internal examination in brief. Viscera & its preservation. Examination of decomposed and mutilated bodies. Precaution to be taken during post mortem examination. Exhumation. Cause of death.

Unit 4: Wounds (10 Hours)

Wounds & its types, Medico-legal aspects, post mortem & ante mortem wounds, General characteristics of injuries from burns, scalds, lightning, electricity and radiation. Forensic importance of wounds.

Unit 5: Deaths in its Medico-legal aspects (10 Hours)

Modes of Death (Coma, Syncope, Asphyxia), Sudden death. Sign of Death, cessation of vital functions, changes in the Eye & Skin, cooling of body, post-mortem lividity, cadaveric changes in the muscles, putrefaction, adipocere & mummification. Estimation of time since Death.

Textbooks:

1. Kannan, K., "Modi's A Textbook of Medical Jurisprudence and Toxicology", Lexis Nexis Butterworth India, 2019.
2. Smith, F.J., "Taylor's Principles and Practice of Medical Jurisprudence. Volume 2 of 2", Gale, Making of Modern Law, 2010.
3. Parick, C.K., "Parikh's Textbook of Medical Jurisprudence, Forensic Medicine and Toxicology", CBS, 6th Edition, 2007.
4. Knight, B., "Simpson's Forensic Medicine", CRC Press, 11th Edition, 1996.
5. Polson, C.J., Gee, D.J., "The Essentials of Forensic Medicine", Pergamon, 4th Revised Edition, 1984.
6. Reddy, K. S. N., Murthy, O.P., "The Essentials of Forensic Medicine and Toxicology", Jaypee Brothers Medical Publishers, 34th Edition, 2017.
7. Aggarwal, A., "APC Textbook of Forensic Medicine and Toxicology", Avichal Publishing Company, Delhi, 2014.
8. Biswas, G., "Practical and Postmortem Record Book of Forensic Medicine and Toxicology", Jaypee Brothers Medical Publishers, First Edition, 2016.
9. Wilson, K.D., "Cause of Death : A Writer's Guide to Death, Murder and Forensic Medicine", Writers Digest Books, 1st Edition, 1992.
10. Joseph, M., Kaur, H., "A Handbook of Forensic Medicine and Toxicology: Question Answer Format with Illustrations", B. Jain Regular, First Edition, 2009.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3									
CO2	3									
CO3		3								
CO4	3									
CO5		3								
CO6						3		3	2	1

'3'-High, '2'- Medium, '1'-Low, '-' No correlation

20FS3018	Human Anatomy, Physiology and Forensic Medicine	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand about human physiology and anatomy
2. know about the forensic medicine and pathology
3. understand about the causes of unexpected natural deaths

Course Outcomes:

The student will be able to

1. understand human anatomy
2. summarize about human physiology
3. understand about the forensic medicine
4. understand the basics of Forensic pathology
5. summarize about the sexual offences and forensic science
6. analyse the reasons for unexpected death

Unit 1: Human Anatomy and Physiology (10 Hours)

Structural levels of organization of human body – Cardiovascular system - Structure and Functions of heart - Arterial & Venous system - Digestive system and its parts - Process of digestion and absorption of food in the alimentary canal - Respiratory system and its parts - Mechanism and regulation of respiration –Nervous system – Structure and functions of neuron – Transmission of nerve impulse -

Central and Peripheral Nervous systems and their functions – Endocrine system - Characteristics of hormones - Endocrine glands and their hormones - Urinogenital system - Structure and functions of kidneys - Formation and composition of urine - Male and female reproductive systems and their functions

Unit 2: Forensic Medicine (9 Hours)

Forensic Medicine – Personal identification of living and dead – Postmortem examination (autopsy) – Medico legal aspects of death – Causes of death - Postmortem changes and their importance in determination of time after death - Mechanical injuries – Thermal injuries – Medico legal aspects of injuries

Unit 3: Forensic pathology (9 Hours)

Preservation of pathological evidence - Examination of decomposed, mutilated and burnt bodies – Exhumation procedure - Deaths from poisoning – Mechanical Asphyxia – Drowning - Starvation - Lightning – Electrocution

Unit 4: Sexual offences (8 Hours)

Rape – Unnatural sexual offences and medicolegal aspects - Abortion & Infanticide –Medico legal aspects – Impotence and sterility – Virginity, Pregnancy and Delivery - Medicolegal aspects - MPT Act - Linkage with forensic science laboratory

Unit 5: Unexpected deaths due to natural causes (9 Hours)

Causes of sudden and unexpected deaths – cardiovascular system – respiratory system – gastrointestinal system – Gynaecological conditions – Deaths from asthma and epilepsy

Textbookss:

1. Pillay, V.V., Handbook of Forensic Medicine and Toxicology, 12th ed., Paras Publication 2001.
2. Modi, J. P., Textbook of Medical Jurisprudence & Toxicology, M.M. Tripathi Publication, (2001)
3. Parikh, C.K., Textbook of Medical Jurisprudence & Toxicology
4. Reddy Narayn, M., Textbook of Medical Jurisprudence & Toxicology
5. James, P.J.: Encyclopedia of Forensic and Legal Medicine, Elsevier, 2005
6. Shepherd R. "Simpson's Forensic Medicine", 12th Edition, A Hodder Arnold Publication, 2003

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	2	1		2	2		1	1	
CO2	2	1		2	2	1		1	1	
CO3	3	2	1	2		2	1	1	2	
CO4	3		2	2	2	1	1	2	2	2
CO5	3	2	3	2		3	2	1	2	3
CO6	2	3	1	3	1	1	1		3	2

‘3’-High, ‘2’- Medium, ‘1’-Low, ‘-’ No correlation

DEPT. OF CHEMISTRY

LIST OF NEW COURSES

Sl.No	Sub Code	NAME OF THE SUBJECT	Credits			
1	19CH1001	Engineering Chemistry For Electrical Engineers	3	0	0	3
2	19CH1002	Chemistry For Computer Science and Engineering	2	0	0	2
3	19CH1003	Engineering Chemistry for Mechanical Engineering	3	0	0	3
4	19CH1004	Engineering Chemistry for Aerospace Engineering	3	0	0	3
5	19CH1005	Chemistry for Electronics and Communication Engineering	2	0	0	2
6	19CH1006	Applied Chemistry for Civil Engineering	3	0	0	3
7	19CH1007	Applied Chemistry Laboratory	0	0	2	1
8	19CH1008	Applied Chemistry for Instrumentation Engineering	3	0	0	3
9	19CH3001	Composite Materials	3	0	0	3
10	19CH3002	Waste to Energy	3	0	0	3

19CH1001	Engineering Chemistry For Electrical Engineers	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student

1. To make the student conversant with the fundamentals of chemical bonding and nanotechnology
2. To encourage students to develop curiosity towards fuels, energy resources and storage devices
3. To acquire knowledge about nanomaterials and surface chemistry

Course Outcomes:

The Student will be able to

1. formulate electronic structures and correlate its properties
2. relate the unique properties of nanomaterials and explain methods of fabricating nanostructures
3. describe the various energy sources
4. learn the various energy storage systems and conversion devices
5. describe the techniques involved in adsorption and colloids
6. realize the applications of the liquid crystals in various domains

Module 1: Chemical Bonding (9 Hours)

Types of bonding – Ionic, Covalent, Coordinate bond, Vanderwaals forces, Hydrogen bond, Metallic bond
VB theory – Hybridization - MO theory, bond order- Homonuclear and heteronuclear diatomic molecules

Module 2: Nanomaterials and Fabrication (6 Hours)

Nanomaterials –Classification - Top down and Bottom up Approaches - High energy Ball milling – microfabrication – CVD, sol-gel – Nanomaterials - Fullerenes – Self assembled monolayers –preparation and application - characterization of nanomaterials – Introduction to XRD, SEM -Applications of nanotechnology

Module 3: Electrochemistry & Corrosion (9 Hours)

Redox reactions – electrode potential - Nernst Equation - Electrochemical series and significance - Electrochemical cell, Corrosion – Dry and Wet Corrosion - Factors Influencing corrosion - Prevention of Corrosion – Galvanic, sacrificial anodic protection.

Module 4: Energy sources and storage devices (9 Hours)

Batteries – Primary cell (Dry batteries), Secondary Cell (lead acid batteries) H_2O_2 - Fuel cell – Microbial Fuel cell - Electrochemical sensors - Photovoltaics

Module 5: Liquid Crystals (6 Hours)

Liquid crystals –classification, thermotropic and Lyotropic liquid crystals, structure of liquid crystal forming compounds, Chemical properties, Applications of liquid crystals.

Module 6: Surface chemistry (6 Hours)

Adsorption- Classification, uses - Langmuir's theory of adsorption - Colloids – types, applications - Colloids – Preparation - Characteristics of Colloids, Micelles.

Text Books:

1. Engineering Chemistry by Jain and Jain, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017
2. University Chemistry, B. M. Mahan, R. J. Meyers, 4th Edition, Pearson, 2009

Reference Books:

1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane, 3rd Edition, McGraw Hill, 1980.
2. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan.
3. Physical Chemistry, by P. W. Atkins, Julio de Paula, 8th Edition, Oxford University press, 2007.

19CH1002	Chemistry For Computer Science And Engineering	L	T	P	C
		2	0	0	2

Course Objectives:

Enable the student to

1. Understand the fundamentals of chemical bonding, polymers and nanotechnology.
2. Recognize the significance of electrochemical reactions and energy storage devices.
3. Infer the modern techniques related to liquid crystals and spectroscopy techniques.

Course Outcomes:

The students will be able to

1. Describe the basic principles of chemical structures and its bonding characteristics.
2. Identify the various types of polymers and its functionalities.
3. Interpret the characteristics of nanomaterials and its applications.
4. Explain the principles of electrochemical reactions and storage devices.
5. Relate the applications of the liquid crystals in various domains
6. Describe the spectroscopic techniques and its related applications

Module 1: Chemical Bonding (5 Hours)

Types of bonding – Ionic, Covalent, Coordinate bond, Vander Waals forces, Hydrogen bond, Metallic bond, VB theory – Hybridization, MO theory.

Module 2: Polymers (5 Hours)

Polymers – Functionality - Tacticity of polymers - Classification – natural, synthetic – thermosetting plastics and thermoplastics- ingredients used in compounding of plastics-Applications of polymers.

Module 3: Nanomaterials (5 Hours)

Nanomaterials –Classification - Top down and Bottom up Approaches - High energy Ball milling – Microfabrication – CVD - Fullerenes – Self assembled monolayers – Applications of Nanotechnology

Module 4: Electrochemical Reactions and Energy Storage Devices (5 Hours)

Redox reactions – Electrode potential-Nernst Equation - Electrochemical series - Electrochemical cell. Primary batteries: Dry cell; Advanced Primary batteries - Lithium batteries - secondary batteries: Lead-acid, Fuel cells: Hydrogen-oxygen fuel cells

Module 5: Liquid Crystals (5 Hours)

Liquid crystals – Classification, thermotropic and Lyotropic liquid crystals, Structure of liquid crystal forming compounds, Chemical properties, Applications of liquid crystals

Module 6: Spectroscopic Techniques (5 Hours)

Electromagnetic radiation, relation between wave length, wave number, frequency and energy–Principles and applications of IR and UV-Visible spectroscopy.

Text Books:

1. Engineering Chemistry by Jain and Jain, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017
2. University Chemistry, B. M. Mahan, R. J. Meyers, 4th Edition, Pearson, 2009

Reference Books:

1. M. J. Sienko and R. A. Plane, "Chemistry: Principles and Applications", 3rd Edition, McGraw Hill, 1980, ISBN-10: 0070573212, ISBN-13: 978-0070573215.
2. B. L. Tembe, Kamaluddin and M. S. Krishnan, "Engineering Chemistry (NPTEL Web-book)".
3. P. W. Atkins, Julio de Paula, "Physical Chemistry", 8th Edition, Oxford University press, 2007.
4. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw-Hill publishing, 2010.

19CH1003	Engineering Chemistry for Mechanical Engineering	L	T	P	C
		3	0	0	3

Course Objectives

Enable the student to

1. To understand the basic concepts in chemistry
2. To have knowledge on the applications of Chemistry
3. To apply chemistry principles in Engineering and Technology

Course Outcomes

The student will be able to

1. Formulate electronic structures and correlate its properties
2. Learn the various factors in water quality and its technology
3. Realize the potential applications of polymers
4. Analyze the combustion process of common fuels
5. Learn the various energy storage systems and conversion devices
6. Apply the instrumental methods for various types of analysis

Module 1: Chemical bonding (8L)

Types of bonding – Ionic, Covalent, Coordinate bond, Vander Waalss forces, Hydrogen bond, Metallic bond VB theory – Hybridization MO theory, bond order- Homonuclear and Heteronuclear diatomic molecules

Module 2: Water Chemistry (8L)

Hardness, Units and calculation of hardness - Determination of hardness by EDTA method - Removal of hardness – Zeolite process - Ion – Exchange process, sludge – formation and disadvantages - Scale - sources and disadvantages Internal conditioning – Calgon & carbonate conditioning - Boiler corrosion – causes (DO, CO₂, acids) & removal methods - Desalination – Reverse Osmosis .

Module 3: Polymers (8L)

Polymers – Introduction, functionality, tacticity of polymers, Classification – natural, synthetic - Addition polymer, condensation polymer, copolymer- thermosetting plastics, thermoplastics- ingredients used in compounding of plastics- compression and injection molding, fiber reinforced plastics- preparation, properties and uses of polyethylene, polyvinyl chloride, Bakelite, epoxy resin, raw rubber – vulcanized rubber – Applications of polymers – conducting polymers

Module 4: Fuels and combustion (7L)

Fuels-classification, calorific value, Dulong's formula - desired properties of good coal - Proximate analysis of coal and its significance- Ultimate analysis of coal and its significance -Knocking-octane number, cetane number, antiknocking characteristics of petrol -Flue Gas Analysis by Orsat Method –Rocket Propellants

Module 5: Energy sources and storage devices (7L)

Redox reactions – electrode potential - Nernst Equation - Electrochemical series and significance - Electrochemical cell, reference electrode - Batteries – dry cell -Lead acid battery - Fuel cell - Solar battery- Electrochemical sensors.

Module 6: Instrumental Methods (7L)

Electromagnetic radiation, relation between wave length, wave number, frequency and energy- General features of absorption photometer – Principles and applications of IR, UV-Visible spectroscopy, - Flame photometer – Introduction to Atomic Absorption Spectroscopy

Text Books:

1. Engineering Chemistry by Jain and Jain, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017
2. University Chemistry, B. M. Mahan, R. J. Meyers, 4th Edition, Pearson, 2009

Reference Books:

1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane, 3rd Edition, McGraw Hill, 1980.
2. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan.
3. Physical Chemistry, by P. W. Atkins, Julio de Paula, 8th Edition, Oxford University press, 2007.
4. Fundamentals of Molecular Spectroscopy, by C. N. Banwell, 4th Edition, Tata McGraw-Hill India Ltd, 2010.

19CH1004	Engineering Chemistry for Aerospace Engineering	L	T	P	C
		3	0	0	3

Course Objectives

Enable the students

1. To understand the basic concepts in chemistry
2. To have knowledge on the applications of Chemistry
3. To apply chemistry principles in Engineering and Technology

Course Outcomes

The student will be able to

1. formulate electronic structures and correlate its properties
2. learn the various factors in water quality and its technology
3. realize the potential applications of polymers
4. analyze the combustion process of common fuels
5. learn the various energy storage systems and their corrosion behaviour
6. Apply the instrumental methods for various types of analysis

Module 1: Chemical bonding (7L)

Types of bonding – Ionic, Covalent, Coordinate bond, Vander Waals forces, Hydrogen bond, Metallic bond
VB theory – Hybridization MO theory, bond order- Homonuclear and Heteronuclear diatomic molecules

Module 2: Water Chemistry (8L)

Hardness, Units and calculation of hardness - Determination of hardness by EDTA method - Removal of hardness – Zeolite process - Ion – Exchange process, sludge – formation and disadvantages - Scale - sources and disadvantages Internal conditioning – Calgon & carbonate conditioning - Boiler corrosion – causes (DO, CO₂, acids) & removal methods - Desalination – Reverse Osmosis .

Module 3: Polymers (7L)

Polymers – Introduction, functionality, tacticity of polymers, Classification – natural, synthetic - Addition polymer, condensation polymer, copolymer- thermosetting plastics, thermoplastics- ingredients used in compounding of plastics- compression and injection molding, fiber reinforced plastics- preparation, properties and uses of polyethylene, polyvinyl chloride, Bakelite, epoxy resin, raw rubber – vulcanized rubber – Applications of polymers

Module 4: Fuels and combustion (7L)

Fuels-classification, calorific value, Dulong's formula - desired properties of good coal - Proximate analysis of coal and its significance- Ultimate analysis of coal and its significance -Knocking-octane number, cetane number, antiknocking characteristics of petrol -Flue Gas Analysis by Orsat Method –Rocket Propellants

Module 5: Electrochemical systems and corrosion (10L)

Redox reactions – electrode potential - Nernst Equation - Electrochemical series and significance - Electrochemical cell, reference electrode - Batteries – dry cell -Lead acid battery - Fuel cell – Corrosion-definition; types – Oxidation corrosion, corrosion by other gases and liquid metal corrosion; Electrochemical corrosion – mechanism and types only; Factors affecting corrosion and corrosion control methods-.

Module 6: Instrumental Methods (6L)

Electromagnetic radiation, relation between wave length, wave number, frequency and energy- General features of absorption photometer – Principles and applications of IR, UV-Visible - Spectroscopy

Text Books:

1. Engineering Chemistry by Jain and Jain, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017
2. University Chemistry, B. M. Mahan, R. J. Meyers, 4th Edition, Pearson, 2009

Reference Books:

1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane, 3rd Edition, McGraw Hill, 1980
2. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
3. Physical Chemistry, by P. W. Atkins, Julio de Paula, 8th Edition, Oxford University press, 2007
4. Fundamentals of Molecular Spectroscopy, by C. N. Banwell, 4th Edition, Tata McGraw-Hill India Ltd, 2010

19CH1005	Chemistry for Electronics and Communication Engineering	L	T	P	C
		2	0	0	2

Course Objectives:

Enable the student to

1. Understand the fundamentals of chemical bonding, polymers and nanotechnology.
2. Recognize the significance of electrochemical reactions and energy storage devices.
3. Infer the modern techniques related to liquid crystals and spectroscopy techniques.

Course Outcomes:

The students will be able to

1. Describe the basic principles of chemical structures and its bonding characteristics.
2. Identify the various types of polymers and its functionalities.
3. Interpret the characteristics of nanomaterials and its applications.
4. Explain the principles of electrochemical reactions and storage devices.
5. Relate the applications of the liquid crystals in various domains
6. Describe the spectroscopic techniques and its related applications

Module 1: Chemical Bonding (5 Hours)

Types of bonding – Ionic, Covalent, Coordinate bond, Vander Waals forces, Hydrogen bond, Metallic bond, VB theory – Hybridization, MO theory.

Module 2: Polymers (5 Hours)

Polymers – Functionality - Tacticity of polymers - Classification – natural, synthetic – thermosetting plastics and thermoplastics- ingredients used in compounding of plastics-Applications of polymers.

Module 3: Nanomaterials (5 Hours)

Nanomaterials –Classification - Top down and Bottom up Approaches - High energy Ball milling – microfabrication – CVD - Fullerenes – Self assembled monolayers – Applications of Nanotechnology

Module 4: Electrochemical Reactions and Energy Storage Devices (5 Hours)

Redox reactions – electrode potential-Nernst Equation - Electrochemical series - Electrochemical cell. Primary batteries: Dry cell; Advanced Primary batteries - Lithium batteries - secondary batteries: Lead-acid, Fuel cells: Hydrogen-oxygen fuel cells

Module 5: Liquid Crystals (5 Hours)

Liquid crystals –classification, thermotropic and Lyotropic liquid crystals, structure of liquid crystal forming compounds, Chemical properties, Applications of liquid crystals

Module 6: Spectroscopic Techniques (5 Hours)

Electromagnetic radiation, relation between wave length, wave number, frequency and energy–Principles and applications of IR and UV-Visible spectroscopy.

Text Books:

1. Engineering Chemistry by Jain and Jain, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017
2. University Chemistry, B. M. Mahan, R. J. Meyers, 4th Edition, Pearson, 2009

Reference Books:

1. M. J. Sienko and R. A. Plane, "Chemistry: Principles and Applications", 3rd Edition, McGraw Hill, 1980, ISBN-10: 0070573212, ISBN-13: 978-0070573215.
2. B. L. Tembe, Kamaluddin and M. S. Krishnan, "Engineering Chemistry (NPTEL Web-book)".
3. P. W. Atkins, Julio de Paula, "Physical Chemistry", 8th Edition, Oxford University press, 2007.
4. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw-Hill publishing, 2010.

19CH1006	Applied Chemistry for Civil Engineering	L	T	P	C
		3	0	0	3

Course Objectives

Enable the students

1. To encourage students to develop curiosity towards water technology, corrosion and nanocomposites
2. To make the student conversant with the fundamentals of Corrosion and corrosion control
3. To acquire knowledge about polymers, concrete.

Course Outcome

Students will be able to

1. understand the various factors in water quality
2. learn the various water purification process and their applications
3. describe the process of corrosion
4. identify the methods to control corrosion
5. analyze the components present in cement and concrete
6. realize the potential applications of polymers

Module 1 Water Technology - I (9L)

Sources of water – Impurities in water - Hardness, Units and calculation of hardness – Determination of hardness by EDTA method -Disadvantages of water – Scales – Sludges – Internal conditioning – Calgon & carbonate conditioning In Caustic embrittlement – Bioiler corrosion - – causes (DO, CO₂, acids) & removal methods – Alkalinity – Calculation of alkalinity – Determination of dissolved oxygen

Module 2 Water Technology - II (6L)

Removal of hardness – Zeolite process - Ion – Exchange process, Municipal water treatment methods – Purification of water for domestic use - Desalination – Electrodialysis - Reverse Osmosis -

Module 3 Corrosion (6L)

Dry Corrosion – Oxidation corrosion – mechanism – Wet corrosion – Mechanism – Galvanic corrosion – Galvanic series – Factors influencing corrosion

Module 4 Corrosion control (7L)

Corrosion control methods - Organic coatings – Paints - constituents of Paints Analysis of oils-acid value, Saponification value, Iodine value, Reichert-Meissl value, Formulation of paints, Failure of a paint film – Varnishes – Emulsion Paints

Module 5 Cement and concrete (8L)

Cement – Introduction – classification, Portland cement – Manufacture – Properties, Chemical composition of cement -Setting and Hardening of Portland cement —. Special cements - Concrete –Uses – Curing of concrete, Reinforced concrete construction (RCC), Decay of concrete, Protection of concrete.

Module 6 Polymers (9L)

Polymers – Introduction, functionality, tacticity of polymers, Classification – natural, synthetic - Addition polymer, condensation polymer, copolymer- Forces between polymeric chains – thermosetting plastics, thermoplastics- ingredients used in compounding of plastics- compression & injection moulding, fiber

reinforced plastics- preparation, properties and uses of polyethylene, polyvinyl chloride, bakelite, epoxy resin, raw rubber – vulcanized rubber – Applications of polymers – conducting polymers

Text Books:

1. Engineering Chemistry by Jain and Jain, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017
2. University Chemistry, B. M. Mahan, R. J. Meyers, 4th Edition, Pearson, 2009

Reference Books:

1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane, 3rd Ed., McGraw Hill, 1980
2. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
3. Physical Chemistry, by P. W. Atkins, Julio de Paula, 8th Ed, Oxford University Press, 2001
4. Advanced Inorganic Chemistry Sathya Prakash, G.D.Tuli, R.D.Madan, S.K.Basu, S. Chand & Company, 2016
5. Principles of Physical Chemistry – Puri, Sharma and Pathania, Vishal Publishing & Co.

19CH1007	Applied Chemistry Laboratory	L	T	P	C
		0	0	2	1

List of Experiments:

1. Estimation of alkalinity in water sample.
2. Estimation of total, permanent and temporary hardness by EDTA method in water sample.
3. Estimation of copper in brass
4. Estimation of calcium in milk powder
5. Determination of dissolved oxygen in water sample.
6. Estimation of iodine content in iodized common salt
7. Conductometric estimation of an acid
8. Estimation of acid using pH measurements
9. Potentiometric estimation of Fe²⁺ ions
10. Estimation of iron in water sample by spectrophotometry
11. Preparation of aspirin
12. Synthesis of cadmium sulfide nanocrystals

Text Books

1. Mendhem J., Denny R. C., Barnes J. D., Thomas M. J. K., Vogel's Quantitative Chemical Analysis, Pearson Education limited, 6th Edition, 2000.
2. Elias, A. J., A Collection of Interesting General Chemistry Experiments, Revised Edition, Universities Press, 2007.

19CH1008	Applied Chemistry for Instrumentation Engineering	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the student to

1. Understand the fundamentals of chemical bonding, polymers and nanotechnology.
2. Recognize the significance of electrochemical reactions and energy storage devices.
3. Infer the advancements in crystallography and spectroscopy techniques.

Course Outcomes:

The students will be able to

1. Describe the basic principles of chemical structures and its bonding characteristics.
2. Identify the various types of polymers and its functionalities.
3. Interpret the characteristics of nanomaterials and its applications.
4. Explain the principles of electrochemical reactions and storage devices.
5. Relate the applications of the crystallography in various domains

6. Describe the spectroscopic techniques and its related applications

Module 1: Chemical Bonding: (8 Hours)

Types of bonding – Ionic, Covalent, Coordinate bond, Vander Waals forces, Hydrogen bond, Metallic bond, VB theory – Hybridization, MO theory.

Module 2: Polymers (7 Hours)

Polymers – Functionality - Tactility of polymers – Classification – natural, synthetic – Thermosetting plastics and thermoplastics- Ingredients used in compounding of plastics -polyurethane -Applications of polymers in medical field.

Module 3: Nanomaterials (7 Hours)

Nanomaterials –Classification - Top down and Bottom up Approaches - High energy Ball milling – microfabrication – CVD - Fullerenes – Self assembled monolayers – Applications of Nanotechnology

Module 4: Electrochemical Reactions and Energy Storage Devices (8 Hours)

Redox reactions – electrode potential-Nernst Equation - Electrochemical series - Electrochemical cell. Primary batteries: Dry cell; Advanced Primary batteries - Lithium batteries - secondary batteries: Lead-acid, Fuel cells: Hydrogen-oxygen fuel cells

Module 5: Crystallography (7 Hours)

Amorphous and Crystalline Solids- Crystal Structure - crystal lattice, x-ray diffraction, Bragg's law, Experimental determination of crystal structure – Crystal imperfections

Module 6: Spectroscopic Techniques (8 Hours)

Electromagnetic spectrum - Relation between wave length, wave number, frequency and energy–Types of Energy -Principles and applications of IR and UV-Visible spectroscopy.

Text Books:

1. Engineering Chemistry by Jain and Jain, 16th Edition, DhanpatRai Publishing Company, New Delhi, 2017
2. University Chemistry, B. M. Mahan, R. J. Meyers, 4th Edition, Pearson, 2009

Reference Books:

1. M. J. Sienko and R. A. Plane, "Chemistry: Principles and Applications", 3rd Edition, McGraw Hill, 1980, ISBN-10: 0070573212, ISBN-13: 978-0070573215.
2. B. L. Tembe, Kamaluddin and M. S. Krishnan, "Engineering Chemistry (NPTEL Web-book)".
3. P. W. Atkins, Julio de Paula, "Physical Chemistry", 8th Edition, Oxford University press, 2007.
4. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw-Hill publishing, 2010.

19CH3001 COMPOSITE MATERIALS

Credits: 3:0:0:3

Course objectives

Enable the student to

1. Understand the importance of composites
2. Know about different types of composite materials
3. Learn various mechanical characterization techniques

Course outcome

Students will be able to

1. Obtain basic knowledge about composite materials
2. Expand their understanding on reinforcement mechanism and mechanical properties
3. Gain more information on metal matrix composite materials
4. Understand thoroughly about polymer matrix composite materials
5. Recognize the influence of nanofillers on mechanical properties polymer matrix composite materials
6. Comprehend more on ceramic matrix composite materials

Module I. Introduction

Introduction to composite material – Definition and classification and characteristics of composites – metal-matrix, polymer, ceramic and carbon-carbon composites – Advantages and applications of composites – Reinforcement - particle filled, short and long fibre reinforced; laminates

Module II. Types of reinforcements

Interface interaction – filler-matrix interaction – Effect of size, shape, distribution, volume fraction on overall performance of composites – 2D reinforcement – layup method; Long or short fibre reinforcement - properties and applications of glass fibres, carbon fibres, Kevlar fibres and boron fibres; Particulate reinforcement – whiskers and various particulate fillers; Mechanical behaviour of polymers – rule of mixtures, inverse rule of mixtures.

Module III. Fabrication of polymer matrix composites

Fabrication of polymer composites - Compounding of plastics – additives added and their significance – moulding processes – injection and compression moulding, lamination, hand lay-up, autoclave technique and filament winding techniques; Polymer nanocomposites - introduction; advantages and limitations of nanofillers; surface functionalization of nanofillers; properties and application of polymer composites.

Module IV. Fabrication of metal matrix composites

Casting – solid state diffusion technique, hot isostatic pressing; properties and applications of metal matrix composites;

Module V. Fabrication of ceramic matrix composites

Fabrication of ceramic matrix composites – liquid metal infiltration, liquid phase sintering; properties and applications of ceramic matrix composites; Fabrication of carbon-carbon composites – influence of knitting, braiding, weaving of carbon fabric – properties and applications of carbon-carbon composites

Module VI. Mechanical characterization of polymer composites

Mechanical behaviour of polymers – Testing of tensile, compressive, impact and fracture strength; Hardness test, Fatigue and creep testing –

Reference Books:

1. K K Chawla, “Composite Materials”, Springer, 2012
2. R. Balasubramaniam, (adapted) “Materials Science and Engineering, An Introduction by W D Callister”, John Wiley and Sons, NY Indian Edition (2007)
3. R. J. Yound and P. A. Lovell, “Introduction to Polymers”, Stanley Thomas Publishers, London, 2000.
4. Y. W. Mai and Z. Z. Yu, “Polymer Nanocomposites”, Woodhead Publishing Ltd., Cambridge, England, 2006.
5. P. Ma, N. A. Siddiqui, G. Marom and J. Kim, “Dispersion and Functionalisation of Carbon Nanotubes for Polymer based Nanocomposites: a review”, Composites: Part A vol. 41 pp 1345-1367, 2010.

19CH3002 WASTE TO ENERGY

Credits: 3:0:0:3

Course Objectives:

To impart knowledge on

1. Types of waste materials
2. Conversion processes to convert waste to energy.
3. Biomass, Biogas and Biodiesel.

Course Outcomes:

The students will able to

1. Understand the concept of waste to energy conversion, based on its properties
2. Select the conditions for biomass pyrolysis.
3. Develop a small size biomass gasifier.
4. Prepare biodiesel and analyze its performance.

5. Understand the current research scenario in waste to energy application
6. Design a community biogas plant.

Module 1: Introduction to Energy from Waste: (7L + 1T)

Classification of waste as fuel – Solid waste Management - Agro based, Forest residue, Industrial waste – Municipal solid waste – Conversion devices – Incinerators, gasifiers, digesters.

Module 2: Catalysis in waste conversion: (5L + 1T)

Catalysts - Preparation of heterogeneous nano based catalyst – Properties – Application in the field of Energy.

Module 3: Biodiesel production (6L + 2T)

Waste vegetable oil and animal fat characteristics – fatty acid composition – oil extraction – oil refining process – Transesterification – ASTM characterization – Application.

Module 4: Biogas Production. (5L + 1T)

Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Types of biogas Plants – Applications - Alcohol production from biomass.

Module 5: Biomass Pyrolysis: (7L + 2T)

Pyrolysis – pyrolysis process based on heating rate – Types, slow fast – Application - Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Module 6: Biomass Gasification: (7L + 1T)

Types of gasification reaction – Types Gasifiers – Fixed bed system – Fluidized bed gasifiers - Downdraft and updraft gasifiers – Design, construction and operation – Application - Bench mark performance parameter.

References:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
5. Introduction to Biomass Energy Conversions, Sergio C. Capareda, CRC press, Taylor & Francis, 2014.
6. Non Conventional Energy Resources, G.D. Rai, 8th reprint, Khanna Publisher, 2013.
7. Biogas system: Principles and Application, K.M. Mital, 1st Edition, New Age International private Ltd., New Delhi, 2012.

CHEMISTRY

LIST OF COURSES

Sl.No	Sub Code	NAME OF THE SUBJECT	Credits L:T:P:C
1	18CH1001	Chemistry-I	3:1:0:4
2	18CH1002	Applied Chemistry Laboratory	0:0:3:1.5
3	18CH1003	Engineering Chemistry	3:1:0:4
4	18CH1004	Chemistry for Computer Science and Engineering	3:1:0:4
5	18CH1005	Chemistry for Civil Engineering	3:1:0:4
6	18CH1006	Applied Chemistry	3:1:0:4
7	18CH2001	Environmental Studies	3:0:0:3
8	18CH2002	Chemical Applications	3:0:0:3
9	18CH2003	Polymer Chemistry	3:0:0:3
10	18CH2004	Experiments in Polymer Chemistry	0:0:4:2
11	18CH3001	Research Methodology and IPR	3:0:0:3
12	18CH3002	Tribology of Polymer Composites	3:0:0:3
13	18CH3003	Laboratory Chemistry for the Daily Life	0:0:4:2
14	18CH3004	Polymer Chemistry	3:0:0:3

18CH1001	Chemistry-I	L	T	P	C
		3	1	0	4

Course Objectives:

1. To understand the basic concepts in chemistry
2. To have knowledge on the applications of chemistry
3. To apply chemistry principles in engineering and technology

Course Outcomes:

The student will be able to

1. To study about the basics of atomic and molecular structure
2. To know about the spectroscopic techniques and its applications
3. To know about the periodic properties
4. To understand the concepts of intermolecular forces
5. To study the concept of free energy and chemical equilibrium
6. To understand the basics of organic chemistry

Module 1: Chemical Bonding (9L + 3T)

Types of bonding – Ionic, Covalent, Coordinate bond, Vanderwaals forces, Hydrogen bond, Metallic bond VB theory – Hybridization MO theory, bond order-Homonuclear and Heteronuclear diatomic molecules

Module 2: Spectroscopic techniques and applications (9L + 3T)

Electromagnetic radiation, relation between wave length, wave number, frequency and energy- General features of absorption photometer – Principles and applications of IR, Raman, UV-Visible, NMR spectroscopy - Flame photometer – Introduction to Atomic Absorption Spectroscopy –Types of Chromatography –Applications

Module 3: Fuels and combustion (6L +2T)

Fuels-classification, calorific value, desired properties of good coal - Dulong's formula -Proximate analysis of coal and its significance- Ultimate analysis of coal and its significance -Knocking-octane number, cetane number, antiknocking characteristics of petrol -Flue Gas Analysis – Orsat Method - Biomass - Biogas-production, biofuels- bio-diesel and bio-ethanol

Module 4: Energy sources and storage devices (9L + 3T)

Redox reactions – electrode potential - Nernst Equation - Electrochemical series and significance - Electrochemical cell, reference electrode - Batteries – dry cell -Lead acid battery - Fuel cell - Solar

battery- Electrochemical sensors -Relationship between electrical energy and heat energy – Gibbs Helmholtz equation, Photovoltaics

Module 5: Water Chemistry (6L + 2T)

Hardness, Units and calculation of hardness - Determination of hardness by EDTA method - Removal of hardness – Zeolite process - Ion – Exchange process, sludge – formation and disadvantages - Scale - sources and disadvantages Internal conditioning – Calgon & carbonate conditioning - Boiler corrosion – causes (DO, CO₂, acids) & removal methods - Desalination – Reverse Osmosis - Municipal water treatment methods.

Module 6: Reaction Mechanism (6L + 2T)

Introduction- Homolytic and heterolytic bond fission- Classification of reactions- Types of Attacking Reagents- Inductive effect- Electromeric effect- Resonance effect- Hyperconjugation- Effect of Hybridization- types of Addition reaction- Types of Substitution reaction- Types of Elimination reaction- Mechanism of elimination reaction- Mechanism of Nucleophilic substitution reaction- Steric hindrance

Text Books:

1. Engineering Chemistry by Jain and Jain, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017
2. University Chemistry, B. M. Mahan, R. J. Meyers, 4th Edition, Pearson, 2009

Reference Books:

1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane, 3rd Edition, McGraw Hill, 1980
2. Fundamentals of Molecular Spectroscopy, by C. N. Banwell, 4th Edition, Tata McGraw-Hill India Ltd, 2010
3. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
4. Physical Chemistry, by P. W. Atkins, Julio de Paula, 8th Edition, Oxford University press, 2007
5. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition, Freeman and Company, New York, 2007

18CH1002	APPLIED CHEMISTRY LABORATORY	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To understand the basic concepts in chemistry
2. To have knowledge on the applications of chemistry
3. To apply chemistry principles in engineering and Technology

Course Outcomes:

The students will be able to:

1. Understand the kinetics of a chemical reaction
2. analyse the water quality
3. apply the electrochemistry principles
4. measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials
5. synthesize a small drug molecule
6. analyse a salt sample

List of Experiments

Choice of 10-12 experiments from the following:

1. Determination of surface tension and viscosity
2. Thin layer chromatography
3. Ion exchange column for removal of hardness of water
4. Determination of chloride content of water
5. Colligative properties using freezing point depression

- Determination of the rate constant of a reaction
- Determination of cell constant and conductance of solutions
- Potentiometry - determination of redox potentials and emfs
- Synthesis of a polymer/drug
- Saponification/acid value of an oil
- Chemical analysis of a salt
- Lattice structures and packing of spheres
- Models of potential energy surfaces
- Chemical oscillations- Iodine clock reaction
- Determination of the partition coefficient of a substance between two immiscible liquids
- Adsorption of acetic acid by charcoal
- Use of the capillary viscosimeters to demonstrate the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

Textbooks:

- H. D. Crockford, J.W. Nowell, *Laboratory Manual of Physical Chemistry*, 8th Edition, Wiley, 1970.
- An Introduction to Practical Biochemistry, third edition by David T Plummer, McGraw-Hill, c. McGraw-Hill Book Company (U.K.) Ltd., London. 1987

18CH1003	ENGINEERING CHEMISTRY	L	T	P	C
		3	1	0	4

Course Objectives:

- To make the student conversant with the fundamentals of chemical bonding and nanotechnology
- To encourage students to develop curiosity towards fuels, energy resources and storage devices
- To acquire knowledge about polymers and surface chemistry

Course Outcomes:

The Student will be able to

- formulate electronic structures and correlate its properties
- realize the potential applications of polymers
- relate the unique properties of nanomaterials and explain methods of fabricating nanostructures
- analyze the *combustion* process of common *fuels*
- learn the various energy storage systems and conversion devices
- describe the techniques involved in adsorption and colloids

Module 1: Chemical Bonding (9L + 3T)

Types of bonding – Ionic, Covalent, Coordinate bond, Vanderwaals forces, Hydrogen bond, Metallic bond VB theory – Hybridization MO theory, bond order- Homonuclear and Heteronuclear diatomic molecules

Module 2: Polymers (9L + 3T)

Polymers – Introduction, functionality, tacticity of polymers, Classification – natural, synthetic - Addition polymer, condensation polymer, copolymer- Forces between polymeric chains – thermosetting plastics, thermoplastics- ingredients used in compounding of plastics- compression & injection molding, fiber reinforced plastics- preparation, properties and uses of polyethylene, polyvinyl chloride, Bakelite, epoxy resin, raw rubber – vulcanized rubber – Applications of polymers – conducting polymers

Module 3: Nanomaterials and Fabrication (6L +2T)

Nanomaterials –Classification - Top down and Bottom up Approaches - High energy Ball milling – microfabrication – CVD, sol-gel – Nanomaterials - Fullerenes – Self assembled monolayers –preparation and application - characterization of nanomaterials – Introduction to XRD, SEM -Applications of nanotechnology

Module 4: Fuels and combustion (6L +2T)

Fuels-classification, calorific value, desired properties of good coal - Dulong's formula -Proximate analysis of coal and its significance- Ultimate analysis of coal and its significance -Knocking-octane number, cetane number, antiknocking characteristics of petrol -Flue Gas Analysis – Orsat Method - Biomass - Biogas-production, biofuels- bio-diesel and bio-ethanol

Module 5: Energy sources and storage devices (9L + 3T)

Redox reactions – electrode potential - Nernst Equation - Electrochemical series and significance - Electrochemical cell, reference electrode - Batteries – dry cell -Lead acid battery - Fuel cell - Solar battery- Electrochemical sensors -Relationship between electrical energy and heat energy – Gibbs Helmholtz equation, Photovoltaics

Module 6: Surface chemistry (6L +2T)

Adsorption- Classification, uses - Langmuir's theory of adsorption - Colloids – types, applications - Colloids – Preparation - Characteristics of Colloids, Micelles

Text Books:

1. Engineering Chemistry by Jain and Jain, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017
2. University Chemistry, B. M. Mahan, R. J. Meyers, 4th Edition, Pearson, 2009

Reference Books:

1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane, 3rd Edition, McGraw Hill, 1980
2. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
3. Physical Chemistry, by P. W. Atkins, Julio de Paula, 8th Edition, Oxford University press, 2007

18CH1004	CHEMISTRY FOR COMPUTER SCIENCE AND ENGINEERING	L	T	P	C
		3	1	0	4

Course objectives

1. To make the student conversant with the fundamentals of chemical bonding and nanotechnology
2. To encourage students to develop curiosity towards energy resources and storage devices
3. To acquire knowledge about solid state and liquid crystals

Course outcome

The Students will be able to

1. formulate electronic structures and correlate its properties
2. realize the potential applications of polymers
3. relate the unique properties of nanomaterials and explain methods of fabricating nanostructures
4. know about various energy storage devices
5. learn the importance of solid state chemistry
6. realize the applications of the liquid crystals in various domains

Module 1: Chemical Bonding (9L + 3T)

Types of bonding – Ionic, Covalent, Coordinate bond, Vanderwaals forces, Hydrogen bond, Metallic bond VB theory – Hybridization MO theory, bond order- Homonuclear and Heteronuclear diatomic molecules

Module 2: Polymers (9L + 3T)

Polymers – Introduction, functionality, tacticity of polymers, Classification – natural, synthetic - Addition polymer, condensation polymer, copolymer- Forces between polymeric chains – thermosetting plastics, thermoplastics- ingredients used in compounding of plastics- compression & injection molding, fiber reinforced plastics- preparation, properties and uses of polyethylene, polyvinyl chloride, Bakelite, epoxy resin, raw rubber – vulcanized rubber – Applications of polymers – conducting polymers

Module 3: Nanomaterials and Fabrication (6L +2T) Nanomaterials –Classification - Top down and Bottom up Approaches - High energy Ball milling – microfabrication – CVD, sol-gel – Nanomaterials -

Fullerenes – Self assembled monolayers –preparation and application - characterization of nanomaterials
– Introduction to XRD, SEM -Applications of nanotechnology

Module 4: Energy sources and storage devices (9L + 3T)

Redox reactions – electrode potential - Nernst Equation - Electrochemical series and significance - Electrochemical cell, reference electrode - Batteries – dry cell -Lead acid battery - Fuel cell - Solar battery- Electrochemical sensors -Relationship between electrical energy and heat energy – Gibbs Helmholtz equation, Photovoltaics

Module 5: Solid State (6L +2T)

Crystal structure-Unit cell, radius ratio -Miller indices, crystal imperfections- Schottky and Frenkel defects - Band theory of solids-types of semi conductors- Intrinsic and Extrinsic semi conductors – Preparation of semiconductors - Super conductors

Module 6: Liquid Crystals (6L +2T)

Liquid crystals –classification, thermotropic and Lyotropic liquid crystals, structure of liquid crystal forming compounds, Chemical properties, Applications of liquid crystals

Reference Books:

1. Engineering Chemistry by Jain and Jain, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017
2. University Chemistry, B. M. Mahan, R. J. Meyers, 4th Edition, Pearson, 2009

Text Books:

1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane, 3rd Edition, McGraw Hill, 1980
2. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
3. Physical Chemistry, by P. W. Atkins, Julio de Paula, 8th Edition, Oxford University press, 2007

18CH1005	CHEMISTRY FOR CIVIL ENGINEERING	L	T	P	C
		3	1	0	4

Course objectives

1. To make the student conversant with the fundamentals of chemical bonding and nanotechnology
2. To encourage students to develop curiosity towards water technology, corrosion and nanocomposites
3. To acquire knowledge about polymers, paints and concrete.

Course outcomes

The Student will be able to

1. formulate electronic structures and correlate its properties
2. realize the potential applications of polymers
3. relate the unique properties of nanomaterials and explain methods of fabricating nanostructures
4. analyze the *components present in paints and concrete*
5. learn the various factors in water quality and its technology
6. describe the process of corrosion and its prevention

Module 1: Chemical Bonding (9L + 3T)

Types of bonding – Ionic, Covalent, Coordinate bond, Vanderwaals forces, Hydrogen bond, Metallic bond VB theory – Hybridization MO theory, bond order- Homonuclear and Heteronuclear diatomic molecules

Module 2: Polymers (9L + 3T)

Polymers – Introduction, functionality, tacticity of polymers, Classification – natural, synthetic - Addition polymer, condensation polymer, copolymer- Forces between polymeric chains – thermosetting plastics, thermoplastics- ingredients used in compounding of plastics- compression & injection molding, fiber reinforced plastics- preparation, properties and uses of polyethylene, polyvinyl chloride, Bakelite, epoxy resin, raw rubber – vulcanized rubber – Applications of polymers – conducting polymers

Module 3: Nanomaterials and Fabrication (6L + 2T)

Nanomaterials –Classification - Top down and Bottom up Approaches - High energy Ball milling – microfabrication – CVD, sol-gel – Nanomaterials - Fullerenes – Self assembled monolayers –preparation and application - characterization of nanomaterials – Introduction to XRD, SEM -Applications of nanotechnology

Module 4: Water Chemistry (9L + 3T)

Hardness, Units and calculation of hardness - Determination of hardness by EDTA method - Removal of hardness – Zeolite process - Ion – Exchange process, sludge – formation and disadvantages - Scale - sources and disadvantages Internal conditioning – Calgon & carbonate conditioning - Boiler corrosion – causes (DO, CO₂, acids) & removal methods - Desalination – Reverse Osmosis - Municipal water treatment methods.

Module 5: Paint and corrosion (6L + 2T)

Protective Coatings, Introduction, Organic coatings, Paints-constituents of Paints Analysis of oils-acid value, Saponification value, Iodine value, Reichert-Meissl value, Formulation of paints, Failure of a paint film - Corrosion – Types – Dry (Oxidation corrosion with mechanism) - Wet Corrosion (Galvanic corrosion with mechanism) - Factors influencing Corrosion - Corrosion control methods.

Module 6: Cement and Concrete (6L + 2T)

Cement – Introduction – classification, Portland cement – Manufacture – Properties, Setting and Hardening of Portland cement – special cement - Concrete – Introduction, Uses – Curing of concrete, Reinforced concrete construction (RCC), Advantage of RCC, Decay of concrete, Protection of concrete.

Text Books:

1. Engineering Chemistry by Jain and Jain, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017
2. University Chemistry, B. M. Mahan, R. J. Meyers, 4th Edition, Pearson, 2009

Reference Books:

1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane, 3rd Edition, McGraw Hill, 1980
2. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
3. Physical Chemistry, by P. W. Atkins, Julio de Paula, 8th Edition, Oxford University press, 2007

18CH1006	APPLIED CHEMISTRY	L	T	P	C
		3	1	0	4

Course objectives

1. To make the student conversant with the fundamentals of chemical bonding, polymers and Organic Chemistry.
2. To encourage students to understand the basis of nanotechnology.
3. To acquire knowledge about Instrumental methods of analysis.

Course outcomes

The Student will be able to

1. Formulate electronic structures and correlate its properties
2. Realize the potential applications of polymers
3. Relate the unique properties of nanomaterials and explain methods of fabricating nanostructures
4. Learn the structure of organic molecules.
5. Predict and understand the reactivity of organic reaction.
6. Apply the instrumental methods for various types of analysis.

Module 1: Chemical Bonding (9L + 3T)

Types of bonding – Ionic, Covalent, Coordinate bond, Vanderwaals forces, Hydrogen bond, Metallic bond VB theory – Hybridization MO theory, bond order- Homonuclear and Heteronuclear diatomic molecules

Module 2: Polymers (9L + 3T)

Polymers – Introduction, functionality, tacticity of polymers, Classification – natural, synthetic - Addition polymer, condensation polymer, copolymer- Forces between polymeric chains – thermosetting plastics, thermoplastics- ingredients used in compounding of plastics- compression & injection molding, fiber reinforced plastics- preparation, properties and uses of polyethylene, polyvinyl chloride, Bakelite, epoxy resin, raw rubber – vulcanized rubber – Applications of polymers – conducting polymers

Module 3: Nanomaterials and Fabrication (6L +2T)

Nanomaterials –Classification - Top down and Bottom up Approaches - High energy Ball milling – microfabrication – CVD, sol-gel – Nanomaterials - Fullerenes – Self assembled monolayers –preparation and application - characterization of nanomaterials – Introduction to XRD, SEM -Applications of nanotechnology

Module 4: Stereochemistry (6L + 2T)

Stereoisomerism- Geometrical Isomerism- Optical Activity- Optical Isomerism, Diastereomers - Optical activity without Asymmetric carbons- E and Z system nomenclature- R and S system nomenclature- D,L system- Conformational isomerism of Butane.

Module 5: Reaction Mechanism (6L + 2T)

Introduction- Homolytic and heterolytic bond fission- Classification of reactions- Types of Attacking Reagents- Inductive effect- Electromeric effect- Resonance effect- Hyperconjugation- Effect of Hybridization- types of Addition reaction- Types of Substitution reaction- Types of Elimination reaction- Mechanism of elimination reaction- Mechanism of Nucleophilic substitution reaction- Steric hindrance

Module 6: Instrumental Methods (9L +3T)

Electromagnetic radiation, relation between wave length, wave number, frequency and energy- General features of absorption photometer – Principles and applications of IR, Raman, UV-Visible, NMR spectroscopy - Flame photometer – Introduction to Atomic Absorption Spectroscopy –Types of Chromatography –Applications

Text Books:

1. Engineering Chemistry by Jain and Jain, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017
2. University Chemistry, B. M. Mahan, R. J. Meyers, 4th Edition, Pearson, 2009

Reference Books:

1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane, 3rd Edition, McGraw Hill, 1980
2. Fundamentals of Molecular Spectroscopy, by C. N. Banwell, 4th Edition, Tata McGraw-Hill India Ltd, 2010
3. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
4. Physical Chemistry, by P. W. Atkins, Julio de Paula, 8th Edition, Oxford University press, 2007
5. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition, Freeman and Company, New York, 2007

18CH2001	ENVIRONMENTAL STUDIES	L	T	P	C
		3	0	0	0

Course Objectives:

1. acquire the knowledge of environmental studies, it's need & importance
2. know about problems related to various types of pollution
3. make the learners sensitive to the environment problems in every professional endeavor in which they participate

Course Outcomes:

The Student will be able to

1. Understand the natural environment and its relationships with human activities.

2. Acquire practical skills for solving pollution related problems
3. Design and evaluate strategies and apply green technologies
4. Identify the methods for sustainable development and for the remediation or restoration of degraded environments.
5. Integrate facts, concepts, and methods from multiple disciplines and apply to environmental and social problems.
6. Analyze the connectivity between the man made activities-Pollution-environmental issues-social problems-eco friendly solutions

Module 1: ENVIRONMENT AND NATURAL RESOURCES: (9L)

Environment - Definition, scope and importance , Renewable and Non-Renewable Resources – Natural resources and associated problems – Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Energy resources: Growing energy needs, renewable and non-renewable energy sources, and use of alternate energy sources. Case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – Role of an individual in conservation of natural resources – Activity: Field study of local area to document environmental assets.

Module 2: ECOSYSTEMS: (5L) Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs

Module 3: BIODIVERSITY: (6L) Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity – Bio geographical classification of India – Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels -Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity – Activity: Model preparation for Ecosystems / Biodiversity (OR) Documentation of available ecosystems/Biodiversity within Campus.

Module 4: ENVIRONMENTAL POLLUTION (9L)

Definition, Causes, effects and control measures (two) – Air pollution (Cyclone separator, Electrostatic Separator) – Water pollution – Soil pollution – Noise pollution – Thermal pollution – Nuclear hazards – Solid waste management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution. Pollution case studies – Green chemistry– principles of sustainable and green chemistry Activity: Visit-nearby Sewage treatment Water Plant.

Module 5: SOCIAL ISSUES AND ENVIRONMENTAL LEGISLATION (9L)

From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting and watershed management –Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, case studies – Environment Protection Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness – Activity: Watching Documentary Movies & Video Clips related to environment problems, Social issues and control measures.

Module 6: HUMAN POPULATION AND THE ENVIRONMENT: (7L)

Population growth, Population explosion—Family Welfare Programme – Environment and human health. Human rights – HIV/AIDS – Women and Child Welfare – Role of Information Technology in environment and human health – Disaster management: Floods, earthquake, cyclone and landslides – Case Studies – Activity: Small projects related to environment problems, Social issues and eco friendly technology.

Text book

1. Deeksha Dave, S. S. Katewa, “Text Book of Environmental Studies”, 2nd Edition. Cengage Learning India Pvt. Ltd., New Delhi, 2012

2. Raman Shivakumar "Introduction Environmental science and Engineering" Tata Mc Graw Hill companies, 2010.
3. Bharucha Erach "Text book on environmental studies" For Undergraduate Courses of all Branches of Higher Education, University Grants Commission, New Delhi, 2004.

Reference Books

1. Trivedi. R.K. "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards" Vol. I and II, Enviro Media.
2. Cunningham, Cooper.C.P. and Gorhani, T.H. "Environmental Encyclopedia" Jaico Publ., House, Mumbai, 2001.
3. Abnubha Kaushik, C.P. Kaushik, "Perspectives in Environmental Studies" New Age International Publishers, Third Edition, 2009.
4. B.K. Sharma, "Environmental Chemistry" Comprehensive covering the UGC Syllabus, 11th Edition, Goel Publishing House, Meerut, Eleventh Edition, 2007.

18CH2002	Chemical Applications	L	T	P	C
		3	0	0	3

Course Objectives:

1. To apply chemistry in technology
2. To acquire knowledge in energy and materials
3. To know about the green chemistry and modern analytical techniques

Course Outcomes:

1. To understand the basics of polymers
2. To know about surfactants, lubricants and corrosion
3. To have knowledge on nano materials
4. To know about the metal and alloys
5. To gain knowledge on modern analytical techniques
6. To know about the basic concepts in energy and green chemistry

Module 1: Polymers (9 lectures)

Classification, Tacticity - Tacticity and Functionality of Polymers - Types of Polymerization Addition, Condensation - Synthesis and properties of Bakelite, PVC, Nylon - Moulding Constituents of Plastics - Thermoplastics and Thermosetting - Vulcanization of Rubber - Applications of Polymers

Module 2: Surfactants and lubricants, corrosion (9 lectures)

Methods of preparation, cleaning mechanism. Critical micelle concentration and its determination - Hydrophobic and hydrophilic interactions. Micelles and reverse micelles.

Detergents. Friction of surfactants. Lubricants-physical and chemical properties, types and mechanism of lubrication - Additives of lubricants and freezing points of lubricants

Corrosion - Introduction - Types - Dry (Oxidation corrosion with mechanism) - Wet Corrosion (Galvanic corrosion with mechanism) - Factors influencing Corrosion - Corrosion control methods.

Module 3: New materials / nano materials (9 lectures)

Nanomaterials - Fabrication - steps - Lithography - Nanolithography - Epitaxial growth - Self assembled monolayers - Molecular and material self assembly - Self assembled monolayer - Carbon nanotubes - Nanoelectronics - Applications of nanomaterials

Module 4: Environmental and green chemistry (6 lectures)

Air and noise pollution. Optimum levels of pollution - Water pollution & Solid waste treatment - Significance and determination of COD and BOD - Greenhouse effect and global warming - E - Waste - radioactive pollution - Applications of green chemistry and green technology

Module 5: Energy Science (6 lectures)

Redox reactions - electrode potential - Nernst Equation - Electrochemical series and significance - Electrochemical cell, reference electrode - Batteries - dry cell - Lead acid battery - Fuel cell - Solar

battery- Electrochemical sensors -Relationship between electrical energy and heat energy – Gibbs Helmholtz equation, Photovoltaics

Module 6: Metal and alloys (6 lectures)

Phase rule and applications to one, two and multi-component systems - Iron-carbon phase diagram.

Types of alloys, carbon steel, alloy steel, alloys of Cu, AL, Pb – Applications of alloys

Text Books:

1. Engineering Chemistry by Jain and Jain, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2017
2. University Chemistry, B. M. Mahan, R. J. Meyers, 4th Edition, Pearson, 2009

Reference Books:

1. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
2. Physical Chemistry, by P. W. Atkins, Julio de Paula, 8th Edition, Oxford University press, 2007

18CH2003	POLYMER CHEMISTRY	L	T	P	C
		3	0	0	3

Course objectives

1. To attain complete knowledge about polymers
2. To recognize the structure-property correlation
3. To understand the applications of polymers in various fields

Course outcome

The student will be able to

1. Analyse different mechanisms of polymer formation and use this information in the synthesis of different polymers
2. Evaluate the effect of factors such as polymer structure, molecular weight, branching and diluents on crystallinity
3. Interpret experimental data and determine parameters such as polymerization rates and copolymer composition
4. Distinguish between enthalpic and entropic contributions to polymerisation/crystallization
5. Distinguish between absolute and relative methods for molecular weight determination
6. Assess the effect of synthetic polymers on the environment

Module 1 Introduction

Introduction - definition, origin and nomenclature; Classification and types of polymers (Natural & synthetic; addition & condensation and thermoplastics & thermosetting); Molecular Weight (MW) of polymers- Number and weight averaged MW; Natural polymers, and Biodegradable polymers (PHB)

Module 1I Chemistry of Polymerisation

Step growth polymerization-reactivity of functional group, ester and amide formation; Condensation polymerization (Nylon 66); Free radical polymerization-reaction, mechanism; Ionic polymerization-cationic polymerization-steps, mechanism; Ionic polymerization- anionic polymerization-steps, mechanism; Ionic polymerization- ring opening polymerization-steps, mechanism; Copolymerization-types, graft, block, alternate, random, example; Composition, reactivity ratio;

Module 1II Properties of Polymers

Polymer solution – process of dissolution; Thermodynamics of polymer; Flory-Huggins theory; Theta conditions-solubility parameter (Miscibility); Osmotic pressure-lower critical solution temperature; MW determination method (viscometry); Thermal behaviour of polymers – Melting (T_M) and Glass transition (T_g); Deformation behaviour of polymers; Colligative properties of polymer-osmotic pressure;

Module 1V Applications of Polymers

Lithography – principle and procedure; Photolithography; Electron beam lithography; X-ray lithography; Ion beam lithography; Conducting polymers-example-types-properties, applications; Photonic

applications, optical information storage; Polyester-Fibres-mechanical property-crystallinity; Stress and strain behaviour; Carbon fibres and nanotubes – introduction and applications;

Unit V Polymer Composites

Introduction - Polymer blends; Polymer composites – characteristics and types; Introduction to Nano-composites; Clay, CNT and particle filled nanocomposites; Advantages and limitations of nanofillers; Surface treatment on nanofillers

Text books:

1. “Polymer Science” V. R. Gowariker, N. V. Viswanathan and Jayadev Sreedhar, New Age Intl. Publishers, (2008).
2. “Textbook of Polymer Science”, F W Billmeyer, Wiley India (2007).

Reference Books:

1. “Introductory Polymer Science”, S K Bashin and Rekha Mann, Dhanpat Rai Publishing Co., (2008)
2. NPTEL Polymer Chemistry Course, D. Dhara, IIT Kharagpur
3. Polymer chemistry and Physics of Modern Materials, 2nd edn, J. M. G. Cowie, Stanley Thornes, UK, 1998
4. Contemporary Polymer Chemistry, 3rd edn. H. R. Allcock, F. W. Lampe and J. E. Mark, Pearson.

18CH2004	Experiments in Polymer Chemistry	L 0	T 0	P 4	C 2

Course Objectives:

1. Have a hands on experience on synthesis of different polymers
2. Analyze the properties of polymer
3. Learn different characterisation technique

Course Outcome

The Student will able to

1. Understand importance of molecular weight of polymers
2. Measure molecular weight and osmotic pressure of polymers
3. Realize the significance of Colligative properties of polymers
4. Know the different synthetic routes of polymers
5. Recognize the importance of epoxy resin
6. Analyze the thermal properties of polymers

List of experiments

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HOD/Director and notify it at the beginning of each semester.

18CH3001	Research Methodology and IPR	L 3	T 0	P 0	C 3

Course Objectives:

1. To make the student conversant with Chemical Abstracts for their Literature collections
2. To encourage students to develop curiosity towards commercial Chemistry softwares for their research
3. To acquire knowledge about chemical reaction set-up and its scientific relevance.

Course Outcomes:

The Student will be able to

1. formulate the chemical reaction design and set-ups
2. realize the potential applications of chemical softwares
3. relate the available informatics applications for the design of potential molecules
4. analyze the *components of rating like impact factor, citation index*

5. learn the procedure for IPR
6. describe a research problem using the available chemistry resources.

Module 1: Chemical Literature Databases: Chemical/Beilstein abstracts, CAS Number, DOI, Citation Index, Impact Factors, *h*-index, Scifinder/Reaxys design, Keyword Text Search, Sub-structure search Identification of Research Problems, Scopus and Web of Sciences.

Module 2: Chemistry Softwares: Structure Tools, Chemical drawings and Chiral representations, Chems sketch, BioRad, Chemoffice, Chemdraw, 3D representation, Energy Minimization process, Substructure identifications, Chemical Structures for manuscript (ACS, RSC, Elsevier), Chemical compounds and Suppliers identification.

Module 3: Chemical Reaction Design: Karl-Fisher Titrations for moisture content, Dean Stork Reaction set-up, Soxhlet extraction set-up, Barr hydrogenation Apparatus, Concept of Rotary evaporator, Auto Titrator, Reaction monitoring- dry/wet reaction set-up, handling hygroscopic compounds. Low Temperature bath (freezing mixture). Anhydrous conditions.

Module 4: Research Ethics and Technical writing: Effective literature studies approaches, analysis – Plagiarism - Research ethics - Effective technical writing, how to write report, Paper - Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Module 5: Intellectual Property Rights: Nature of Intellectual Property: Patents, Designs, Trade and Copyright - Process of Patenting and Development: technological research, innovation - patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT - Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Reference Books:

1. R. Burns, “Introduction to Research Methods”, Addison Wesley Longman, Third Edition, 1997
1. C. R. Kothari, “Research Methodology: Methods and Techniques”, New- Age International, 2008
2. S.Usharani, “Analytical Chemistry”, first edition, Mcmillan, India Ltd, 2000.
3. Vogel’s Text Book of Practical Organic Chemistry by Furiniss, Harnaford, Smith, Talchall, VII Edition 2010.

18CH3002	Tribology of Polymer Composites	L 3	T 0	P 0	C 3

Course objectives

1. Understand the properties of polymers
2. Recognize the importance of wear and tear of materials in particular polymers
3. Be aware of the applications of polymer and their composites in various fields

Course outcome

The student will be able to

1. Acquire basic knowledge about polymers
2. Recognize the polymer composites and their fabrication processes
3. Appreciate the fundamentals of tribology
4. Identify various types of friction and wear test modes
5. Correlate the friction and wear behaviour of polymers with various material as well as operating properties
6. Realize the influence of nanofillers on friction and wear properties of polymer nanocomposites

Module 1. Introduction to Polymer

Introduction to material – metal, polymer and ceramic; Polymers – functionality and tacticity; classification of polymers –force that exists between the polymer chain; structure-property relationships;

Thermal behaviour of polymers - T_g, T_m and their relationships; Elastic effect of polymers – Hooke, Newton, Maxwell and Voight models -.

Module 2. Polymer Composites

Polymer composites – Introduction; types of composites – particle filled, short and long fibre reinforced; laminates; filler-matrix interaction; Fabrication of polymer nano-composites - Compounding of plastics – additives added and their significance – moulding process – injection and compression moulding, lamination, hand lay-up and filament winding techniques; Characterisation – mechanical and thermal-;

Module 3. Basic Concepts of Tribology

Tribology – Basic concept and its economical importance; Introduction to friction, wear and lubrication; Factors influencing friction and wear of polymers; advantages of polymers over metal; Friction and Wear studies – abrasive, adhesive, erosive, fretting wear modes -; Various types of wear test rigs – Pin-on-disc, block-on-ring.;

Module 4. Tribology of Polymer Composites

Friction and Wear studies - polymer composites in different wear modes; Influence of operating parameters viz. load, speed, counter-face roughness.; correlation between material properties and wear behaviour; Worn surface analysis;-

Module 5. Tribology of Polymer Nanocomposites

Polymer nanocomposites – introduction; various types of nanofillers; advantages and limitations of nanofillers; surface treatment of nanofillers; effect of nanofillers on friction and wear behaviour of polymers; Worn surface analysis; applications of polymer nanocomposites – automotive and mechanical components;

Reference Books:

1. J. Paulo Davim (Ed.), “Tribology of Nanocomposites”, Materials Forming, Machining and Tribology series, Springer, 2013.
2. A. S. Paipetis and V. Kostopoulos (Ed.), “Carbon Nanotube Enhanced Aerospace Composite Materials”, Solid Mechanics and its Applications Series, G. M. L. Gladwell (Ed.), Springer, 2013.
3. Y. W. Mai and Z. Z. Yu, “Polymer Nanocomposites”, Woodhead Publishing Ltd., Cambridge, England, 2006.
4. Peter C LeBaron, Z. Wang and T. J. Pinnavaia, “Polymer Layered Silicate Nanocomposites: an overview”, Applied Clay Science vol. 15 pp 11-29, 1999.
5. P. Ma, N. A. Siddiqui, G. Marom and J. Kim, “Dispersion and Functionalisation of Carbon Nanotubes for Polymer based Nanocomposites: a review”, Composites: Part A vol. 41 pp 1345-1367, 2010.
6. Anil Kumar and Rakesh K Gupta, “Fundamentals of Polymer Engineering”, Tata McGraw Hill Publication Ltd., New Delhi 2003 (revised and expanded edition).
7. R. J. Yound and P. A. Lovell, “Introduction to Polymers”, Stanley Thomas Publishers, London, 2000.

18CH3003	Laboratory Chemistry for the Daily Life	L	T	P	C
		0	0	3	2

Course Objectives

1. To make the student familiar with ayurvedic products in daily life
2. To encourage students to develop curiosity towards the preparation of cosmetics
3. To acquire knowledge about soaps and detergents

Course Outcomes

The student will be able to

1. formulate Ayurveda tooth paste, mouth was and hair hail
2. prepare instant head ache relief bam and dish wash powders
3. lip balm from vegetable extracts

4. Preparation of phenyl and analyzing
5. learn the procedures for preparing natural Insect repellent spray/ointment
6. learn the techniques involved in preparation homemade lotion and cream

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HOD/Director and notify it at the beginning of each semester.

References:

1. Surfactants, Disinfectants, Cleaners, Toiletries, Personal Care Products Manufacturing and Formulations by NPCS Board of Consultants & Engineers, NIIR Project Consultancy Services, 2016
2. Modern Technology of Soaps, Detergents & Toiletries (with Formulae & Project Profiles) 4th Revised Edition, P. K. Chattopadhyay, NIIR Project Consultancy Services, 2016

18CH3004	POLYMER CHEMISTRY	L	T	P	C
		3	0	0	3

Course objectives

- To attain complete knowledge about polymers
- To know the structure-property correlation
- To understand the applications of polymers in various fields

Course outcome

- Understand the overview of various properties of polymers
- Analyse different mechanisms of polymer formation and use this information in the synthesis of different polymers
- Interpret experimental data and determine parameters such as polymerization rates and copolymer composition
- Evaluate the effect of factors such as polymer structure, molecular weight, branching and diluents on their properties
- Discriminate the different types of industrial polymerisation process and their fabrication techniques
- Know more about various types of novel polymeric nanocomposites

Module I. Basic concepts of polymers

6 hrs

Basic concepts of polymers – classification of polymers – source, polymerisation and its mechanism, force that exists between the polymer chain - polymers tacticity – interpenetrating networks – structure property relationships – polymerization reactions – classifications – polymer resins – reaction of polymers – introduction of new groups – cross linking, isomerisation, cyclisation and degradation reactions

Module II. Principles of polymerization

12 hrs

Principles and mechanisms of polymerization – addition, step growth polymerization and co-ordination (Ziegler-Natta) – reactivity of functional groups – Carothers equation – kinetics – characteristics of step growth polymerization – examples – mechanisms, choice of monomers, effect of inhibitors or retarders – examples – co-polymerization – monomer reactivity – ratio – composition, types, the Q-e scheme.

Module III. Polymer properties

7 hrs

polymer solutions – molecular weight determination methods - stereochemistry of polymer – amorphous, crystalline and crystallites – Thermal behaviour of polymers - T_g, T_m and their relationships – Elastic effect of polymers –

Module IV. Polymerization processes and fabrication of plastics

8 hrs

Polymerization processes – bulk, solution, emulsion and suspension – industrially important polymers and their polymerization processes – poly styrene – nylon 6,6 – PET – Compounding of plastics –

additives added and their significance – moulding process – injection, compression and blow moulding, lamination, hand lay-up and filament winding techniques.

Module V. Polymer Nanocomposites

12 hrs

Polymer composites - introduction – filler-matrix interaction, fiber reinforced composites (FRP) – short, continuous fiber reinforced composites, laminates – Introduction to polymer nanocomposites – clay, graphene, CNT, particle filled – advantages and limitations of nano fillers – surface treatment on nano fillers – applications of polymer nanocomposites – automotive, packaging and mechanical components etc. -

Text Books:

8. A. Rudin, “The elements of polymer science and engineering” – Academic press, New York, 1982.
9. V.R. Gowariker, “Polymer Science”, 5th Edition, Wiley Eastern Ltd., 1992.
10. G.S. Misra, “Introductory polymer chemistry”, New Age International Pvt. Ltd., 1996.
11. Anil Kumar and S.K. Gupta, “Fundamentals of polymer science and engineering” Tata McGraw Hill Publication Ltd., New Delhi, 1978.
12. F W Billmeyer Jr., “Textbook of Polymer Science” 3rd edition, Wiley India 1984.

Reference Books:

1. David Sobolev, “A first course in polymer chemistry”, MIR publishers, Moscow 1971.
2. R. J. Young, “Introduction to polymers” Chapman and Hall Ltd., London , 1981.
3. D. H. Morton and Jones, “Polymer processing” Chapman and Hall, London, 1989.
4. J. A. Brydson, “Plastic materials” 4th edition, Butterworth–Heinmann Ltd., London 1995.
5. J. A. Biesenberger and H. Sebastian, “Principles of polymerization engineering” , Wiley Interscience publications, New York, 1988
6. Stephen and Rosen, “Fundamental principles of polymeric materials” 2nd edition, John-Wiley and Sons Inc., New York, 1993.
7. R B Seymour, “Introduction to Polymer Chemistry”, Tata McGraw Hill
8. M Alexandre and P Dubois, Material Science and Engineering Review (2000) 1

LIST OF COURSES

Sl.No	Sub Code	NAME OF THE SUBJECT	Credits
1	17CH1001	Instrumental Techniques in Chemistry	2:0:2
2	17CH1002	Applied Chemistry	3:0:0
3	17CH1003	Applied Chemistry Lab	0:0:2
4	17CH1004	Environmental Studies	3:0:0
5	17CH2001	Chemical Bonding and Concepts of Acids and Bases	3:0:0
6	17CH2002	Organic Reaction Intermediates and Stereochemistry	3:0:0
7	17CH2003	Atomic Structure, Thermodynamics and Electrochemistry	3:0:0
8	17CH2004	Chemistry of Transition and Inner-transition Elements	3:0:0
9	17CH2005	Reaction Mechanism and Heterocyclic Chemistry	3:0:0
10	17CH2006	Surface chemistry and Chemical Kinetics	3:0:0
11	17CH2007	Qualitative Analysis and Inorganic Preparations Lab	0:0:2
12	17CH2008	Titrimetric Analysis and Gravimetric Analysis lab	0:0:2
13	17CH2009	Organic Qualitative Analysis Lab	0:0:2
14	17CH2010	Physical Chemistry Lab - I	0:0:2
15	17CH2011	Chemistry In Everyday Life	3:0:0
16	17CH2012	Applied Nanochemistry and Next Generation Materials	3:0:0
17	17CH3001	Chemical Kinetics and Photochemistry	3:1:0
18	17CH3002	Chemical Bonding and Nuclear Chemistry	3:0:0
19	17CH3003	Organic Reaction Mechanism and Stereochemistry	3:1:0
20	17CH3004	Quantum Chemistry and Group Theory	3:1:0
21	17CH3005	Coordination Chemistry	3:1:0
22	17CH3006	Molecular Spectroscopy	3:0:0
23	17CH3007	Chemical Thermodynamics and Electrochemistry	3:0:0
24	17CH3008	Organometallic, Bioinorganic and Solid State Chemistry	3:1:0
25	17CH3009	Synthetic Methodology and Natural Products	3:0:0
26	17CH3010	Qualitative and Quantitative Inorganic Analysis Lab	0:0:4
27	17CH3011	Qualitative and Quantitative Organic Analysis Lab	0:0:4
28	17CH3012	Physical Chemistry Lab	0:0:4
29	17CH3013	Modern Instrumental Analysis Lab	0:0:2
30	17CH3014	Preparative Inorganic Chemistry Lab	0:0:2
31	17CH3015	Synthetic Organic Chemistry Lab	0:0:2
32	17CH3016	Instrumental Methods of Analysis	3:0:0
33	17CH3017	Main Group Chemistry	3:0:0
34	17CH3018	Synthetic Reagents and Concerted Reactions	3:0:0
35	17CH3019	Spectroscopic Methods for Structural Elucidation	3:0:0
36	17CH3020	Supramolecular Chemistry and Green Chemistry	3:0:0
37	17CH3021	Applied Electrochemistry	3:0:0
38	17CH3022	Molecular and Material Self Assembly	3:0:0
39	17CH3023	Polymer Chemistry	3:0:0
40	17CH3024	Analytical Chemistry	3:0:0
41	17CH3025	Medicinal Chemistry	3:0:0
42	17CH3026	Supramolecular Chemistry	3:0:0

17CH1001 INSTRUMENTAL TECHNIQUES IN CHEMISTRY

Credits: 2:0:2

Course Objectives :

Enable the student to

- educate the principles of various types of titrations
- know the instrumentation techniques used in chemistry
- train the practical knowledge of the analytical techniques in chemistry

Course Outcomes :

The student will be able to

- understand the importance of accuracy in measurement of data
- utilize the quantitative techniques in chemistry
- understand the principles of spectroscopic techniques
- apply the principles of titration techniques
- apply the principles of electroanalytical techniques
- choose the appropriate separation technique

UNIT I: VOLUMETRIC AND GRAVIMETRIC ANALYSIS: Data Analysis – Accuracy and Precision - Classification of quantitative methods – Volumetric Analysis – Standardization – Buffer – Neutralization, Complexometric and Redox titrations -Titration – Gravimetry – Conditions of Precipitation - Instrumental Techniques

UNIT II ELECTROANALYTICAL METHODS: Conductometry – Principles - Potentiometry – Reference electrodes – Indicator electrodes – Liquid Junction Potential - Potentiometric titrations - Sensors

UNIT III: SPECTROSCOPIC METHOD OF ANALYSIS: Electromagnetic Spectrum – Principles and applications of Infrared and UV-Visible Spectroscopy – Atomic Absorption Spectroscopy – Principles and Applications – Emission Spectroscopy - Applications

UNIT IV: CHROMATOGRAPHY: Principles – Migration rates of Solutes – Optimization of Column Performance - Applications of Liquid column, Solid/liquid, Liquid/liquid, Ion exchange, HPLC and Gas chromatography

UNIT V: THERMAL METHODS AND WATER ANALYSIS: Thermal Methods – Thermogravimetry – Differential Thermal Analysis – Differential Scanning Calorimetry - Water analysis –Hardness, Alkalinity – Food analysis

Practicals:

1. Estimation of sodium hydroxide.
2. Estimation of Fe^{2+} ions.
3. Estimation of Total, Permanent and Temporary hardness by EDTA method.
4. Estimation of Alkalinity in water sample.
5. Estimation of dissolved oxygen in water sample.
6. Estimation of Iodine Content in Iodized Common Salt
7. Estimation of Copper in Brass
8. Estimation of Calcium in Milk Powder
9. Conductometric estimation of an acid.
10. Potentiometric estimation of Fe^{2+} ions.
11. pH Measurements for Acid/Alkali Titration.
12. Estimation of iron in water sample by spectrophotometry.
13. Estimation of Potassium using Flame Photometry
14. Analysis by Thin Layer Chromatography
15. Separation of compounds by Column Chromatography
16. Gravimetric Estimation of Nickel

Reference Books:

1. Willard H, Merrit L, Dean J. A. & Settle F.A., “Instrumental methods of chemical analysis”, CBS Publishers and Distributors Pvt. Ltd, New Delhi, 7th edition, 1986.
2. Skoog D. A, West D. M, Holler F. J & Crouch S. R, “Fundamentals of Analytical Chemistry”, Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.
3. Day R. A. & Underwood A. L., “Quantitative Analysis”, 6th Edition, Printice Hall of India Pvt Ltd, New Delhi, 2006
4. Christian G.D, “Analytical Chemistry” John Wiley & Sons, 6th Edition, 2004
5. Srivatsava A. K. & Jain P. C, “Chemical Analysis”, S. Chand Publications, New Delhi, 3rd edition, 1997.
6. Chatwal G. R & Anand S. K, “Instrumental Methods of Chemical Analysis”, Himalaya Publishing House, Mumbai, India, 5th Edition, Reprint 2011.
7. G. Sharma, B K Chaturvedi, Richard E. Wolfe, Basic Analytical Chemistry, DK publishers, 2011

Credits: 3:0:0

Course Objectives :

Enable the student to

- Learn the problems associated water treatment methods.
- Understand the concepts of thermodynamics and energy resources
- Classify the types of materials and their applications

Course Outcomes

Students will be able to

- recognize hard water and softening methods
- understand chemical thermodynamics
- identify the types of batteries
- explain the problems associated with corrosion
- appraise the significances of polymers
- utilize the knowledge of advanced materials

Unit I - WATER TREATMENT: Hardness, Units and calculation of hardness, Estimation of hardness by EDTA method, Softening of water – External conditioning - Zeolite process, Ion – Exchange process, Scale and sludge – sources and disadvantages, Internal conditioning – Calgon & Carbonate conditioning, Boiler corrosion – causes (DO, CO₂, acids) & removal methods, Desalination – Reverse Osmosis, Municipal water treatment.

Unit II - THERMODYNAMICS: Thermodynamic Concepts – System, surroundings, open, closed, Isolated system, Mass, Energy, Internal energy & work. Extensive property & Internal property, Exothermic and Endothermic reaction, State function. Thermodynamics process: Isothermal, Adiabatic, Isobaric, Isochoric. Zeroth and first law of thermodynamics – statements with suitable analogy. Enthalpy – relation between pressure, volume and work, ΔH & ΔU , Hess's Law and its applications (Heat of reactions & its calculation), Heat and Heat capacity, Relation between Cp & Cv for ideal gases. Cyclic process – Carnot theorem, Entropy – Definition and entropy change in reversible and an irreversible process, spontaneity of a reaction (definition) – Gibb's free energy and standard Gibb's free energy of systems, second law of thermodynamics – statements, Gibb's – Helmholtz equation.

Unit III - ELECTROCHEMISTRY: Specific, Molar & Equivalent conductivities (definition), Redox reaction, Electrode potential, Measurement of electrode potential, Nernst equation, Electrochemical series and its importance, Electrochemical cells, Liquid Junction Potential, Batteries – Primary cells (dry and alkaline cells), Secondary cells (lead acid battery), H₂–O₂ fuel cells, Electrochemical sensor – working principle and its applications.

Unit IV - CORROSION & POLYMERS: Corrosion – Types – Dry (Oxidation corrosion with mechanism) and Wet Corrosions (Galvanic corrosion with mechanism) – Factors influencing Corrosion and Control methods. Polymers – Introduction, properties of polymers, applications of polymers in medicine, Polymer blends & alloys, Moulding constituents of plastics, Fabrication – Injection & compression mouldings. Biodegradable polymers – Classification and its applications, Biopolymers – definition and functions of Carbohydrates and Proteins.

Unit V - ADVANCED MATERIALS: Nanomaterials - Introduction, Types with examples (particulate (metal/metal oxide), tubular/fibre (CNT/CNF), layered (Nanoclays, Graphene Oxide) and its properties. Preparation of nanomaterials – Top down (Ball milling, CVD) and Bottom up (Self-assembly, sol-gel), Applications – Medicine & medical implants, Next generation computer technology (High definition), Data & energy storage, Fabric industry, Automotive and aerospace, Environment, Electronics (satellites), Solar cells – photovoltaic cells – need, design, working and its limitations.

Reference Books

- 1 B.R. Puri, L.R. Sharma, M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing Company, 2008.
- 2 Engineering Chemistry – A Text book of Chemistry for Engineers Wiley India Pvt. Ltd, 2012.
- 3 Jain P. C, Monica Jain, A Textbook of Engineering Chemistry, Dhanpat Rai publications, New Delhi, 16th edition, 2015.
- 4 M.A. Shah, Principles of Nanoscience and Nanotechnology, Narosa Publishing House, New Delhi, 2011.

17CH1003 APPLIED CHEMISTRY LAB

Credits: 0:0:2

Course Objectives:

Enable the student to

- Learn the methods to estimate the amount of substance present in a solution quantitatively.
- analyze the quality of water
- have a hands on experience on the electrochemical and spectrophotometric techniques

Course Outcomes:

Students will be able to

- recognize the effects of hardness of water in industrial applications and its estimation.
- know the merits and demerits of dissolved oxygen in water and their estimation.
- understand the principles of complexometric titrations.
- estimate water contamination using titrations.
- apply the principles of electrochemical techniques.
- understand the principles of spectrophotometry.

12 approved experiments will be notified at the beginning of the semester

17CH1004 ENVIRONMENTAL STUDIES

Credits: 3:0:0

Course Objectives:

Enable the student to

- acquire the knowledge of environmental studies, its need & importance
- know about problems related to various types of pollution
- make the learners sensitive to the environment problems in every professional endeavor in which they participate

Course Outcomes:

Students will be able to

- Understand the natural environment and its relationships with human activities.
- Acquire practical skills for solving pollution related problems
- Design and evaluate strategies and apply green technologies
- Identify the methods for sustainable development and for the remediation or restoration of degraded environments.
- Integrate facts, concepts, and methods from multiple disciplines and apply to environmental and social problems.
- Analyze the connectivity between the man made activities-Pollution-environmental issues-social problems-eco friendly solutions

Unit I : ENVIRONMENT AND NATURAL RESOURCES: Environment - Definition, scope and importance , Renewable and Non-Renewable Resources – Natural resources and associated problems – Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Energy resources: Growing energy needs, renewable and non-renewable energy sources, and use of alternate energy sources. Case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – Role of an individual in conservation of natural resources – Activity: Field study of local area to document environmental assets.

Unit II - ECOSYSTEMS AND BIODIVERSITY: Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs -Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity – Bio geographical classification of India – Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels -Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity – Activity: Model

preparation for Ecosystems / Biodiversity (OR) Documentation of available ecosystems/Biodiversity within Campus.

Unit III - ENVIRONMENTAL POLLUTION: Definition, Causes, effects and control measures (two) – Air pollution (Cyclone separator, Electrostatic Separator) – Water pollution – Soil pollution – Noise pollution – Thermal pollution – Nuclear hazards – Solid waste management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution. Pollution case studies – Green chemistry– principles of sustainable and green chemistry Activity: Visit-nearby Sewage treatment Water Plant.

UNIT IV - SOCIAL ISSUES AND ENVIRONMENTAL LEGISLATION: From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting and watershed management –Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, case studies – Environment Protection Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness – Activity: Watching Documentary Movies & Video Clips related to environment problems, Social issues and control measures.

Unit V - HUMAN POPULATION AND THE ENVIRONMENT: Population growth, Population explosion— Family Welfare Programme – Environment and human health. Human rights – HIV/AIDS – Women and Child Welfare – Role of Information Technology in environment and human health – Disaster management: Floods, earthquake, cyclone and landslides – Case Studies – Activity: Small projects related to environment problems, Social issues and eco friendly technology.

Reference Books:

1. Deeksha Dave, “Environmental Studies”, Cengage Learning India Pvt Ltd, New Delhi – 2011
2. Raman Shivakumar, “Introduction Environmental science and Engineering”, Tata Mc Graw Hill, 2010.
3. Bharucha Erach, “Text book on environmental studies” For Undergraduate Courses of all Branches of Higher Education, University Grants Commission, New Delhi, 2004.
4. Abnubha Kaushik, Kaushik C.P., “Perspectives in Environmental Studies” New Age International Publishers, Third Edition, 2009.
5. Sharma B.K. “Environmental Chemistry” Comprehensive covering the UGC Syllabus, 11th Edition, Goel Publishing House, Meerut, Eleventh Edition, 2007.

17CH2001 – CHEMICAL BONDING AND CONCEPTS OF ACIDS AND BASES

Credits: 3:0:0

Course Objectives:

Enable the student to

- Learn the types of bonds and theories regarding bonding interactions
- Understand the concepts of acids and bases
- Learn about the allotropy of carbon

Course Outcomes:

Students will be able to

- recognize different types of bonds
- understand the theories of bond
- know the basics of bonding interactions
- explain the concepts acids and bases
- understand the theories of acids and bases
- acquire knowledge about carbon allotropes

UNIT I - Atomic Structure - Bohr Theory - Dual Nature of Electron -Heisenberg Uncertainty Principle -Radial and angular functions -Pauli exclusion Principle - Hund's rule-- Type of bonds --Covalent bonds -Ionic bond- Coordinate bonds - Melting points -Vander Waal's forces

UNIT II - Preparation of ionic compound-Melting point - Conductivity – Solubility- Structure of ionic compound: Radius ratio - Close Packing -Classification of ionic Structure AX(NaCl,CsCl), AX₂ (TiO₂, CaF₂, SiO₂)Layer Structure (CdF₂) – Lattice energy – Born lande equation. - Defects in Solids : Stoichiometric defects – Non Stoichiometric defects -Born Haber Cycle.

UNIT III - General properties of metals in conductivities, Malleability, Luster -Bond lengths-Theories of bonding: free e⁻-VB, Molecular bond theory-Conductors, insulators and semiconductors Super conductivity-And Alloys

UNIT IV - Theories: Lewis theory – Sidgwick-Powell theory, -VSEPR Theory: Effect of lone pairs, electronegativity, Example (BF_3 , NH_3 , H_2O , PCl_5 , ClF_3 , SF_6 , I_3SF_6 , IF_7) VB theory: Hybridization – σ orbital π bonds-Molecular Orbital Theory : LCAO method – rules for linear combination of atomic orbital – Homonuclear diatomic molecules -Heteronuclear diatomic molecules-(NO, CO), $-\text{CO}_3^{2-}$

UNIT V - Introduction of Acids and bases -Arrhenius theory-Bronsted theory of acids and bases-Lewis theory of acids and bases-Carbon allotroph – graphite, diamond, carbon nanotubes, fullerenes-Silicates-Silicones

Reference Books:

1. Lee J. D, "Concise Inorganic Chemistry", Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Shriver and Atkins, "Inorganic Chemistry", Oxford University Press, New Delhi, India, 4th edition, 2009.
3. Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
4. W. H. Madan, G. D. Tuli, R. D. Madan, "Selected Topics in Inorganic Chemistry", S. Chand & Company Ltd, Reprint 2009.

17CH2002 – ORGANIC REACTION INTERMEDIATES AND STEREOCHEMISTRY

Credits: 3:0:0

Course Objectives:

Enable the student to

- impart basic understanding about reaction intermediates
- illustrate the concepts of electronic effects
- highlight the importance of stereoisomerism and conformational analysis

Course Outcomes:

Students will be able to

- understand the structural basics of organic compounds.
- Know the various types of organic reactions and their properties.
- Recognize the importance of carbonyl and nitrogen containing compounds
- understand the concept of stereoisomerism.
- Name the compound based on CIP nomenclature.
- Apply the conformational analysis for the cyclic systems

Unit I - INTRODUCTION TO ORGANIC CHEMISTRY: Classification of organic compounds – Functional groups – Nomenclature of Organic compounds – Nomenclature of heterocyclic compounds – Fission of bonds – Electrophiles and nucleophiles (Definition, Discussion on the conditions these are formed) – Carbocation and Carbanion, Free radicals, Arynes (Structure and reaction only; methods to identify these species are not required).

Unit II - ELECTRONIC EFFECTS AND TYPES OF REACTIONS: Inductive effect and field effect – Electron delocalization and resonance, Rules of resonance – Steric inhibition of resonance and steric enhancement of resonance (with only one example for each) – Hyperconjugation – Tautomerism.

Unit III - ALIPHATIC AND AROMATIC CHEMISTRY: Aliphatic carbonyl compounds (aldehydes and ketones) – Aliphatic nitrogen containing compounds – Aromatic aldehydes and ketones – Aromatic nitrogen containing compounds – Azines – Arenediazonium salts.

Unit IV - STEREOCHEMISTRY: Stereoisomerism – Cis-trans isomerism (Definition and examples only) – E, Z nomenclature (Rules and examples only) – Optical isomerism – Cause of optical activity – Racemization – Resolution methods – Absolute configuration – R, S nomenclature – Cahn, Ingold, Prelog nomenclature.

Unit V - CONFORMATIONS: Conformations of Ethane – conformations of cyclohexane – conformations of nono substituted cyclohexane – conformations of disubstituted cyclohexane - Saw-horse, Staggered, Skew, Gauche forms.

Reference Books:

1. J. March. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 4th edn., Wiley Student Edition, John Wiley & Sons Asia Pvt. Ltd., 2005
2. B. Mehta, M. Metha. Organic Chemistry, 3rd edn., Prentice-Hall of India Pvt. Ltd., 2008.

3. R.T. Morrison & R.N. Boyd, Organic Chemistry, 6th Edition, Pearson Education Pvt Ltd., Singapore, 2003
4. P.S. Kalsi, Stereo Chemistry Conformation and Mechanism, New Age Publishing Ltd., New Delhi, 2002.
5. Bhupinder Mehta, Manju Mehta, Organic Chemistry, Prentice Hall of India private ltd., New Delhi, 2008.
6. O.D. Tyagi, M. Yadav, A Text Book of Organic Chemistry, Anmol Publishing Ltd., New Delhi, 2002
7. I.L. Finar, Organic Chemistry, Pearson Education Pvt. Ltd., Vol. I & II, 5th Edition, Singapore, 1975

17CH2003 ATOMIC STRUCTURE, THERMODYNAMICS AND ELECTROCHEMISTRY

Credits: 3:0:0

Course Objectives:

Enable the student to

- understand the basics of Quantum Chemistry
- know the principles of chemical thermodynamics and electrochemistry
- apply the concept of Phase Rule

Course Outcomes:

Students will be able to

- recognize the importance of Quantum Chemistry
- know the importance of Thermodynamics
- understand the significance of Phase rule
- know the principles of electrochemistry
- classify the various types of electrochemical cells
- apply the proper method to prevent corrosion

Unit I - Atomic Structure: Quantum Theory of Radiation – Photoelectric effect – Dalton theory – Thomsons atomic model - Bohr Theory – Dual Character of Electron – Heisenberg Uncertainty Principle – Quantum mechanical model of atom (by Schrodinger) – probability distribution – Quantum numbers.

Unit II - Quantum chemistry: Black body radiation - Planck's quantum theory – wave-particle duality – uncertainty principle – operators and commutation relations – postulates of quantum mechanics - Schrodinger equation – particle in one dimensional and three dimensional box - degeneracy - quantum numbers.

Unit III – Thermodynamics: definition - First law of thermodynamics, relation between C_p and C_v , enthalpies of physical and chemical changes – second law of thermodynamics, entropy, Gibbs-Helmholtz equation – third law of thermodynamics and calculation of entropy

Free energy and entropy of mixing, partial molar quantities, Gibbs-Duhem equation – equilibrium constant, temperature dependence of equilibrium constant

Unit IV - Electrochemistry I: Kohlrausch law - equivalent conductance - molar conductance - Electrode potential – Measurement of electrode potential – Nernst equation for electrode potential – Electrochemical Series – Electrochemical cell or Voltaic cell – Concentration cell – Primary Cell– LeClanche cell - Secondary batteries – alkaline batteries – Lead acid and Li batteries

Unit V - Electrochemistry II: Corrosion – Types – Dry corrosion – mechanism – Nature of oxide layers – examples - Wet corrosion – types – mechanism – galvanic corrosion –examples Differential aeration theory – examples - Liquid metal corrosion - examples - factors influencing the rate of corrosion – prevention of corrosion – inhibitors – types - examples

Reference Books:

1. B.R. Puri, L.R. Sharma and Madan S. Pathania, "Principles of Physical Chemistry", Vishal Publishing Co., Jalandhar, 2008
2. Peter Atkins, "Elements of Physical Chemistry", OUP Oxford, 6th edition, 2012
3. Samuel H. Maron and Carl F. Prutton, "Principles of Physical Chemistry", fourth edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, reprinted in 2009
4. Un Dash, Op Dharmarha and P.L. Soni, "Text book of Physical Chemistry", Sultan Chand & Sons, New Delhi, 2011
5. A.K Chandra, "Introduction to Quantum Chemistry", Tata McGraw Hill, New Delhi, 1997 (recent edition)

6. J. C. Kuriacose and J. Rajaram, "Thermodynamics for students of chemistry", 3rd Edition, Shoban Lal Nagin Chand & Co., Jalandhar, 1999 (recent edition)
7. Samuel Glasstone, "An introduction to electrochemistry" Atlantic Publishers, 2007

17CH2004 CHEMISTRY OF TRANSITION AND INNER-TRANSITION ELEMENTS

Credits:3:0:0

Course Objectives:

Enable the student to

- Learn the properties of transition metals and f-block elements
- understand the various theories of coordination chemistry.
- Learn the principles of organometallic chemistry

Course Outcomes:

Students will be able to

- Know the properties of transition metal compounds.
- have complete understanding of formation of coordination complexes
- know the various types of isomerism in coordination chemistry
- understand the factors affecting the stability of metal complexes
- apply the 18 electron rule.
- Recognize the importance of f-block elements.

Unit I - Transition Metals: Introduction – Metallic Character – Variable oxidation state – stability of the oxidation states - Complexes – Size of atoms and ions – Density – Melting and boiling points – Reactivity of metals – ionization energies – Colour – Polarization – Incompletely filled d or f shell – Magnetic properties – Measurement of magnetic moments – An example – Catalytic properties – Nonstoichiometry – Abundance

Unit II - Coordination compounds: Double salts and Coordination compounds – Werners work – more recent methods of studying complexes – Effective atomic numbers – Shapes of d orbitals – Bonding of transition metal complexes – Valence bond theory – Crystal field theory – Molecular orbital Theory – Octahedral complexes – effects of crystal field splitting – Tetragonal distortion of octahedral complexes (Jahn Teller distortion)- square planar arrangements – Tetrahedral complexes – Chelates – Magnetism – Extension of the crystal field theory to allow for some covalency

Unit III - Isomerism and Stability in Coordinate compounds: Isomerism – Polymerization isomerism – Ionization isomerism – Hydrate isomerism – Linkage isomerism – Coordination isomerism – Coordination position Isomerism –Geometric isomerism or Stereo isomerism – optical isomerism – Stability – Relationship between stepwise and overall stability constant

UNIT IV - Organometallic Chemistry: Effective Atomic Number - 18-electron rule, metal carbonyls, Metal alkyls, carbenes, carbines and alkenes – Metallocenes – Ferrocene – Preparation – Properties – Uses - Reactions – Homogeneous and heterogeneous catalysis -Wilkinsons catalyst – Ziegler – Natta Catalyst.

Unit V - Inner Transition Elements: Introduction –Electronic structure – Oxidation states – Ionic Radii - Lanthanide contraction – Consequences - Colour and spectra - Magnetic Properties - Abundance – Extraction and uses - Extraction, Properties and Uses of Thorium and Uranium

Reference Books:

1. Lee J. D, "Concise Inorganic Chemistry", Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Shriver and Atkins, " Inorganic Chemistry", Oxford University Press, New Delhi, India, 4th edition, 2009.
3. Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
4. W. H. Madan, G. D. Tuli, R. D. Madan, "Selected Topics in Inorganic Chemistry", S. Chand & Company Ltd, Reprint 2009.

17CH2005 – REACTION MECHANISM AND HETEROCYCLIC CHEMISTRY

Credits: 3:0:0

Course Objectives:

Enable the student to

- learn various types of reaction mechanisms
- expect the reaction products and the changes that occur in the structure of organic compounds interacting depending on the type of interactions
- know the role of heterocycles in organic, pharmaceutical and biological chemistry.

Course Outcomes:

Students will be able to

- elucidate the mechanisms of organic reactions
- propose more complex syntheses
- predict the reactivity of an organic compound from its structure
- develop the knowledge on the fundamental theoretical understanding of heterocyclic chemistry
- propose syntheses of heterocycles from the major classes
- get the ability to relate significant chemical properties to structure

Unit I - Aromatic and Aliphatic Nucleophilic Substitutions: The S_NAr mechanism – S_N1 mechanism – Benzyne mechanism – Reactivity – Effect of substrate structure, Leaving group, Attacking nucleophile – Bucherer reaction – Chichibabin reaction – S_N1 and S_N2 mechanisms – Neighboring group participation – Non-classical carbocations – Effect of substrate structure, Attacking nucleophile, Leaving group, and reaction medium on nucleophilic substitution – Ambident nucleophiles and regioselectivity.

Unit II - Aromatic and Aliphatic Electrophilic Substitutions: Arenium ion mechanism – Orientation and reactivity in mono-substituted aromatic rings – Quantitative treatment – Hammett equation – Effect of leaving group – Nitration, Diazonium coupling, Nitrosation, – Mechanisms S_E2 mechanism – S_E1 mechanism – Reactivity – Aliphatic diazonium coupling – Acylation at an aliphatic carbon – The Stork-enamine reaction.

Unit III - Addition and Elimination Reactions: Addition reactions - Electrophilic, Nucleophilic, and free-radical addition to double and triple bonds – Hydration, Hydroxylation, Michael addition, Hydroboration - Addition to carbonyl compounds – Mannich reaction Elimination reactions – mechanism – E_1 , E_2 mechanisms, Hofmann, Saytzeff rules, Bredt's rule – Chugaev reaction, Hofmann degradation

Unit IV - Heterocyclic Chemistry with one hetero atom: Heterocyclic Chemistry – one hetero atom - pyrrole, furan, thiophene, Pyridine – Preparation, reactions and properties.

Unit V - Heterocyclic Chemistry with two hetero atom: Heterocyclic Chemistry– two hetero atom – pyrazole, imidazole, thiazole, Piperidine – Preparations, reactions and properties

Reference Books:

1. S. H. Pine, Organic Chemistry, 5th edn., McGraw-Hill, 1987
2. J. March. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 4th edn., Wiley Student Edition, John Wiley & Sons Asia Pvt. Ltd., 2005
3. F. A. Carey & R. J. Sundberg. Advanced Organic Chemistry, Part A and B, 3rd edn. 1990
4. Wamser & Harris, Fundamentals of Organic Reaction Mechanisms, John Wiley (1990).
5. R.T.Morrison & R.N.Boyd, Organic Chemistry, 6th Edition, Pearson Education Pvt Ltd., Singapore, 2003
6. Raj.K. Bansal, "Heterocyclic Chemistry", New Age International Publishers, 4th Edition, Reprint, 2009.

17CH2006 SURFACE CHEMISTRY AND CHEMICAL KINETICS

Credits: 3:0:0

Course Objectives:

Enable the student to

- learn the fundamental properties of liquid state and liquid crystals
- understand the principles of colloidal state and surface phenomena
- learn the kinetics of chemical reactions

Course Outcomes:

Students will be able to

- understand the properties of liquid state and liquid crystals

- recognize the importance of surface energy
- know about the colloidal system and their stability
- understand the origin of charges on colloidal particles
- distinguish the kinetics of various types of chemical reactions
- understand the factors affecting the enzyme catalysed reactions

UNIT I - LIQUID CRYSTALS: The vacancy theory - Vapour pressure - Surface tension & surface energy - Some effects of surface tension - Interfacial tension - Surface active agent - Liquid crystal- introduction - Vapour pressure – temperature - Classification of liquid crystal – smectic and nematic - Compounds exhibiting both smectic and nematic characters -

UNIT II - COLLOIDAL STATE-I: introduction & types -Preparation of lyophobic colloidal solutions – dispersion methods - Preparation of lyophobic colloidal solutions – condensation methods - Purification of colloidal solutions - General properties of colloidal system - Some specific properties of hydrophobic colloidal systems – Origin of charge on colloidal particles - Some specific properties of hydrophobic colloidal systems – Electrical double layer - DLVO theory of stability of Lyophobic colloids - Coagulation of colloidal sols – by the action of electrolyte

UNIT III - COLLOIDAL STATE –II: Electro-kinetic properties - Determination of size of colloidal particles - Emulsions – types & formations - Factors determining the stability of emulsion - Micro-emulsion – qualitative and quantitative theories - Gels – types & preparation - Importance and applications of colloids - Surfactants – types and HLB - Micelle – formation & types - Critical micelle concentration (CMC) - Factors affecting CMC in aqueous media -

UNIT IV - ABSORPTION: introduction & types - Freundlich & Langmuir adsorption isotherm - BET theory of multilayer adsorption - Modern techniques for investigating surfaces

UNIT V - KINETICS: Chemical kinetics – introduction -Rate of reaction, rate constant, order of reaction - Integration of rate expression for first order reaction - Integration of rate expression for second order reaction - Half-life of first and second order reactions - Catalysis – effect of temperature on reaction rates - Arrhenius equation - Enzyme catalysis

Reference Books:

1. B.R. Puri, L.R. Sharma and Madan S. Pathania, “Principles of Physical Chemistry”, Vishal Publishing Co., Jalandhar, 2008
2. Peter Atkins, “Elements of Physical Chemistry”, OUP Oxford, 6th edition, 2012
3. Samuel H. Maron and Carl F. Prutton, “Principles of Physical Chemistry”, fourth edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 1965 (reprinted in 2009)
4. I.N. Levine, “Physical Chemistry”, 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007
5. Un Dash, Op Dharmarha and P.L. Soni, “Text book of Physical Chemistry”, Sultan Chand & Sons, New Delhi, 2011
6. K.J. Laidler, “Chemical Kinetics”, 3rd Edition 1997, Benjamin-Cummings. Indian reprint – Pearson, 2009
7. A.W. Adamson, “Physical Chemistry of Surfaces”, 5th edition, Wiley, 1997 (recent edition)

17CH2007 QUALITATIVE ANALYSIS AND INORGANIC PREPARATIONS LAB

Credits: 0:0:2

Course Objectives:

Enable the student to

- Learn the theoretical basis of qualitative inorganic analysis
- Learn the methods of identification using semimicro analysis
- Get trained for the synthesis of inorganic complexes

Course Outcomes

Students will be able to

- gain the laboratory skills to synthesize the inorganic complexes
- understand the theory and mechanism of formation of metal complexes
- recognize the classification of ions under different groups
- in analyze the mixtures using semi micro analysis

- identify the common ions
- acquire separation skills

12 approved experiments will be notified at the beginning of the semester

Reference Books:

1. Mendham J., Denney R. C., Barnes J. D. and Thomas M. J. K., "Vogel's Textbook of Quantitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, Seventh impression 2008.
2. Ramanujam V. V., "Inorganic semimicro qualitative analysis", 3rd edition, The national publishing company, Chennai, India, reprinted 2008.
3. Svehla G., "Vogel's Textbook of Qualitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression 2008

17CH2008 TITRIMETRIC ANALYSIS AND GRAVIMETRIC ANALYSIS LAB

Credits: 0:0:2

Course Objectives:

Enable the student to

- learn quantitative methods of analysis
- understand the importance of titrimetric analysis
- estimate the amount of substance using gravimetric analysis

Course Outcomes:

Students will be able to

- improve their analytical skills with respect to estimation
- recognize the importance of volumetric analysis
- apply the volumetric analysis for the estimation of ions
- understand the theory of various types of titrations
- estimate the amount of substance using gravimetry
- know the theory of gravimetric analysis

12 approved experiments will be notified at the beginning of the semester

Reference Books:

1. Mendham J., Denney R. C., Barnes J. D. and Thomas M. J. K., "Vogel's Textbook of Quantitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, Seventh impression 2008.
2. Ramanujam V. V., "Inorganic semimicro qualitative analysis", 3rd edition, The national publishing company, Chennai, India, reprinted 2008.
3. Svehla G., "Vogel's Textbook of Qualitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression 2008

17CH2009 ORGANIC QUALITATIVE ANALYSIS LAB

Credits: 0:0:2

Course Objectives:

Enable the student to

- Identify the functional group of the organic compound
- carryout various types of organic reactions to analyze the organic compound
- Understand the principle of systematic organic qualitative analysis

Course Outcomes:

Students will be able to

- Enhance the knowledge of systematic analysis of an organic compound
- Understand the mechanism of the various reactions.
- Recognize the importance of analyzing a organic compound
- Employ various organic reaction types

- apply the knowledge in analyzing real samples
- Prepare derivatives for the given organic compound

12 approved experiments will be notified at the beginning of the semester

Reference Books:

1. A.I. Vogel – “Text book of practical organic chemistry”, 5th Ed. ELBS, London, 1989
2. B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
3. Daniel R. Palleros, “Experimental Organic Chemistry” John Wiley & Sons, Inc., New York, 2000
4. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, “Text book of Practical Organic Chemistry”, LBS, Singapore, 1994
5. S.M. Khopar, “Basic concepts of Analytical Chemistry”, John Wiley & Sons, 1984
6. Gnanapragasam N.S., Ramamurthy G, “Organic Chemistry Lab Manual”, revised edition, S. Viswanathan printers and publishers Pvt. Ltd., Chennai, Reprinted 2011.

17CH2010 PHYSICAL CHEMISTRY LAB – I

Credits: 0:0:2

Course Objectives:

Enable the student to

- train the students on instrumental methods of analysis
- carryout experiments on chemical kinetics
- get an basic idea about electrochemistry

Course Outcomes:

Students will be able to

- Understand the principle and working of various instrument methods of analysis.
- apply the principle of chemical kinetics
- apply the knowledge in measuring real samples
- distinguish different terms used to express concentration
- understand the factors affecting the reaction rate
- utilize the knowledge of electroanalytical techniques

12 approved experiments will be notified at the beginning of the semester

Reference Books:

1. S.M. Khopar, “Basic concepts of Analytical Chemistry”, John Wiley & Sons, 1984
2. Mendham J., Denney R. C., Barnes J. D. and Thomas M. J. K., “Vogel’s Textbook of Quantitative Chemical Analysis”, 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, Seventh impression 2008.

17CH2011 CHEMISTRY IN EVERYDAY LIFE

Credits: 3:0:0

Course Objectives :

Enable the student to

- learn the chemistry connections of everyday life.
- relate the chemistry involved in day-to-day life
- develop a sense of responsibility towards the environment to safeguard.

Course Outcomes :

Students will be able to

- know the practical aspects of chemistry in day-to-day life.
- apply the chemistry concepts in day-to-day activities.
- think innovative and develop application oriented products.
- gain knowledge in buying certified food products

- make right choice in choosing the right food.
- gain right perspective to guard the environment

Unit I - DRUGS AND DISEASES: Clinical chemistry – antibiotics, antiseptics, antipyretics – definitions, examples (common drugs available in the market) – incurable diseases – causes for polio, diabetes, AIDS, cancer – signs and symptoms – vaccination – protein misfolding and disease – common drugs banned in India – effects of using banned drugs – effects of steroidal injections.

Unit II - PERFUMES, EXPLOSIVES, AND DYES: Perfumes: historical significance – the olfactory system – categories – chemistry of ice cream making – chemistry of paint – chemistry of explosives – TNT, RDX, nitrocellulose, nitroglycerine (structure and properties only) – natural dyes and synthetic dyes – types, advantages, applications – hair dye – petrochemicals.

Unit III - CHEMICALS IN EVERYDAY PRODUCTS: Advantages and disadvantages of the following: monosodium glutamate (aginomotto) – lycopene (in tomato) – umami, the fifth taste and glutamate – caffeine and theobromine (in chocolates) – polyphenols (in tea) – docosahexanoic acid (in fish) – thiols (in onion) – polycyclic aromatic hydrocarbons (formed during cooking meat) – constituents of talcum powder and pulmonary fibrosis – ingredients of tooth paste – melatonin (in anti-ageing product) – microban (in toys) – alpha tocopherol (in body lotions) – aluminum chloride (in antiperspirants) – aspartame (in artificial sweetener) – chloral hydrate (in sedatives) – citric acid (in citrus fruits).

Unit IV - CHEMICAL BASIS OF EVERYDAY PHENOMENA: Chemical basis of everyday phenomena – reasoning: kitchen gas burner burns yellow when a pot of boiling water overflows – cosmetic creams feel cool when applied to skin – seashells vary in color – old paintings discolor over time – hair color products remove gray on hair – disappearing inks disappear – water does not relieve the burning sensation of chilly – sniffing dogs detect explosives and bombs – flesh of fish smells different from other meat – puff pastries expand when prepared – some fabrics are water-repellent – cotton is highly water absorbent but dries slowly.

Unit V - KNOWING CHEMISTRY FOR BETTER LIFE: Food adulteration – consumption of alcohol and its ill effects – PAH from oil – balanced diet – iodized salt – fluoride tooth paste – saturated and unsaturated fat – cholesterol (LDL and HDL) – ill health and fast food – organic food – crackers – ill effects of crackers – molecules of emotion (Adrenaline, Acetylcholine, Dopamine, Epinephrine, Norepinephrine, Serotonin, Melatonin, Oxytocin).

Reference Books:

1. Karukstis K.K., and Hecke G.R.V., “Chemistry connections: the chemical basis of everyday phenomena” Elsevier Science and Technology books, 2nd edition, 2003.
2. Grace Ross Lewis, “1001 Chemicals in everyday products”, John Wiley and sons, 3rd edition, 2001.
3. www.listverse.com/2007/10/04/top-10-incurable-diseases/
4. www.bama.ua.edu/
5. www.foodproductdesign.com
6. www.angelfire.com/linux/chemistryofpaint/
7. www.srsi.org/sr1/weapon.explode.htm
8. Paul Engel, “Pain-free Biochemistry”, Wiley – Blackwell publishers, 2009.

17CH2012 APPLIED NANO CHEMISTRY AND NEXT GENERATION MATERIALS

Credits: 3:0:0

Course Objectives:

Enable the student to

- understand the various types of nanomaterials
- know the methods of preparation of nanomaterials and their characterization
- explore the applications of nanomaterials in various fields

Course Outcomes

Students will be able to

- know the various types of nanomaterials.
- recognize nanomaterials present in nature and various methods available to access them
- understand about the effect of size on the properties of materials
- analyze and characterize nanomaterials using various instruments and techniques available

- understand the importance of nanomaterials in electronics and medical field
- think and propose novel materials to replace the present one.

UNIT I - INTRODUCTION TO NANOMATERIALS: Nanomaterials – Emergence of Nanotechnology - Fabrication – Top-down, Bottom-up methods of generation – Surface Energy – Agglomeration – Ostwald ripening – Steric stabilization

UNIT II - CLASSIFICATION OF NANOMATERIALS: Zero Dimensional Nanostructures: Metallic and Semiconductor Nanoparticles – Core-Shell Nanoparticles – One Dimensional Nanostructures- Nanorod – Nanowire – VLS Growth – Electrospinning - Two Dimensional Nanostructures – Thin film – Epitaxy – Physical and Chemical Vapor Deposition - Special nanomaterials – Carbon nanotubes – Fullerenes – Inorganic nanocomposites

UNIT III - NANOSTRUCTURES BY PHYSICAL TECHNIQUES: Lithography – Photolithography – Electron Beam Lithography – Nanolithography – Soft Lithography – Dip Pen nanolithography

UNIT IV - CHARACTERIZATION AND PROPERTIES OF NANOMATERIALS: Structural Characterization - X-ray Diffraction – Scanning Electron Microscopy – Transmission electron Microscopy – Scanning Probe Microscopy – Introduction to Optical Spectroscopy — Optical – Electrical and Magnetic Properties

UNIT V - APPLICATIONS OF NANOMATERIALS: Nanoelectronics – Biological applications of nanoparticles – Nanomechanics – Photonic crystals

Reference Books:

1. G.Cao, “Nanostructures and Nanomaterials-Synthesis, Properties and Applications”, Imperial College Press, London, 2008
2. M.A.Shah and T. Ahmed, “Principles of Nanoscience and Nanotechnology”, Narosa Publishing House, New Delhi, 2010.
3. Atkins, Overton, Rourke, Weller, Armstrong, “ Shriver & Atkins Inorganic Chemistry”, 4th Edition, Oxford University Press, New Delhi, 2010
4. Daniel L. Schodek, Paulo Ferreira, Michael F. Ashby, “Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers and Architects” Butterworth-Heinemann Ltd, UK, 2009

17CH3001 CHEMICAL KINETICS AND PHOTOCHEMISTRY

Credits: 3:1:0

Course Objectives:

Enable the student to

- Learn the kinetics of rate equations
- get thorough knowledge about catalysis
- learn the physical properties of electronic excited state

Course Outcomes:

Students will be able to

- understand the types and kinetics of fast reactions
- know the kinetics of flow techniques
- understand the theory of acid – base catalysis
- distinguish different isotherms
- recognize the importance of photosensitization of Chemiluminescence

Unit I - Chemical Kinetics – I: Chemical kinetics – Basic concepts – rate law – rate equation – Kinetics of zero, first, second and third order reactions – Kinetics – composite reactions (complex reaction) – Opposing (reversible) reactions – Consecutive reactions – Chain reactions – Stationary chain reaction –Collision theory of bimolecular and unimolecular reactions – Arrhenius theory of reaction rates – Theory of absolute reaction rates – Thermodynamic treatment of reaction rate - Lindemann’s theory – Kinetics of fast reactions.

Unit II - Chemical Kinetics – II: Study of kinetics of stopped flow techniques – flash photolysis – shock tubes – Reaction rates in solution – Effect of dielectric constant and ionic strength – Kinetic isotope effects – Hammett relationship - ionic reactions in solution – effect of ionic strength – Linear free energy relationships – Taft equation – Yukawa-Tsuno equation – Luminescence and energy transformations – Chemiluminescence – reactions in molecular beam.

Unit III – Catalysis: Acid – Base catalysis – general scheme – Arrhenius complex – Vant Hoff's complex – specific and general catalysis – catalytic constants – Bronsted relationship – Hammett acidity functions – mechanism of acid-base catalysed reaction – Catalysis by metal salts (transition metal complex) – enzyme catalysis – theory and applications - Mechanism of heterogeneous catalysis - Langmuir-Hinshelwood mechanism and Langmuir Reidel mechanism - Examples of heterogeneous catalytic reactions - hydrogenation of ethylene, synthesis of ammonia, oxidation of SO₂ and Fischer- Tropsch method for the synthesis of methanol.

Unit IV - Surface Chemistry & Colloids: Adsorption – Difference between adsorption and absorption – Classification of adsorption – Physisorption – Chemisorption – Adsorption isotherm – Freundlich's adsorption isotherm – Applications of adsorption – Types of solutions – Types of colloidal solutions – Preparation of colloidal solutions – Condensation methods – Disintegration methods – Purification of colloidal solutions – Dialysis – Ultrafiltration – Characteristics of colloidal solutions – Emulsions – Micelles.

Unit V – Photochemistry: Absorption and emission of radiation – Theories – Spontaneous and induced emission – Laser – Franck Condon principle - Type 1 & 2 – Physical properties of electronic excited state – Emission – Resonance emission – Selection rule – Fluorescence – Phosphorescence – Delayed fluorescence: E-Type and P-Type – Excimer and Exciplex complex formation – Photosensitization and Chemiluminescence – Experimental techniques – Actinometry – Chemical actinometry – Flash photolysis.

Reference Books :

1. Laidler K.J., "Chemical Kinetics", Harper and Row, New York, 3rd Edition, 2008.
2. Rajaram J & Kuriakose, J.C., "Kinetics and mechanism of chemical transformation", McMillan India Ltd., New Delhi, 2011.
3. Adamson, A.W., "Physical Chemistry of Surfaces", Wiley, 6th edition, 1997.
4. Rohatgi Mukherjee K. K., "Fundamentals of photochemistry", New Age International Pvt. Ltd., New Delhi, 2009.
5. Atkins P.W., "Physical Chemistry", Oxford University Press, 8th edition, 2006.
6. Kalidas, C. "Chemical Kinetic Methods: Principles of Relaxations Techniques and application", New Age International (P) Ltd, Chennai, 2005.
7. Levine I.N., "Physical Chemistry", Tata Mc Graw Hill, NY, 2007.

17CH3002 CHEMICAL BONDING AND NUCLEAR CHEMISTRY

Credits: 3:0:0

Course Objectives :

Enable the student to

- learn the theory of acids and bases and non-aqueous solvents.
- Know about the various types of chemical bonding.
- Learn about nuclear chemistry and their applications

Course Outcomes :

Students will be able to

- have clear knowledge of theory of acids and bases
- recognize the importance and applications of non-aqueous solvents
- understand the various theories of chemical bonding.
- distinguish different types of interactions in molecules
- understand the theory of Nuclear stability
- identify the applications of nuclear chemistry in various fields

UNIT I - ACID-BASE CHEMISTRY: Periodicity – Bronsted-Lowry Theory – Lewis Theory – Measures of acid-base strength - Hard and Soft acids and bases – Classification – Symbiosis – Electronegativity and hardness and softness -

UNIT II - NON-AQUEOUS SOLVENTS: Protic and Aprotic solvents - Leveling Effect – Reactions in Non-aqueous solvents – Liquid Ammonia – Sulfuric acid – Hydrofluoric Acid – Sulfur dioxide – Dinitrogen tetroxide -

UNIT III - IONIC BONDING: Lattice energy – Born Lande Equation – Born Haber Cycle – Fajan's rule – Size effects – Factors affecting the radii of ions – Radius Ratio

UNIT IV - COVALENT BOND AND WEAK INTERACTIONS: VB Theory – Hybridization – MO Theory of Diatomic Molecules – Delocalization – Resonance – Electronegativity and MO Theory – Group Electronegativity

- VSEPR Theory – Experimental determination of Molecular structure – Berry pseudorotation – Ion-dipole Interaction – Hydrogen Bonding

UNIT V - NUCLEAR CHEMISTRY: Nuclear Stability – Nuclear Fission – Nuclear Fusion – Radioactive Detectors - Nuclear Reactions - Neutron Activation Analysis – Carbon and Rock Dating –Applications of Tracers

Reference Books:

1. Lee J. D, “Concise Inorganic Chemistry”, Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Huheey J. E, Keiter E. A & Keiter R. L, “Inorganic Chemistry – Principles of structure and reactivity”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
3. Sharpe A.G. “Inorganic Chemistry”, Dorling Kindersley (India) Pvt. Ltd, 2nd impression, 2008.
4. Satyaprakash, Tuli G. D, Basu S. K & Madan R. D, “Advanced Inorganic Chemistry” Vol I and II, S. Chand and Company Ltd, NewDelhi, India, Reprint: 2009.
5. Mido Y, Taguchi S, Sethi M.S & Iqbal S. A, “Chemistry in Aquous and Non-aqueous Solvents”, Discovery Publishing House, New Delhi, 2003
6. Arnikaar H. J, “Essentials of Nuclear Chemistry”, New Age International Publishers Ltd., New Delhi, India, 4th edition, 2007.

17CH3003 ORGANIC REACTION MECHANISM AND STEREOCHEMISTRY

Credits: 3:1:0

Course Objectives :

Enable the student to

- impart the importance of chirality in organic compounds
- understand the stereochemistry of organic reactions
- explain the mechanism and molecular rearrangements of organic reactions.

Course Outcomes :

Students will be able to

- understand the reaction pathway in organic transformation
- Improve the skill of proposing mechanism for particular reaction
- propose the expected product based on the mechanism
- explain the selectivity in the organic reactions
- enrich the basic understanding on arrangement of atoms or groups in the space.
- reason out the stereoselectivity in organic reactions in the presence chiral environment

Unit I - REACTION MECHANISM – I: Effect of structure and reactivity – Resonance and field effects – Steric effects – Quantitative treatments of the effect of structure and reactivity – LFER – Hammett and Taft equation - Importance of σ and ρ values in aromatic electrophilic substitutions – Labelling and kinetic isotopic effects. Aromaticity – Huckel’s rule – Aromatic systems with electron numbers other than six – Annulenes and Hetero annulenes.

Unit II - REACTION MECHANISM – II: Aliphatic nucleophilic substitution – Mechanisms – S_N2 , S_N1 , mixed S_N1 and S_N2 , S_Ni , SET, Neighbouring group mechanism – Reactivity – Effect of substrate, attacking nucleophile, leaving group and reaction medium – Substitution at vinylic and allylic carbons. Aromatic nucleophilic substitutions – Mechanism – S_NAr – S_N1 – Benzyne – Reactivity – Effect of substrate, leaving group and attacking nucleophile.

Unit III - REACTION MECHANISM – III: Aromatic electrophilic substitution – Arenium ion mechanism – Orientation and reactivity in monosubstituted benzene rings – Benzene rings with more than one substituent - Effect of leaving group – o/p ratio – Addition to C-C-multiple bonds – Mechanisms – Electrophilic, nucleophilic, free radical – Orientation and reactivity – Addition to conjugated systems – Elimination – Mechanisms of β elimination – ($E2$, $E1$, $E1cB$) – $E1$ – $E2$ – $E1cB$ spectrum, orientation of double bonds – Reactivity – Effect of substrate, attacking base, leaving group and medium.

Unit IV - STEREOCHEMISTRY – I: Stereoisomerism – Definitions and classification – Molecular representation and inter conversion – Classification of stereo isomers – Stereoisomerism and center of chirality – Molecules with a single stereogenic center – Projection structure of stereoisomers – Fischer – DL, RS and EZ notations - Configurational nomenclature – Molecules with two or more chiral centers – Stereoisomerism in cyclic compounds – Axial chirality, planar chirality and helicity.

Unit V - STEREOCHEMISTRY – II: Difference between conformation and configuration – Conformation of ethane, substituted ethanes – Conformation of cyclohexanes, mono, and disubstituted cyclohexanes – Saw-horse, staggered, skew, gauche forms – Explanation and conversion of one representation to another – Fused ring systems – Decalins – Biphenyls - Stereoisomerism in Allenes Dynamic stereochemistry: Stereoselectivity and stereospecificity – Curtin-Hammett principle – Enantioselective, diastereoselective synthesis – Enzymatic and kinetic methods – Conformation and reactivity in acyclic compounds and cyclohexanes.

Reference Books :

1. Jerry March, "Advanced Organic Chemistry", Wiley Eastern Limited, New Delhi, 4th edition, 2008.
2. Bahl. B.S. and Arun Bahl, "A Text book of Organic Chemistry", S. Chand & company Ltd., New Delhi, Reprint, 2011.
3. Peter Sykes, "A Guidebook to Mechanism in Organic Chemistry", Longman Press, London and New York, Reprint, 2006.
4. Ernest. L. Eliel, "Stereochemistry of carbon compounds", Tata-McGraw Hill, New Delhi, 22nd Reprint 2009.
5. Nasipuri. D. "Stereochemistry of organic compounds – Principles and applications", New Age international, 2nd edition, 2002.
6. Kalsi. P.S. "Stereochemistry Conformation and Mechanism", New Age International Publishers, New Delhi, 6th Edition, Reprint, 2005.
7. Finar. I.L., "Organic Chemistry, Volume 1", Doorling Kindersley (Indian), 6th Edition, 5th impression, 2008.
8. Raj K. Bansal, "Organic reaction mechanism", Tata McGraw Hill, New Delhi, 4th Edition, 2005.
9. Carey. F.A. "Organic Chemistry", McGraw Hill, Inc., 2nd edition, 1992.
10. Morrison and Boyd, "Organic Chemistry", United States of America, 3rd edition, 1992.
11. Carey, F.A, and Sundberg. R. J, "Advanced Organic Chemistry Part – A", Plenum Press, 2007.

17CH3004 QUANTUM CHEMISTRY AND GROUP THEORY

Credits: 3:1:0

Course Objectives :

Enable the student to

- learn the importance of quantum chemistry
- understand the concepts of group theory to atoms and molecules.
- know the importance of quantum chemistry and group theory in spectroscopy

Course Outcomes :

Students will be able to

- understand the importance and application of quantization in molecular energy levels
- explain the shape, energy of atomic orbitals and molecular orbitals and the bond formation between atoms
- reason out the spectral behavior of molecules and atoms
- appreciate the symmetry in molecules and in nature
- able to identify and group the objects or molecules of same category based on the symmetry elements
- correlate between symmetry and spectral behavior

UNIT I - INTRODUCTION TO QUANTUM MECHANICS: The failures of classical mechanism – heat capacities – black body radiation – The photo electric effect – The Compton effect – The diffraction of electrons – wave particles duality- de Broglie Equation- Problems – Hydrogen spectrum- Uncertainty principle, Problems, operators and commutation relations – Postulates of quantum mechanics

UNIT II - QUANTUM CHEMISTRY OF ATOMS AND MOLECULES Scrodinger equation-derivation, Free particle, particle in one dimensional box, three dimensional box Harmonic oscillator, – Rigid rotor – The Schrodinger equation for hydrogen atom – Angular momentum – Spin, coupling of angular momentum – Spin-orbit coupling. Variation and perturbation theory – Application of perturbation / variation theorems to ground state of helium atom

UNIT III - QUANTUM CHEMISTRY OF BONDING: Antisymmetry and Pauli's exclusion principle – Aufbau principle – Slater detrimental wave functions – Term symbols and spectroscopic states – Born Oppenheimer approximation –Linear Combination of atomic orbitals (LCAO), MO and VB treatments of

hydrogen molecule – Hybridization – Huckel theory of linear conjugated systems ethylene, butadiene – Cyclic systems -cyclobutene – Woodward Hoffman rules.

Unit IV - GROUP THEORY: Molecular symmetry – symmetry elements and symmetry operations-successive operations, inverse operations - Cartesian coordinate system - relations among symmetry elements - Properties of a group – Abelian, non abelian and Isomorphic groups - Multiplication tables – classes, subgroups - Molecular point groups - Schoenflies symbols - Matrices of symmetry operations - Representations of a group-Reducible and irreducible, representations - Statement and proof of Great orthogonality theorem - Characters and construction of character table (C_{2v}, C_{3v}) – Explanation of a character table - Direct product groups.

Unit V - APPLICATIONS OF GROUP THEORY: Standard reduction formula relating reducible and irreducible representations -Symmetries of normal modes of vibration in non-linear molecules (H₂O, NH₃, BF₃) - Selection rules for vibrational spectra – IR and Raman active fundamentals – Mutual exclusion rule - Symmetries of M.O and symmetry selection rule for electronic transition in ethylene and formaldehyde - Hybridization schemes for atoms in methane, ethylene and butadiene.

Reference Books :

1. Chandra, A.K. "Quantum Chemistry" Tata McGraw –Hill Pvt. Ltd., New Delhi, 4th Edition, 2002.
2. Donald A McQuarrie, "Quantum Chemistry", Viva Books, New Delhi, 2008.
3. Hanna, M.W., "Quantum Mechanics in Chemistry", Addison Wesley, London, 3rd edition, 1981.
4. Swarnalakshmi S. "A Simple Approach to Group Theory in Chemistry" Universities Press, 2009.
5. Raman, K.V. "Group theory and its applications to chemistry", Tata Mac Graw Hill, 2004.
6. Cotton F.A. "Chemical application of group theory", Wiley India Pvt. Ltd., New Delhi, India, 3rd edition, 2009.
7. Carter R.L., Molecular Symmetry and Group Theory, John Wiley & Sons, NY, 2005.

17CH3005 COORDINATION CHEMISTRY

Credits: 3:1:0

Course Objectives :

Enable the student to

- learn the various bonding theories in coordination chemistry and their application in understanding spectra and magnetism
- understand Reaction Mechanism in Coordination Chemistry
- understand the importance of f-block elements and their applications

Course Outcomes :

Students will be able to

- understand the structure, isomerism and bonding in coordination complexes
- characterize the electronic spectra of metal complexes
- predict the magnetic properties of coordination complexes
- understand the factors affecting the stability of metal complexes
- understand the types of mechanisms in reactions of metal complexes
- recognize the chemistry of lanthanides and actinides and their applications

UNIT – I: Theories of coordination Chemistry: Ligands – Classification - Formation of Complexes – Bonding theories – Werner's theory – Sidgwick Theory - VB Theory – Advantages and Defects - Crystal Field Theory – Shapes of d orbitals – Assumptions - CFSE – Measurement of 10Dq - Factors Affecting 10Dq – Spectrochemical Series – Consequences – Merits and limitations of Crystal field theory - MO Theory – σ Bond and π Bond – Advantages

UNIT – II: Electronic and Magnetic Properties: Electronic Spectra — Types of Transitions - Term Symbols – Spin-Spin and Spin-orbit Coupling - Ground Terms for d Configuration, - Problems -Terms Generated in Ligand Fields Correlation Diagrams, - Orgel Diagram – Nephelauxetic Ratio - Racah Parameter -Tanabe Sugano Diagram – Selection Rules for Electronic Transitions - Width of the spectra, Jahn-Teller Effect – Electronic Spectra of dⁿ Complexes - CT Spectra –Types - Magnetic Properties – Magnetic moment - Determination of Magnetic Susceptibility - Orbital Contribution to Magnetic Moment – Quenching

UNIT – III: Isomerism and Stability: Isomerism - Structural Isomerism – Stereoisomerism – Δ and λ isomers – Cotton effect - Stepwise and Overall Stability Constant - Irving William Series - Factors Affecting the Stability Constant - Chelate and Macrocyclic Effects – Determination of Stability Constant Problems

UNIT – III: Reaction Mechanism in Coordination Complexes: Thermodynamic and Kinetic Stability - Labile and Inert Complexes - Substitution in Octahedral Complexes – Rate constants for water exchange reactions - S_N1 , S_N2 and $S_N1(CB)$ Mechanism - Isomerization Reactions, Anation Reactions - Reactions of Coordinated Ligands - Substitution in square Planar Complexes – Trans Effect – Series - Applications of Trans Effect - Theories of Trans Effect – Electron transfer reactions – Types - Outer and Innersphere Reactions – Marcus Theory –Nature of Bridging Ligand

Unit V: Chemistry of f-block elements: Abundance and Distribution, Uses - Lanthanide Contraction – Magnetic and Spectroscopic properties of Lanthanides - Separation of Lanthanides and Actinides - Transactinides

Reference Books:

1. Huheey J. E, Keiter E. A & Keiter R. L, “Inorganic Chemistry – Principles of structure and reactivity”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
2. Purcell K. F & Kotz J. C., “Inorganic Chemistry” Cengage Learning, New Delhi, India, Reprint, 2010.
3. Greenwood N. N. & Earnshaw A, ”Chemistry of the Elements”, Reed Elsevier India Private Ltd, Gurgaon, India, 2nd edition, Reprinted 2010.
4. Miessler G. L & Tarr D. A., “Inorganic Chemistry”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 3rd Edition, 2009.
5. Gopalan R, Ramalingam V, Concise Coordination Chemistry, Vikas Publishing House Pvt. Ltd, 2001
6. Cotton F. A & Wilkinson G, “Advanced Inorganic Chemistry”, 6th edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.
7. Jordan R. B, “Reaction Mechanisms of Inorganic and Organometallic Systems”, Oxford University Press, New York, USA, 3rd Edition, 2007.
8. Satyaprakash, Tuli G. D, Basu S. K & Madan R. D, “Advanced Inorganic Chemistry” Vol I and II, S. Chand and Company Ltd, NewDelhi, India, Reprint: 2009.
9. Shriver and Atkins, “ Inorganic Chemistry”, Oxford University Press, New Delhi, India, 4th edition, 2009.
10. Figgis B. N. & Hitchman M. A, “Ligand Field Theory and Its Applications”, Wiley-VCH Verlag GmbH & Co, Weinheim, Germany, 2000.

17CH3006 MOLECULAR SPECTROSCOPY

Credits: 3:0:0

Course Objectives:

Enable the student to

- learn the principles of Molecular Spectroscopy
- understand the principles of Emission Spectroscopy
- learn the theoretical basis of Mossbauer Spectroscopy

Course Outcomes:

Students will be able to

- know the various regions of the spectrum
- Understand the principle of rotation, vibration and electronic spectroscopy
- Know the principle and applications of NMR and ESR spectroscopy
- Understand the principle and applications of fluorescence spectroscopy
- Know the principle and application of photoelectron and mossbauer spectroscopy
- Elucidate the structure of unknown compounds from the spectroscopic data

Unit I - Electromagnetic radiation and Rotation: Introduction to electromagnetic radiation- Regions of the spectrum, characterisation of electromagnetic radiation, Introduction to rotational spectroscopy, rotational spectra diatomic molecules – the rigid diatomic molecule, selection rules for rotational spectra, Effect of isotopic substitution, the non rigid rotator, Polyatomic molecules- Linear molecules, Techniques and instrumentation and chemical analysis by microwave spectroscopy,

Unit II - Vibration and Ramanspectroscopy: Vibrating diatomic molecule, the simple harmonic oscillator, Anharmonic oscillator, The vibration rotation spectrum of carbon monoxide. Born Oppenheimer approximation: the interaction of rotations and vibrations, Vibrations of polyatomic molecules, different modes of stretching and bending, principles – $3N-6$ (5) rule, Overtone and combination frequencies, factors affecting vibrational frequencies, Techniques and instrumentation & applications of infrared spectroscopy, Fermi resonance. Raman

spectroscopy- introduction, quantum theory of raman effect, Classical theory of raman effect- molecular polarizability, Polarization of light and the Raman effect, Pure rotational raman spectra- linear, symmetric top and asymmetric top molecules, Vibrational raman spectra, Mutual exclusion principle, overtone and combination vibrations, techniques and instrumentation of Raman spectroscopy, Electronic spectroscopy of diatomic and polyatomic molecules, Transition moment integral, Predissociation

Unit II - NMR and ESR spectrometry: NMR spectroscopy- introduction, Nuclear magnetic resonance phenomenon, The absorption process, Relaxation process- spin spin relaxation, Spin lattice relaxation, Chemical shift, factors influencing chemical shift, ESR spectroscopy – introduction, g factor, Spectra of simple organic radicals, Spectra of first row transition metals, Zero field splitting, Kramer's degeneracy

Unit III - Mossbauer and Photoelectron Spectroscopy: Mossbauer spectroscopy- introduction, principle, Isomer shift, Quadrupole effects, Hyperfine splitting, Applications of Mossbauer spectroscopy. Photoelectron spectroscopy (PES)- Principle Photoelectron spectroscopy (PES)- instrumentation, Ultraviolet Photo electron spectroscopy (UPS) X-Ray Photo electron spectroscopy (XPS) Auger electron spectroscopy

Unit V - Fluorescence spectroscopy: Fluorescence spectroscopy- introduction, principle, instrumentation, Jablonski diagram, Fluorescence, Phosphorescence, Delayed fluorescence, Characteristics of Fluorescence emission, Fluorescence Lifetimes and quantum yields, Fluorescence Quenching, Resonance energy transfer (RET), Steady state and time resolved Fluorescence.

Reference Books :

1. Fundamentals of Molecular Spectroscopy. C. N. Banwell and E. M. McCash, Tata McGraw-Hill publishing.
2. Molecular Spectroscopy. I. N. Levine, Wiley Interscience Publication.
3. Drago R. S, Physical Methods for Chemists, 2nd Revised edition, n Saunders (W.B.) Co Ltd;
4. Molecular Spectra & Molecular Structure. G. Herzberg, Van Nostrand Reinhold Company
5. Satya Narayana D. N, "Vibrational Spectroscopy Theory and Applications", New Age International Publishers, New Delhi, 2004.
6. Satya Narayana D. N, "Electronic Absorption Spectroscopy and Related Techniques", Universities Press (India) Ltd, Hyderabad, 2001.
7. Lakowicz J. R, "Principles of fluorescence spectroscopy", Springer Science+Business Media, New York, USA, 3rd edition, 2006.
8. Principles of Ultraviolet Photoelectron Spectroscopy, J. W. Rabalais, John Wiley & Sons.
9. Satya Narayana D.N., "Magnetic Resonance Spectroscopy ESR, NMR, NQR", I. K. International, New Delhi, 2009
10. Graybeal J. D., Molecular Spectroscopy., McGraw Hill.
11. Hollas J. M., Modern Spectroscopy. John Wiley & Sons.

17CH3007 - CHEMICAL THERMODYNAMICS AND ELECTROCHEMISTRY

Credits: 3:0:0

Course Objectives:

Enable the student to

- learn the fundamentals of classical thermodynamics
- understand the principles of statistical thermodynamics
- know the concepts of electrochemistry

Course Outcomes:

Students will be able to

- understand the influence of temperature on the molecules
- understand the concept of activity and fugacity
- relate various thermodynamic parameters
- understand the distribution of energy among the molecules
- know the relationship between the molecular functions and the thermodynamic parameters
- describe the theoretical background of electrode kinetics

Unit I - First law of thermodynamics – Heat and work, internal energy, enthalpy and heat capacity of a system – Expansion of an ideal gas and changes in thermodynamic property - Limitation of first law of thermodynamics -

Second law of thermodynamics – Carnot cycle (four stroke engine) – Efficiency of heat engine, concept of entropy and its physical significances – Entropy change in phase transformations – Entropy changes of an ideal gas in different processes.

Unit II - Gibbs-Helmholtz equation – variation of Gibbs energy with temperature – Thermodynamics of open system - Partial molar properties – Chemical potential – Gibbs-Duhem equation – Variation of chemical potential with temperature and pressure – Activity – Activity coefficient – Ideal solution – Real solution – Fugacity – Determination of a fugacity of a gas - Third law of thermodynamics – Nernst theorem – Determination of absolute entropy of solids, liquids and gases.

Unit III - Concepts of probability – Entropy and thermodynamic probability – Maxwell-Boltzmann statistics – Basic derivation – prove that $\beta = 1/KT$ – Derivation of Bose-Einstein statistics and Fermi-Dirac statistics – Basic derivation - Relationship between entropy and thermodynamic probability – Molecular partition function for an ideal gas - Derivation of Translational, Rotational, Vibrational partition function –

Unit IV - Derivation of thermodynamic functions in terms of partition function – entropy for monoatomic gases – Sackur-Tetrode equation - Heat capacity of solids – Debye theory and Einstein theory – Irreversible thermodynamics – the steady – coupled flows – application –

Unit V - Steaming potential – electro dialysis – the Dorn effect – electrical double layer – Structure of electrical double layer – Helmholtz model, Gouy-Chapman model and Stern model – Electrode kinetics - Derivation of Butler-Volmer Equation - over potential – decomposition potential.

Reference Books :

1. Atkins P.W., “Physical Chemistry”, Oxford University Press, 8th edition, 2006.
2. Glasstone S., “Thermodynamics for Chemists”, East West Press Pvt. Ltd., New Delhi, 2005.
3. Levine I.N., “Physical Chemistry”, Tata Mac Graw Hill, NY, 2007.
4. N.D. Smith, “Elementary Statistical Thermodynamics”, Plenum Press, New York, 1984.
5. Samuel Glasstone, “An Introduction to Electrochemistry”, Maurice Press, 2007.
6. John O'M. Bockris, Amulya K. N. Reddy, “Modern Electrochemistry”, Vol. I and II, Plenum Publishing, 2008.

17CH3008 ORGANOMETALLIC, BIOINORGANIC AND SOLID STATE CHEMISTRY

Credits: 3:1:0

Course Objectives :

Enable the student to

- learn the Structure, Reactions and Catalysis in Organometallic Chemistry
- know the role of metals in biological chemistry
- understand the importance of inorganic photochemistry and Solid State Chemistry

Course Outcomes :

Students will be able to

- recognize the importance of 18 electron rule
- understand the chemistry of various types of transition metal organometallic complexes
- know the applications of organometallic complexes in catalysis
- identify the metal complexes that can be used for solar energy conversion
- understand the role of metals in biology
- distinguish the structures of various solids

UNIT I - Organometallic Chemistry – structure: 18 Electron Rule - MO theory and 18 electron rule – Electron Counting - Problems - Metal carbonyl complexes - Preparation and Properties - Polynuclear metal carbonyls - Carbonylate anions - Carbonyl Hydride Complexes - Structure prediction for organometallic cluster Metal Nitrosyl Complexes - Metal nitrogen complexes - Alkyl complexes - Chemistry of Metal carbene and Carbyne complexes - Alkene and Alkyne complexes - Allyl and Arene complexes - Metallocenes – Fluxionality

UNIT II - Reactions in Organometallic chemistry and Catalysis: Reactions – Types – Ligand Cone angle – Oxidative addition - Reductive elimination – Insertion – Migration - Nucleophilic and electrophilic attack on coordinated ligands - Carbonylate anions as nucleophile - Catalysis – Tolman loop – Hydrogenation - Carbonylation - Hydroformylation - Wacker Process - Zeigler-Natta Catalysis

UNIT III - Inorganic Photochemistry: Properties of excited states - Basic Photochemical Processes – Energy transfer – Charge transfer photochemistry – Photodissociation - Photosubstitution reactions – photoisomerization - Photoredox reactions – Ligand Photoreactions – Ruthenium Polypyridine complexes – Photochemical conversion and storage of Solar energy

UNIT II - Biological Inorganic Chemistry: Essential and Trace elements in Biological Systems – Bioinorganic Chemistry of Fe, Co, Cu, Mn and Zn – Metalloporphyrin and Heme - Fe- Oxygen Binding – Structure and functions of hemoglobin – Myoglobin - physiology of O₂ binding - Electron transport – Ferridoxin, rubridoxin - Blue – Copper Proteins – Photosynthesis - Chlorophyll - Enzymes – Model Complexes - Carboxy peptidase - Carbonic anhydrase - Nitrogen Fixation – Hydrogenase - Vitamin B12 and B12 coenzymes – Model complexes - Platinum anticancer drugs – Biomaterials

UNIT-V: Solid State Chemistry: Crystal Systems – Defects – Conductivity in ionic solids - Band Theory of Solids – Close packing in crystals – Radius ratio - Structures of Compounds of types AX – NaCl, CsCl, ZnS , NiAs, Structures of type AX₂ – CaF₂, TiO₂ – Structures of type ABX₃ – Perovskite, Ilmenite

Reference Books:

1. Huheey J. E, Keiter E. A & Keiter R. L, “Inorganic Chemistry – Principles of structure and reactivity”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
1. Shriver and Atkins, “ Inorganic Chemistry”, Oxford University Press, New Delhi, India, 4th edition, 2009.
2. Porterfield W. W, “Inorganic Chemistry A Unified Approach”, Reed Elsevier India Private Ltd, Gurgaon, India, 2nd Edition, Reprinted 2009.
3. Purcell K. F & Kotz J. C., “Inorganic Chemistry” Cengage Learning, New Delhi, India, Reprint, 2010.
4. Cotton F. A & Wilkinson G, “Advanced Inorganic Chemistry”, 6th edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.
5. Gupta B. D & Elias A. J, “Basic Organometallic Chemistry”, CRC Press, New Delhi, India, 2010.
6. Greenwood N. N. & Earnshaw A, “Chemistry of the Elements”, Reed Elsevier India Private Ltd, Gurgaon, India, 2nd edition, Reprinted 2010.
7. K. Hussain Reddy, BIOINORGANIC CHEMISTRY, New Age International Ltd, 2003
8. Bertini I, Gray H. B, Lippard S. J & Valentine J. S, “Bioinorganic Chemistry”, Viva Books Private Ltd, New Delhi, India, 2007.
9. West R, “Solid State Chemistry and its Applications”, Wiley India Pvt. Ltd, New Delhi, India, 2007.

17CH3009 SYNTHETIC METHODOLOGY AND NATURAL PRODUCTS

Credits 3:0:0

Course Objectives :

Enable the student to

- Learn modern Synthetic Methods using Reagents
- understand the chemistry of heterocycles having 2 or more heteroatoms,
- understand the modern methods for molecular fashions applied in pharmaceutical industry.

Course Outcomes :

Students will be able to

- understand the importance of coupling reactions
- apply modern synthetic reagents in organic synthesis
- identify the applications of heterocycles in various fields
- summarize the extraction and structure elucidation of natural products
- describe the steps involved in the synthesis of natural products
- recognize the importance of biomolecules and their functions

Unit I - Modern Synthetic methods : Coupling reactions: Introduction modern synthetic methodology, concept of coupling reactions and it types, oxidative reduction and reductive elimination, Coupling reactions-HECK reaction, Suzuki Coupling, Stille Coupling, Ullmann reaction, catalytic cycles. Synthetic Reagents : NBS, DDQ, DCC, Gilman Reagents

Unit II - Modern Synthetic methods using Reagents and Multicomponent reaction Modern Synthetic Reagents : Introduction to multicomponent reactions, Design strategies (3MCRs) and types, Strecker's Reaction, Ugi reaction, Passinieri reaction, Biginelli reactions and its problems

Unit III - Heterocyclic Chemistry: Introduction and Nomenclature, Structure, synthesis, properties and uses of pyrazine, Imidazole (5 member rings) and Pyridazine, Pyrimidine (6 membered rings).

Unit IV - Natural products and structural elucidation: Natural products extraction, General methods of structure elucidation of alkaloids, Terpenoids, steroids and anthocyanidines, properties and uses.

Unit V - Chemistry of Biological Molecules: Chemistry of Vitamins, Chemistry of carbohydrates, Introduction of Amino acids, Introduction of proteins and its structures and introduction of nucleic acids.

Reference Books:

1. Smith M. B., Organic Synthesis, 3rd Edition, Wave Functions Inc. 2010.
2. Carruthers, W.; Coldham, I. Modern Methods of Organic Synthesis, 04th Edition Cambridge University Press, 2004.
3. Joule, J. A. and Mills K. Heterocyclic Chemistry, 05th Edition, Wiley, 2010.
4. Agarwal. O.P, "Chemistry of natural products, Vol.1 & 2", Goel publishing house, 36th Edition, 2009.
5. Raj.K. Bansal, "Heterocyclic Chemistry", New Age International Publishers, 4th Edition, Reprint, 2009.
6. Finar. I.L., "Organic Chemistry", Volume 2, Doorling Kindersley (Indian), 6th Edition, 5th Impression 2008.
7. Gurdeep R. Chatwal, "Organic Chemistry of Natural Products", Himalaya Publishing Home, New Delhi, 5th & Enlarged Edition, 2008.
8. Lehninger Principles of Biochemistry 5th edition, 2008 - Nelson, D. L. and M. M. Cox. (W. H. Freeman & Co.).
9. Organic Chemistry (5th Edn.) Robert. T.Morrison & N. Boyd. Hill edition.

17CH3010 QUALITATIVE AND QUANTITATIVE INORGANIC ANALYSIS LAB

Credits: 0:0:4

Course Objectives :

Enable the student to

- Learn about accurate and precise chemical analysis.
- Learn about the methods used in qualitative inorganic analysis containing common and less common ions
- Classify the various quantitative estimation of metal ions

Course Outcomes :

Students will be able to

- Perform semimicro nalysis
- classify the ions into various groups
- differentiate between common and less common ions
- gain laboratory skills for quantitative estimation
- understand the theory of various types of titrations
- recognize the importance of back titration

Course Description :

12 approved experiments will be notified at the beginning of the semester

Reference Books :

1. Mendham J., Denney R. C., Barnes J. D. and Thomas M. J. K., "Vogel's Textbook of Quantitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, Seventh impression 2008.
2. Ramanujam V. V., "Inorganic semimicro qualitative analysis", 3rd edition, The national publishing company, Chennai, India, reprinted 2008.
3. Svehla G., "Vogel's Textbook of Qualitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression 2008.

17CH3011 QUALITATIVE AND QUANTITATIVE ORGANIC ANALYSIS LAB

Credits: 0:0:4

Course Objectives:

Enable the student to

- Learn the identification of the functional group of the organic compound
- obtain the practical skills in setting up of an organic reaction
- identify the elements present in the small organic molecules

Course Outcomes:

The student will be able to

- perform the systematic analysis of an organic compound
- Apply the concept of polarity to separate the organic mixture
- identify various functional groups in the organic mixtures
- Analyze the functional group present in the organic compounds
- Evaluate the given organic mixture by confirmative tests and elemental analysis
- Synthesize the derivatives of the given mixture of organic compounds

12 approved experiments will be notified at the beginning of the semester and estimations of phenol, aniline, ascorbic acid and glucose.

Reference Books:

1. A.I. Vogel – “Text book of practical organic chemistry”, 5th Ed. ELBS, London, 1989
2. B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
3. Daniel R. Palleros, “Experimental Organic Chemistry” John Wiley & Sons, Inc., New York, 2000
4. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, “Text book of Practical Organic Chemistry”, LBS, Singapore, 1994
5. S.M. Khopar, “Basic concepts of Analytical Chemistry”, John Wiley & Sons, 1984
6. Gnanapragasam N.S., Ramamurthy G, “Organic Chemistry Lab Manual”, revised edition, S. Viswanathan printers and publishers Pvt. Ltd., Chennai, Reprinted 2011.

17CH3012 PHYSICAL CHEMISTRY LAB

Credits: 0:0:4

Course Objectives:

Enable the student to

- carryout chemical reaction which would be monitored by electroanalytical and other experimental studies.
- develop skills in the application area of electrochemical techniques experiments.
- Learn the techniques used for kinetics.

Course Outcomes:

Students will be able to

- Apply the physical chemistry concepts in chemical kinetics
- Handle the experiments like Conductometry, Spectrophotometry, Potentiometry.
- Understand the importance of the velocity of the reaction, distribution properties and adsorption studies.
- Recognize the factors affecting the rate of the reactions
- Understand the importance of absorption studies.
- Apply the practical knowledge and its solving route.

Course Description:

12 approved experiments will be notified at the beginning of the semester

Reference Book

1. Svehla G., “Vogel’s Textbook of Qualitative Chemical Analysis”, 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression 2008.

17CH3013 MODERN INSTRUMENTAL ANALYSIS LAB

Credits: 0:0:2

Course Objectives:

Enable the student to

- understand theory, instrumentation, and applications of separation techniques
- carryout simple chemical reactions that would be monitored by Conductometry Potentiometry, Spectrophotometry techniques.
- to understand theory, instrumentation, and applications of FT-IR and PXRD

Course Outcomes:

Students will be able to

- handle various analytical techniques like Conductometry Potentiometry, Spectrophotometry and X-ray Diffraction
- Describe physical and chemical principles involved in instrumental analysis and Practical skills
- Understand the principles of data acquisition and data analyses.
- Interpret analytical data and communicate the information about identification of different materials.
- solve qualitative and quantitative analytical problems.
- Choose the instrument for specific characterization

Course Description:

12 approved experiments will be notified at the beginning of the semester

Reference Book

1. Mendham J., Denny R. C., Barnes J. D. and Thomas M. J. K., "Vogel's Textbook of Quantitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, Seventh impression 2008.

17CH3014 PREPARATIVE INORGANIC CHEMISTRY LAB

Credits: 0:0:2

Course Objectives :

Enable the student to

- learn the Basic principles of formation of Inorganic complexes
- provide the students an appreciation for the preparation of Inorganic complexes.
- obtain knowledge pertaining to the appropriate selection of instruments for the successful analysis of complex mixtures

Course Outcomes :

Students will be able to

- know the concept of preparation techniques.
- gain the laboratory skills to prepare the inorganic complexes.
- Purify and check the purity of the prepared compounds
- understand the mechanism of the various preparative synthetic steps.
- apply the theory of infrared and ultraviolet spectroscopic techniques.
- characterize the inorganic complexes by spectroscopic techniques

Course Description:

12 approved experiments will be notified at the beginning of the semester

Reference Books :

1. Gopalan R, Ramalingam V, Concise Coordination Chemistry, Vikas Publishing House Pvt. Ltd, 2001
2. Allcock, H, R., "Inorganic Syntheses", Volume 25, John Wiley & Sons, New York, USA, 1989

17CH3015 SYNTHETIC ORGANIC CHEMISTRY LAB

Credits: 0:0:2

Course Objectives:

Enable the student to

- Develop various skills for preparing organic compounds.
- Know the various organic preparative techniques available.
- Impart awareness about reaction conditions for various types of organic reactions.

Course Outcomes:

Students will be able to

- Design and prepare organic compounds in one step in the lab.
- Purify the prepared organic compound and check the purity of prepared compound.
- Setup the apparatus for various preparative techniques.
- Understand the mechanism of the various preparative synthetic steps.
- Recognize the importance of distillation, refluxing and recrystallization techniques.
- Employ various organic reaction types.

Course Description :

12 approved experiments will be notified at the beginning of the semester

Reference Books :

1. A.I. Vogel – “Text book of practical organic chemistry”, 5th Ed. ELBS, London, 1989
2. B.B. Dey and M.V. Sitharaman, “Laboratory manual of Organic Chemistry” Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
3. Daniel R. Palleros, “Experimental Organic Chemistry” John Wiley & Sons, Inc., New York, 2000
4. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, “Text book of Practical Organic Chemistry”, LBS, Singapore, 1994
5. S.M. Khopar, “Basic concepts of Analytical Chemistry”, John Wiley & Sons, 1984

17CH3016 INSTRUMENTAL METHODS OF ANALYSIS

Credits: 3:0:0

Course Objectives :

Enable the student to

- develop sufficient knowledge about the physical/chemical basis of measurement
- obtain knowledge pertaining to the appropriate selection of instruments for the successful analysis of complex mixtures
- understand the applications of various instrumental techniques

Course Outcomes :

Students will be able to

- understand the range and theories of instrumental methods available in analytical chemistry
- select the appropriate instruments for analyzing complex mixtures
- choose the proper separation technique
- know the importance of thermal methods of analysis
- analyze the sample using microscopic techniques
- recognize the importance of instrumentation techniques in water, food and body fluid analysis

Unit I - Data Analysis: Errors in chemical analysis – Defining terms: mean, median, accuracy and precision – classification of errors: Systematic errors and random errors. Improving accuracy of analysis – mean, standard deviation and Q-test - Principles of Titrations – Instrumental Techniques – Classification – Modern Analytical Techniques

Unit II - Chromatographic methods: Classification – techniques and applications in column, size-exclusion, ion exchange, paper and thin layer chromatography. Gas chromatography and high performance liquid chromatography (HPLC) – principle, equipment design, sample injection system, columns, detectors and applications.

Unit III - Thermal Methods of Analysis: Thermal Characterization techniques Principle and applications of Differential Thermal Analysis (DTA), Differentials Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) Thermometric titration - Theory – Instrumentation – Factors affecting TG, DTA and DSC Curves – Applications

Unit IV - Microscopy methods: Atomic absorption and emission spectroscopy- ICP-AES - X-ray diffraction Methods – Instrumentation — Diffraction pattern – Structure factor – Reliability factor - Applications – Surface Characterization Techniques – SEM – TEM.

Unit V - Automation and Process control: Water analysis - Food analysis - Body Fluid analysis - Process Instruments – Automation Strategy –Chemical Sensors – Automatic Chemical Analysers – Laboratory Robot

Reference Books:

1. Willard H, Merrit L, Dean J. A. & Settle F.A., "Instrumental methods of chemical analysis", CBS Publishers and Distributors Pvt. Ltd, New Delhi, 7th edition, 1986.
2. Skoog D. A, West D. M, Holler F. J & Crouch S. R, "Fundamentals of Analytical Chemistry", Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.
3. Day R. A. & Underwood A. L., "Quantitative Analysis", 6th Edition, Printice Hall of India Pvt Ltd, New Delhi, 2006
4. G.D. Chritiain. Analytical Chemistry Wiley
5. Srivatsava A. K. & Jain P. C, "Chemical Analysis", S. Chand Publications, New Delhi, 3rd edition, 1997.
6. Chatwal G. R & Anand S. K, "Instrumental Methods of Chemical Analysis", Himalaya Publishing House, Mumbai, India, 5th Edition, Reprint 2011.
7. Valcarcel, Miguel, Principles of Analytical Chemistry, Springer, 2000.
8. G. Sharma, B K Chaturvedi, Richard E. Wolfe, Basic Analytical Chemistry, DK publishers, 2011
9. Zhou W, Wang Z. L, "Scanning Microscopy for Nanotechnology: Techniques and Applications", Springer, New York, USA, 2006.
10. R.P. Braun, Introduction to Instrumental Analysis, McGraw Hill

17CH3017 MAIN GROUP CHEMISTRY**Credits: 3:0:0****Course Objectives:**

Enable the student to

- Understand the synthesis, structure, bonding, and reaction mechanisms of main group Compounds
- learn the chemistry of inorganic polymers
- To understand the bonding in Inorganic cages and clusters

Course Outcomes:

Students will be able to

- understand the structure and bonding in main group Chemistry
- recognize the importance of inorganic polymers
- understand the structure and bonding in inorganic cages and clusters.
- describe the chemical reactivities of B-O, B-N, silicones, polyphosphazene and (SN)compounds.
- know the importance of the electron counting rules
- prepare different Boron hydrides compounds

Unit I - Chemistry of Alkali and Alkaline Earth Metals: Periodic property, Synthesis of Crown ether and Cryptands, Application of Crown ethers in extraction of alkali and alkaline earth metals; Compounds of Beryllium-Aqua and hydroxo complexes, Beryllium chloride, Carbonates, Carboxylates, Dimethylberyllium, Beryllium azide, Grignard reagents and their application.

Unit II - Polymorphism and Allotropy: Allotropes of carbon-Fullerenes, Carbon nanotubes, Diamond, Graphite(synthesis, structure and applications); Allotropes of Phosphorus-Synthesis, Structure and Properties; Allotropes of Sulphur-Classification, Synthesis, Structure and Properties

Unit III - Chemistry of B and C Group Elements: Bonding, Preparation and Structure-Hydrides of boron, Boron oxides, Oxoacids, Borates, Aminoboranes; Chemistry of Silicates; Organometallic Compounds of B, Al, Si, Sn, Pb, and Bi-Synthesis, Structure and Reactions

Unit IV - Chemistry of N, O, Halogen and Noble group Elements: Oxides and oxyacids of S, Se, Te and N-Synthesis, Structures and Properties; Interhalogens, Polyhalides, Pseudohalides- Synthesis and Structure; Xenon compounds- Synthesis and Structure

Unit V - Compounds of Cluster, Cages, Chains and Rings: Hydroborane Clusters, Electron counting schemes: Effective Atomic Number (EAN) Rule – Wade-Mingos Rules, Styx numbers; P-S cages and P-O cages- Synthesis, Structure and Reactivity; Phosphazenes and Poly Phosphazenes; Borazines and Poly Borazines; S-N polymer, Boron nitrides, Polysilanes, Silicones - Carboranes, Metallacarboranes- Synthesis, Structures and bonding

Reference Books:

1. Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
2. Greenwood N. N. & Earnshaw A, "Chemistry of the Elements", Reed Elsevier India Private Ltd, Gurgaon, India, 2nd edition, Reprinted 2010.
3. Purcell K. F & Kotz J. C., "Inorganic Chemistry" Cengage Learning, New Delhi, India, Reprint, 2010.
4. Shriver and Atkins, "Inorganic Chemistry", Oxford University Press, New Delhi, India, 4th edition, 2009.
5. Cotton F. A & Wilkinson G, "Advanced Inorganic Chemistry", 6th edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.
6. Driess M. & Nöth H, "Molecular Clusters of the Main Group Elements", Wiley-VCH Verlag GmbH & Co, Weinheim, Germany, 2004.
7. Chandrasekhar V, "Inorganic and Organometallic Polymers" Springer-Verlag Berlin, Heidelberg Germany, 2005
8. Henderson W, "Main Group Chemistry", Royal Society of Chemistry, United Kingdom, 2000.
9. Chivers T & Manners I, "Inorganic Rings and Polymers of the p-Block Elements", Royal Society of Chemistry, United Kingdom, 2009.
10. Archer R. D, "Inorganic and Organometallic Polymers", John Wiley and Sons, New York, USA, 2001.

17CH3018 SYNTHETIC REAGENTS AND CONCERTED REACTIONS**Credits 3:0:0****Course Objectives:**

Enable the student to

- rationalize, control, and predict the behavior and outcomes of organic reactions
- understand the fundamental principles of Pericyclic and photochemical reactions
- expand and utilize the skills in designing organic synthesis through retrosynthetic approach

Course Outcomes:

Students will be able to

- understand the mechanisms involved in various naming reactions to synthesize their target molecules
- select the appropriate reagents for oxidation and reduction reactions
- know the principles and applications of Pericyclic reactions.
- develop the required skills to execute the various types of Concerted reactions
- design photochemical reactions
- synthesize complex molecules through retrosynthetic approach

Unit I - Organic Name Reactions and Reagents Based On Oxidation and Reduction: Reagents based on Oxidation – PCC – OsO₄ – Reagents based on Reduction – NaBH₄, LiAlH₄, DIBAL – Name reaction based on Oxidation – Swern Oxidation and Baeyer Villiger Oxidation - Name reaction based on Reduction – Birch Reduction, Meerwein-Ponndorf-Verley Reduction.

Unit II - Photochemical excitation and ketone photochemistry: Light absorption – Experimental techniques – Electronic transitions – Frank – Condon principle – Jablonski diagrams – Intersystem crossing – Energy transfer – Molecular orbital view of excitation – The Geometry of excited states – Reactivity of Electronically excited ketones – α -cleavage – γ -hydrogen transfer Norrish Type I, Type II reactions – Photoreduction – Oxetane formation – Reactivity of π, π^* excited ketones – Photochemistry of α, β -unsaturated ketones – Dienone phenol rearrangement.

Unit III - Photochemistry of alkenes and aromatic compound: Olefin photochemistry – conjugated olefins – Isomerisation and rearrangements – Cis trans isomerisation – valence isomerisation – rearrangement of 1,4 and 1,5 dienes – di π -methane rearrangement - Cope and Claisen rearrangement – cycloaddition reactions – Photochemistry of Aromatic compounds – Arene photoisomerisation – Photodimerisation – Cycloaddition reactions – 1,2 cycloadditions – Photooxygenation – ene reaction.

Unit IV - Pericyclic Reactions and their stereochemistry: The stereochemistry of electrocyclic reactions – Symmetry properties of molecular orbitals – Symmetry control of electrocyclic reactions – perturbation theory in pericyclic reactions – Woodward Hoffmann rules – orbital correlation diagrams – The Frontier orbital theory – Electrocyclic conversion of 1,3 – dienes and 1,3,5 – trienes. Sigmatropic reaction – Stereochemistry of sigmatropic reactions – cycloaddition – classification of cycloaddition reaction – orbital symmetry and

cycloaddition – concerted Vs Non-concerted cycloaddition - 2+2 and Diel's Alder reaction – Reactivity of dienophile and diene components – orientation – stereochemistry of Diel's Alder reaction.

Unit V - Retrosynthesis – The Disconnection Approach: Synthons and reagents – Strategy I : The order of events – one group disconnection – Strategy II : Chemoselectivity – Two group Disconnection – Strategy III; Reversal of polarity and cyclization – Strategy IV: protecting groups – Strategy V : Stereoselectivity – Strategy VI : Carbonyl condensation - Strategy VII : Aliphatic nitro compounds – Strategy VIII : Ring synthesis.

Reference Books :

1. Stuart Warren, "Organic Synthesis – The disconnection approach" – A John Wiley and Sons, Ltd., 2nd Edition, reprint, 2010.
2. Jagadamba Singh and Jaya Singh, "Photochemistry and Pericyclic Reactions", New Age International Publishers, New Delhi, 3rd Revised Edition, Reprint, 2011.
3. Carey, F.A, and Sundberg. R. J, "Advanced Organic Chemistry Part – B: Reactions and Synthesis", Plenum Press, 2008.
4. Gurdeep R. Chatwal, "Reaction Mechanism and Reagents in Organic Chemistry", Himalaya Publishing House, New Delhi, 2007.
5. Finar. I. L, "Organic Chemistry", Volume 2, Doorling Kindersley (Indian), 6th Edition, 2008.
6. Hassner. A & Stumber. C, "Organic Synthesis based on name reactions", Pergamon Press, 2002.
7. Ahluwalia. V. K, and Rakesh Kumar Parashar, "Organic Reaction Mechanisms", Narosa Publishing House, New Delhi, 4th Edition, 2011.
8. Gilchrist. T. L, & Storr. R.C, "Organic reaction orbital symmetry", Cambridge university press, 1979.
9. Jerry March, "Advanced Organic Chemistry – Reactions, Mechanisms and structure", John Wiley & Sons, 4th Edition, 2008.
10. Mukherji. S. M, and Singh. S.P, Reaction Mechanism in Organic Chemistry, Macmillan Publishers, 3rd Edition, Reprinted, 2010.
11. Normon and Coxon J.M. Principals of Organic Chemistry, 3rd edition Chapman and Hall 1993.
12. Coxon. J.M, and Halton. B, "Organic Photochemistry", Cambridge University Press, London, 1st Paper back edition, 2011.

17CH3019 SPECTROSCOPIC METHODS FOR STRUCTURE ELUCIDATION

Credits: 3:0:0

Course Objectives:

Enable the student to

- learn the principles of Molecular Spectroscopy to Organic Molecules
- characterize the organic molecule using various spectroscopic technique
- derive the structure of the molecule using the spectroscopic techniques

Course Outcomes:

Students will be able to

- Understand the principle and applications of UV-Visible and IR spectroscopy
- Elucidate the structure of the unknown compounds using the provided UV Visible and IR spectroscopic data
- Know the principle and applications of NMR spectroscopy
- Classify the types of 2D NMR spectroscopy
- Understand mass spectrometry
- Derive the structure of the unknown organic molecule using the provided spectroscopic data

Unit I - UV Visible spectroscopy and ORD CD: Introduction to UV Visible spectroscopy – principle and instrumentation Woodward–Fieser rules for dienes and trienes – rules and problems, Woodward Fieser rules for α,β -unsaturated compounds – rules and problems, Woodward Fieser rules for aromatic compounds – rules and problems, Applications of UV Visible spectroscopy –poly-yenes, aromatic hydrocarbons other than benzene, heterocyclic systems, Problems on calculating absorption maximum using woodwardfieser rules. Principles of ORD, Instrumentation – Cotton effect, Octant rule, Axial halo ketone rule

Unit II - FTIR spectroscopy: FTIR – principle, instrumentation & the infrared absorption process, FTIR – modes of stretching and bending. Finger print region correlation chart and tables, concept of combination bands and overtones, factors influencing vibrational frequencies, IR spectrum of hydrocarbons: alkanes, alkenes and alkynes,

aromatic rings, alcohols, phenols, ethers and related problems, IR spectrum of carbonyl compounds - aldehydes, ketones and related problems, IR spectrum of carboxylic acids and esters and related problems, IR spectrum of amides, acid chlorides and anhydrides and related problems, IR spectrum of amines, nitriles, isocyanates, isothiocyanates, imines, nitro compounds and related problems, IR spectrum of sulfur, phosphorous, alkyl and aryl compounds and related problems, Problems in IR spectroscopy.

Unit III - ^1H NMR spectroscopy: NMR: Principle, the phenomenon of magnetic resonance, Instrumentation, Chemical shift, spin – spin relaxation and spin – lattice relaxation, Spin-spin coupling, problems based on ^1H NMR spectroscopy, Factors influencing chemical shift, Coupling constant- one bond, two bond, three bond and long range coupling,

Unit IV - Multinuclear and 2D NMR spectroscopy: ^{13}C spectroscopy- principle and instrumentation, Difference between ^1H and ^{13}C NMR spectroscopy, problems on ^{13}C NMR spectroscopy, Proton decoupled ^{13}C spectra, Simplification of complex spectra, Nuclear Overhauser Enhancement Effect (NOE), Second order spectra, DEPT spectra, problems on DEPT spectra, ^1H - ^1H COSY spectroscopy, HETCOR spectroscopy, NOESY, ROSEY- definition, Problems on ^1H , ^{13}C , 2D NMR and DEPT spectroscopy – Introduction to ^{31}P , ^{19}F and Silicon spectroscopy

Unit V - Mass spectrometry: Mass spectrometry: Principle– Instrumentation, Ionization methods – Electron ionization, Chemical ionization, Desorption ionization techniques, Electrospray Ionisation (ESI), Mass spectrum - Molecular ion peak – Base peak Metastable ions, Nitrogen rule, odd even rule, Fragmentation patterns- McLafferty rearrangement - Isotopic effect - Combined structure problems (with all spectral data, DBE, FTIR, ^1H , ^{13}C NMR, DEPT, Mass)

Reference Books:

1. R. M. Silverstein, F. X. Webster, D. J. Kiemle, Spectrometric identification of organic compounds, 7th edition, John Wiley, 2005.
2. Organic Spectroscopy, W. Kemp, 3rd edition, Macmillan, 2011.
3. D. H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, mcgraw Hill, 6th edition 2007.
4. D. L. Pavia and G. M. Lampman Spectroscopy 4th Edition, Brooks Cole, 2012.
5. P. S. Kalsi, Spectroscopy of Organic Compounds, 6th edition, New age international, 2004.

17CH3020 Supramolecular Chemistry and Green Chemistry

Credits: 3:0:0

Course Objectives :

Enable the student to

- learn the supramolecular constructs of current importance.
- Understand the principles of formation of various types of supramolecular architecture
- Know the importance of solid state supramolecular chemistry and green chemistry

Course Outcomes :

Students will be able to

- Understand the various types of bonding in supramolecular chemistry
- know the selectivity in formation of supramolecular chemistry and catalysis.
- synthesize and assemble molecular structures of different shapes and dimensions.
- understand the importance of green chemical pathways in reactions and their applications.
- Construct supramolecular architecture based on of crystal engineering concepts
- Recognize the application of supramolecular chemistry in various fields

UNIT I - INTRODUCTION TO SUPRAMOLECULAR CHEMISTRY: Introduction to supramolecular chemistry – Selectivity – Lock and key principle and induced fit model – complementarity – Co-operativity and chelate effect – Pre-organization – Binding constants – Kinetic and thermodynamic selectivity.

UNIT II - SOLUTION HOST-GUEST CHEMISTRY: Introduction: guests in solution – Macrocyclic vs. acyclic hosts – High-dilution synthesis – Template synthesis – Cation binding – Crown ethers and cryptands – Spherands – Heterocrowns – Biological ligands: ion channels – Anion binding – Charged receptors – Neutral receptors – Lewis acid receptors – Neutral molecule binding – Calixarenes, cyclodextrins and dendrimers as catalysts.

UNIT III - SUPRAMOLECULAR STRUCTURES: Ladders, polygons, and helices – Self-assembly using metal templates – Racks, ladders, and grids – Helicates – Molecular polygons – Rotaxanes, catenanes, and knots – Topological connectivity – Rotaxanes and catenanes as molecular devices – Borromean rings – Knots (structure and function of the above species). Self-assembling capsules – Molecular containers – Metal directed capsules – Hydrogen bonded capsules

UNIT IV - SOLID STATE SUPRAMOLECULAR CHEMISTRY: Introduction – Zeolites: structure – Zeolite composition – Zeolites and catalysis – Clathrates – Urea/thiourea clathrates – Trimesic acid clathrates – Hydroquinone and Dianin's compound – Clathrate hydrates (structure and function of the above species) –Uses. Crystal engineering with hydrogen bonds – Pi interactions - Solid state reactivity – Metal-organic frameworks – Guest properties of metal-organic frameworks.

UNIT V - GREEN CHEMISTRY: Need of Green chemistry-Twelve principles of Green chemistry- Green solvents- supercritical carbon dioxide-water as solvent-solvent-free synthesis- applications of Green chemistry- Environmental benign synthesis- catalysis

Reference Books :

1. Jonathan Steed, David Turner, Carl Wallace, Core Concepts in Supramolecular and Nanochemistry, John Wiley & Sons, 2007.
2. V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, Second Edition, CRC Press, 2012.
3. I. Chorkendorff, J. W. Niemantsverdriet, Concepts of Modern Catalysis and Kinetics, Second Edition, Wiley-VCH Publishers, 2007

17CH3021 APPLIED ELECTROCHEMISTRY

Credits: 3:0:0

Course Objectives:

Enable the student to

- understand the basics of electrode kinetics
- learn the applications of electroanalytical techniques
- know the types corrosion of materials and electroplating procedures

Course Outcomes:

Students will be able to

- understand the basics of electrokinetics
- know the types of electroanalytical techniques
- understand the types and mechanism of corrosion
- choose the methods to resist corrosion
- understand the principles of electrochemical energy conversion
- classify the batteries based on their application

Unit I - Basics of Electrochemistry: Electrodics – Transducers – Macro and Microelectrodes - Polarography – Tast Polarography – Cyclic Voltammetry – Normal pulse and Differential Pulse Voltammetry – Tafel Plot - AC Voltammetry – Impedance Spectroscopy – Spectroelectrochemistry.

Unit II - Corrosion Science: Introduction – Types of corrosion – Theories of corrosion – Mechanism of corrosion – Dry corrosion – Electrochemical corrosion – Types – Passivity – Types – Factors influencing rate of corrosion – Nature of metal, environment – Pourbaix diagram – Corrosion control techniques – Inhibitors – Cathodic protection methods – Corrosion monitoring techniques.

Unit III - Industrial Metal Finishing: Introduction – Objectives of electroplating – Characteristics of electrodeposition and factors – Copper electroplating – alkaline and acid bath – Chromium electroplating – Zinc electroplating – Gold plating – Anodizing and electroforming.

Unit IV - Electrochemical Power Sources – I: Principles of energy conservation - Electrochemical energy conservation- Thermodynamic reversibility - Gibbs's equation - Classification of batteries, types of electrolytes - Battery characteristics - Battery specifications - Battery components, Evaluation of battery performance.

Unit V - Electrochemical Power Sources – II: Construction and characteristics of primary batteries: Dry Leclanche cells, alkaline primary batteries and family of lithium batteries - Secondary batteries: Lead acid – car, traction, stationary, standby and sealed batteries. Nickel cadmium – pocket plates and sintered plates – vented and

sealed maintenance free designs. Fuel cells- Introduction, types of fuel cells, advantages – Photoelectrochemical cells.

Reference Books :

1. Bard & Faulkner, Electrochemical Methods: Fundamentals And Applications, Second Edition
2. Fritz Scholz, Electroanalytical Methods - Guide To Experiments And Applications, 2nd Ed, Springer-Verlag Berlin Heidelberg 2010
3. Joseph Wang, Analytical Electrochemistry, Third Edition 2006 John Wiley & Sons,
4. Vijay G. Singh, Applied Electrochemistry, Nova Science Publishers, 2010
5. John O'M Bockris, Amulya K. N. Reddy, Maria E. Gamboa-Adeco, "Modern Electrochemistry Vol.2 Part 1", Springer Science & Business Media, 2000
6. Raj Narayan, "An Introduction to metallic corrosion and its prevention", Oxford & IBH, 1983
7. Schlesinger, "Modern Electroplating", John Wiley, 2002
8. Jacek Lipkowski and Phil N. Ross, "Electrocatalysis", John Wiley & Sons, 1998
9. Thomas Reddy, "Linden's Handbook of Batteries" 4th Edition, McGraw-Hill, 2010

17CH3022 MOLECULAR AND MATERIALS SELF-ASSEMBLY

Credits: 3:0:0

Course Objectives:

Enable the student to

- Learn the different types of assembly of nanomaterials
- know the bottom-up approach in nanotechnology based on self-assembly.
- Classify the molecular and materials self-assembly on the basis of the driving force needed for them to form.

Course Outcomes:

Students will be able to

- understand the formation of self-assembly in nanomaterials
- describe the process of bottom-up approach based on self-assembly
- give examples of nanocluster self-assembly
- design self-assembled monolayers through different approaches
- understand the fundamental principles of self-assembling block co-polymers
- relate significant self-assembled properties to structure

Unit I - Fundamentals of Self-Assembly and Self-Assembled Monolayers: Self-assembly: definition – Molecular vs. materials self-assembly – Hierarchical self-assembly – Forms, patterns and functions – Self-assembled monolayers (SAMs) – Soft lithography – Microlens arrays – Transfer printing – Electrically contacting SAMs – SAM crystal engineering - Switching SAM function – Chemical reactions on SAMs – Applications of SAMs.

Unit II - Layer-By-Layer Self Assembly: Electrostatic superlattices – Organic polyelectrolyte multilayers – Assembling metallo-polymers – Polyelectrolyte-Colloid multilayers – Graded composition LbL films – LbL MEMS – Crystal engineering of oriented zeolite film – Zeolite-ordered multi-crystal arrays – Cross-linked crystal arrays – Patterned multilayers – Non-electrostatic LbL assembly – LbL self-limiting reactions.

Unit III - Nanorod, Nanowire Self-Assembly: Templating nanowires – Modulated diameter gold nanorods – Self-assembling nanorods – Magnetic nanorods – Magnetic nanorods and nanoclusters – Hierarchically ordered nanorods – Nanorod devices – Nanotubes from nanoporous templates – VLS synthesis of nanowires – Nanowire quantum size effects – Manipulating nanowires – Crossed semiconductor nanowire smallest LCD – Nanowire sensors.

Unit IV - Nanocluster Self-Assembly: Definitions for nanocrystal, nanoparticle, and nanocluster – Synthesis of capped semiconductor nanoclusters – Electrons and holes in nanocluster boxes – Nanocrystal semiconductor alloys – Nanocluster phase transition – Capped gold nanoclusters– Alkanethiolate capped nanocluster diagnostics – Water soluble nanoclusters – Alkanethiolate capped silver nanoclusters superlattice – Core-shell magnetic nanoclusters – Nanocluster- Polymer nanocomposites.

Unit V - Self-Assembling Block Copolymers: Block copolymer self-assembly – Nanostructured ceramics – Block copolymer thin films – Electrical ordering – Spatial confinement of block copolymers – Block copolymer

lithography – Decorating block copolymers – Nanowires from block copolymers – Making micelles – Harnessing rigid rods – Block co-polypeptides – Block copolymer bio-factories.

Reference Books:

1. G. A. Ozin and A. C. Arsenault, “Nanotechnology: A chemical Approach to nanomaterials” RSC Publishing, 2005
2. Zhong Cao G, “Nanostructures and Nanomaterials: Synthesis, Properties and Applications”, Imperial College Press, London, United Kingdom, 2004.
3. Nanotechnology, G.B. Sergeyev, Elsevier, 2007.
4. Core Concepts on supramolecular chemistry and nanotechnology, Jonathan Steed, Wiley Eastern Publishers, 2006
5. Nano: The essentials, T. Pradeep, McGraw Hill Publishers, 2007.
6. Supramolecular chemistry –Fundamentals and applications advanced textbook, Katsuhiko Ariga · ToyokiKunitake, Springer-Verlag, 2000.
7. D. Vollatah,,Nanomaterials: An Introduction to Synthesis, Properties and Applications, springer, 2011.

17CH3023 – POLYMER CHEMISTRY

Credits: 3:0:0

Course Objectives:

Enable the student to

- know the classification and mechanism of polymer formation
- Understand the characterisation techniques used in polymer chemistry
- know concepts of polymer nanocomposites.

Course Outcomes:

Students will be able to

- acquire the basic knowledge about polymers
- choose the methods for characterizing the polymer
- understand the thermal and mechanical properties of various polymers
- develop various fabrication techniques
- understand the filler-matrix interaction
- recognize the importance and applications of nanofillers

Unit I - Basic concepts of polymers – classification of polymers - ladder, star comb - polymers tacticity – interpenetrating network - structure property relationships – naturally occurring polymers – polysaccharides – cellulose and proteins – polymerization reactions – classifications – polymer resins – polymer solutions – reaction of polymers – introduction of new groups – cross linking, isomerisation, cyclisation and degradation reactions- Bio polymers – introduction.

Unit II - Principles and mechanisms of polymerization – addition, step growth polymerization and coordination polymerization (Zeigler-Natta)- reactivity of functional groups – Carothers equation – Kinetics – characteristics of step growth polymerization – examples – mechanisms, choice of polymers, effect of inhibitors or retarders – copolymerization - monomer reactivity – ratio, composition, types, the Q-e scheme.

Unit III - Molecular weight determination methods – polymer stereochemistry – amorphous, crystalline and crystallites – viscous flow – viscosity – thermal behaviour of polymers – T_g , T_m and their relationship – elastic effect of polymers

Unit IV - Polymerization process – bulk, solution, emulsion and suspension – industrially important polymers and their processes – polyethylene – polystyrene – Nylon 6,6 – PET – Natural Rubber – Compounding of plastics – additives added and their significance – Moulding processes – injection, compression, blow moulding

Unit V - Introduction to – conducting polymers and composites, applications in sensors, batteries – conventional composites – filler-matrix interaction, continuous (or long) and short fibre reinforced composites, laminates – introduction to polymer nanocomposites – clay, CNT, particle filled – Advantages and limitations of nanofillers – Surface treatment on nanofillers – Applications of polymer nanocomposites – packaging, automotive, mechanical components

Reference Books:

1. V.R. Gowariker, N.V. Viswanathan, N.V. Jayadev Sreedhar, "Polymer Science", I edition, New Age International Publishers Pvt. Ltd., New Delhi, 2008.
2. G.S. Misra, "Introductory Polymer chemistry", New Age International Pvt. Ltd., 2008
3. Anil Kumar and Rakesh K. Gupta, "Fundamentals of polymer engineering" Tata McGraw Hill Publication Ltd., New Delhi, 2003 (revised and expanded edition)
4. R.J. Young, P.A. Lovell, "Introduction to polymers" Stanley Thomas Publishers, London, 2000
5. P. Bahadur, "Principles of polymer science", Alpha Science International Ltd., 2nd Edition, 2005.
6. G. Odian, "Principles of Polymerisation", IV Edition, Wiley Student Edition, New Delhi, 2007.
7. M.G. Arora, M. Singh and M.S. Yadav, "Polymer Chemistry" II revised Edition, Anmol Publications Pvt. Ltd., 2003

14CH3024 ANALYTICAL CHEMISTRY**Credits: 3:0:0****Course Objectives:**

Enable the student to

- Learn the importance of various analytical techniques used in chemistry
- Understand the principles of different chromatographic separation techniques
- Know the principles and applications of spectroscopic techniques and thermal methods

Course Outcomes:

Students will be able to

- Distinguish between different chromatographic techniques
- Select appropriate technique for analysis
- Plan the analysis of any prepared compound
- Utilize the proper spectroscopic technique for the characterization
- Interpret the spectra obtained from various techniques
- Apply the thermal methods and X-ray diffraction methods

UNIT I – CHROMATOGRAPHY: Theory, instrumentation, basic principles and applications of the following – Column, thin layer, and ion-exchange chromatography – HPLC - applications in chemical analysis – Gas chromatography

UNIT – II - INFRARED SPECTROSCOPY: Introduction to electromagnetic radiation- Regions of the spectrum, characterisation of electromagnetic radiation - The vibrating diatomic molecule – Selection rule - The simple harmonic oscillator - Vibrations of polyatomic molecules – Fundamental vibrations and overtones - Instrumentation –Sampling techniques - Factors influencing vibrational frequencies - Application to organic and inorganic compounds - Finger print region - Identification of functional groups - Simple problems in functional group identification using IR spectrum.

UNIT III - ELECTRONIC SPECTRA: Electronic spectra of diatomic molecules – physical principles – laws of absorption – absorption transitions – chromophores and auxochromes – effects of conjugation – Woodward-Fieser rules for α,β -unsaturated carbonyl compounds and dienes – aromatic systems with extended conjugation – application to organic and inorganic compounds – instrumentation.

UNIT IV - NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY

Theory- Nuclear spin- Interaction between spin and magnetic field - Population of energy levels - Larmor precession frequency - Relaxation processes – Instrumentation – Continuous wave and FT NMR - Proton NMR - Chemical shifts and its measurement – Reference compound – Factors affecting Chemical Shifts – Solvents used in NMR –Spin-spin coupling – Theory - Magnitude and factors affecting coupling constant - Long Range coupling – Second order spectra – AX, AMX, and ABX systems- Simplification of complex spectra - Applications of ^1H NMR to determine the structure of simple organic compounds - Introduction to Two Dimensional NMR (^1H - ^1H COSY) spectroscopy.

Unit V: Thermal Methods of Analysis and X-ray Diffraction method: Thermal Characterization techniques Principle and applications of Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) Thermometric titration - Theory – Instrumentation – Factors affecting TG, DTA and DSC Curves – Applications - - X-ray diffraction Methods – Instrumentation — Diffraction pattern – Structure factor – Reliability factor - Applications

Reference Books:

1. Chatwal G. R & Anand S. K, "Instrumental Methods of Chemical Analysis", Himalaya Publishing House, Mumbai, India, 5th Edition, Reprint 2011.
2. Kalsi P. S, "Spectroscopy of Organic Compounds", New Age International Publishers, New Delhi, 6th Edition, 2004.
3. Skoog D. A, West D. M, Holler F. J & Crouch S. R, "Fundamentals of Analytical Chemistry", Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.
4. Srivatsava A. K. & Jain P. C, "Chemical Analysis", S. Chand Publications, New Delhi, 3rd edition, 1997.
5. Willard H, Merrit L, Dean J. A. & Settle F.A., "Instrumental methods of chemical analysis", CBS Publishers and Distributors Pvt. Ltd, New Delhi, 7th edition, 1986.
6. Valcarcel, Miguel, Principles of Analytical Chemistry, Springer, 2000.
7. G. Sharma, B K Chaturvedi, Richard E. Wolfe, Basic Analytical Chemistry, DK publishers, 2011

17CH3025 MEDICINAL CHEMISTRY**Credits: 3:0:0****Course Objectives:**

Enable the student to

- equip with a thorough understanding of different aspects of pharmaceutical chemistry
- learn about the enzyme kinetics
- understand the various steps and procedures in the drug design

Course Outcomes:

Students will be able to

- understand and apply the design and synthetic approaches used in pharmaceutical chemistry
- recognize the importance of enzyme kinetics
- identify the factors affecting the solubility of the drugs
- know the process of pharmacokinetics
- understand the importance of clinical trials
- design some small organic drug molecules

Unit I - Basics of medicinal chemistry: Brief history of medicinal chemistry – classification of drugs – brief description of biological, chemical, computer revolutions in drug design – pro drugs and soft drugs – design of pro drug system – multiple pro drug formation – soft drug principle and applications

Unit II - Drug targets and drug solubility: Enzymes and enzyme inhibitors – competitive and non-competitive inhibitors – reversible and irreversible inhibitors – ligand-receptor theories – Clark's theory and Paton's rate theory – proteins, lipids, and nucleic acids as drug targets – effect of pH, pK_a, and polarity on drug solubility

Unit III - Pharmacokinetics and drug metabolism Natural resources of lead compounds – absorption, distribution, metabolism, and elimination – oxidation and hydrolysis – testing drugs in vitro – high-throughput screening – testing drugs in vivo – therapeutic index and therapeutic ratio

Unit IV - Various phases in preclinical testing and clinical trials – designing organic synthesis – convergent synthesis – patenting and manufacture – complexes and chelating agents – metal clusters – detoxification – drug action and metal chelation

Unit V - Development of new drugs: Five classic steps in the design of a new drug – procedures in drug design – isolation of bioactive compounds – accidental discovery – examination of metabolites – interference with fundamental life processes – exploitation of side effects of drugs - random screening – synthesis of drugs ab initio – molecular modification of lead compounds – factors affecting drug development

Reference Books:

1. Ashutosh Kar, "Medicinal Chemistry" New Age International Publishers, 5th Revised and Expanded edition, 2010.
2. Richard B. Silverman, "The Organic Chemistry of Drug Design and Drug Action", 2nd Edition, Academic Press, Reprinted, 2010.
3. Rama Rao Nandella, "Principles of Organic Medicinal Chemistry" New Age International Publishers, New Delhi, Reprint, 2008.
4. Gareth Thomas "Fundamentals of Medicinal Chemistry", London, Reprint, 2003.

- David A. Williams, William O. Foye, Thomas L. Lemke, Lippincott Williams & Wilkins, Foye's Principles of Medicinal Chemistry, Philadelphia, 5th edition, 2002.
- Donald J. Abraham, David P. Rotella, "Burger's Medicinal Chemistry, Drug Discovery and Development, 8 Volume Set, John Wiley & Sons Ltd., 7th Edition, 2003.
- Graham L. Patrick, "An introduction to Medicinal Chemistry", Oxford university Press, 1995.

17CH3026 SUPRAMOLECULAR CHEMISTRY

Credits: 3:0:0

Course Objectives:

Enable the student to

- Learn the structural and functional basics of building blocks of supramolecular structures
- Know driving forces of supramolecular structure formation
- Classify the supramolecules based on structure and the chemistry behind host-guest assembly.

Course Outcomes:

Students will be able to

- understand the selectivity in supramolecule formation
- identify the various factors affecting the formation of supramolecules
- understand the concepts of solution host-guest chemistry
- design the various types of supramolecular architectures
- recognize the importance of coordination polymers
- apply the supramolecules in various fields

Unit I - INTRODUCTION TO SUPRAMOLECULAR CHEMISTRY: Introduction to supramolecular chemistry – Selectivity – Lock and key principle and induced fit model – complementarity – Co-operativity and chelate effect – Pre-organization – Binding constants – Kinetic and thermodynamic selectivity – Optically active supra-molecules – Self-assembly of intrinsically chiral molecular capsules.

Unit II - SOLUTION HOST–GUEST CHEMISTRY: Introduction: guests in solution – Macrocyclic vs. acyclic hosts – High-dilution synthesis – Template synthesis – Cation binding – Crown ethers and cryptands – Spherands – Heterocrowns – Biological ligands: ion channels – Anion binding – Charged receptors – Neutral receptors – Lewis acid receptors – Neutral molecule binding – Calixarenes, cyclodextrins and dendrimers as catalysts.

Unit III - SUPRAMOLECULAR STRUCTURES: Ladders, polygons, and helices – Self-assembly using metal templates – Racks, ladders, and grids – Helicates – Molecular polygons – Rotaxanes, catenanes, and knots – Topological connectivity – Rotaxanes and catenanes as molecular devices – Borromean rings – Knots (structure and function of the above species).

Unit IV - SOLID STATE SUPRAMOLECULAR CHEMISTRY: Introduction – Zeolites: structure – Zeolite composition – Zeolites and catalysis – Clathrates – Urea/thiourea clathrates – Trimesic acid clathrates – Hydroquinone and Dianin's compound – Clathrate hydrates (structure and function of the above species) –Uses.

Unit V - SELF-ASSEMBLING CAPSULES: Self-assembling capsules – Molecular containers – Metal directed capsules – Hydrogen bonded capsules – Concepts in crystal engineering – The Cambridge structural database - Crystal engineering with hydrogen bonds – Pi interactions - Solid state reactivity – Metal-organic frameworks – Guest properties of metal-organic frameworks.

Reference Books:

- Jonathan Steed, David Turner, Carl Wallace, Core concepts in Supramolecular Chemistry and nanochemistry, John Wiley & sons, 2007.
- Jean-Marie Lehn, Supramolecular Chemistry, RCS pubs., 2005
- Supramolecular chemistry –Fundamentals and applications advanced textbook, Katsuhiko Ariga · Toyoki Kunitake, Springer-Verlag, 2000.
- Nano: The essentials, T. Pradeep, McGraw Hill Publishers, 2007.
- Nanochemistry, G.B. Sergeev, Elsevier, 2007.
- G. A. Ozin and A. C. Arsenault, "Nanochemistry: A chemical Approach to nanomaterials" RSC Publishing, 2005
- Zhong Cao G, "Nanostructures and Nanomaterials: Synthesis, Properties and Applications", Imperial College Press, London, United Kingdom, 2004.
- Paul Engel, "Pain-free Biochemistry", Wiley – Blackwell publishers, 2009.

LIST OF COURSES

Sl. No	Course Code	Name of The Course	Credits
1	16CH1001	Applied Chemistry	3:0:0
2	16CH1002	Applied Chemistry for Engineers	3:0:1
3	16CH2001	Chemical Bonding and Concepts of Acids and Bases	3:0:0
4	16CH2002	Organic Reaction Intermediates and Stereochemistry	3:0:0
5	16CH2003	Atomic Structure, Thermodynamics and Electrochemistry	3:0:0
6	16CH2004	Chemistry of Transition and Inner-transition Elements	3:0:0
7	16CH2005	Reaction Mechanism and Heterocyclic Chemistry	3:0:0
8	16CH2006	Surface Chemistry and Chemical Kinetics	3:0:0
9	16CH3001	Research Methodology	3:0:0
10	16CH3002	Molecular and Material Self Assembly	3:0:0

16CH1001 APPLIED CHEMISTRY

Credits: 3:0:0

Course Objectives

To impart knowledge on

- Understanding the problems associated with hard water and treatment methods.
- Thermodynamic concepts and energy resources
- The importance of corrosion control methods
- Polymers and types and applications of Materials

Course Outcomes

The students will be able to

- Get a compendium of applicable knowledge on Chemistry
- Understand the Hard Water Treatment methods
- Apply the knowledge of thermodynamics and Electrochemistry concepts
- Utilize the knowledge of advanced materials

Course Description:

Hard Water – Estimation and softening methods – Desalination and Municipal water treatment methods – Chemical Thermodynamics - Definitions – Thermodynamic processes – Laws of thermodynamics – Relation between C_v and C_p – Gibbs-Helmholtz equation – Electrochemistry – Nernst equation – Electrochemical cells – Batteries and fuel cells – Electrochemical sensors - Corrosion – Polymers – Synthetic and Natural – Properties and applications – Moulding constituents – Fabrication –Advanced materials –Nanomaterials – Types - Applications – Photo voltaic cells – Design and working.

Reference Books

1. B.R. Puri, L.R. Sharma, M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing Company, 2008.
2. Engineering Chemistry – A Text book of Chemistry for Engineers Wiley India Pvt. Ltd, 2012.
3. Jain P. C, Monica Jain, A Textbook of Engineering Chemistry, Dhanpat Rai Publications, New Delhi, 16th edition, 2008.
4. M.A. Shah, Principles of Nanoscience and Nanotechnology, Narosa Publishing House, New Delhi, 2011.

5. Peter Atkins; Julio de Paula, Physical Chemistry, 9th Edition Oxford University Press, New York, 2009

16CH1002 APPLIED CHEMISTRY FOR ENGINEERS

Credits: 3:0:1

Objectives

The course aims to impart knowledge on

- Various types of bonding interactions
- Water Purification Processes
- Role of polymer in engineering applications
- Effect of additives in food and Health
- Need for alternative energy and nanochemistry

Outcome

At the end of the course, the student will learn

- About the chemistry of factors affecting the quality of water, food and health
- The importance of polymers in various fields and corrosion control methods
- About the significance of clean energy and nanochemistry

Chemical bonding and interactions – Relative energy – Requirement of water treatment – Parameters – Process - Surfactants - Micelle formation – Classification of Polymers - Industrial and ecofriendly Polymers – Chemistry of Food and for better health - Free radicals - Molecules of emotions – Electrode potential – Batteries and Supercapacitors - Fuel cells – Corrosion - Prevention of Corrosion - Peaceful uses of Chemistry – Weapons of destruction – Nanochemistry – Evolution - Top down and bottom up approaches – Classification - Applications – Nanopollution

References

1. Jain P. C, Monica Jain, A Text Book of Engineering Chemistry, Dhanpat Rai Publications, New Delhi, 16th Edition, 2008.
2. M.A. Shah and T.Ahmed, “Principles of Nanoscience and Nanotechnology” , Narosa Publishing House, New Delhi, 2010.
3. Grace Ross Lewis, “1001 Chemicals in Everyday Products”, John Wiley and Sons, 3rd Edition, 2001.

Experiments (Any Ten Experiments)

1. Determination of Hardness in water
2. Determination of dissolved oxygen in water
3. Estimation of Alkalinity in water
4. Estimation of iron in water by spectrophotometry
5. pH based experiment by pH Meter
6. pH based experiment using conductivity bridge
7. Softening of water by ion exchange method
8. Estimation of Iodine in iodized salt
9. Estimation of Calcium in milk powder
10. Synthesis of Aspirin
11. Analysis of Milk Adulteration
12. Analysis of oil
13. Calorie measurement
14. Estimation of Fe²⁺ by potentiometry
15. Estimation of copper in alloy
16. Synthesis of nanoparticles

16CH2001 CHEMICAL BONDING AND CONCEPTS OF ACIDS AND BASES

Credits : 3:0:0

Course Objectives:

- To impart knowledge about various kinds of bonding in inorganic chemistry.
- To impart the concepts of acids and bases

Course outcomes:

The Students will

- Understand the basics of bonding interactions
- Have a clear understanding of acid base theory.

Course Description:

Types of Bonds – Ionic bond – Radius ratio – Ionic compounds of type AX, AX₂ – Defects - Born Haber cycle – Covalent bond- Lewis theory -VSEPR Theory-VB theory – σ and π bonds - MO theory- LCAO method – Diatomic molecules- Hydrogen Bond and other weak interactions - Applications - Acids and Bases - Bronsted Lowry and Lewis theory - Hard and Soft acids and bases - Allotropy of Carbon- Silicates – Silicones - Applications.

Reference Books:

1. Lee J. D, "Concise Inorganic Chemistry", Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Shriver and Atkins, " Inorganic Chemistry", Oxford University Press, New Delhi, India, 4th edition, 2009.
3. Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
4. W. H. Madan, G. D. Tuli, R. D.Madan, "Selected Topics in Inorganic Chemistry", S. Chand & Company Ltd, Reprint 2009.

16CH2002 ORGANIC REACTION INTERMEDIATES AND STEREOCHEMISTRY

Credits: 3:0:0

Objective:

- To impart basic understanding about reaction intermediates
- To illustrate the concepts of electronic effects
- To highlight the importance of stereoisomerism and conformation

Outcome:

The students will get

- The understanding on the structural basics of organic compounds and their reactions
- Knowledge on the reactions of carbonyl and nitrogen containing compounds

Course Description:

Classification and Nomenclature of organic compounds – Electrophiles and nucleophiles – Carbocation and Carbanion, Free radicals, Arynes - Inductive effect and field effect – Hyperconjugation – Tautomerism – Aliphatic and Aromatic nitrogen containing compounds – Aliphatic and Aromatic carbonyl compounds - Stereoisomerism – Cis-trans isomerism – E, Z nomenclature – Optical isomerism – Absolute configuration – R, S nomenclature – Cahn, Ingold, Prelog nomenclature – Conformation of ethane and cyclohexanes

Reference Books:

1. Michael B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 7th edn., Wiley Student Edition, John Wiley & Sons Asia Pvt. Ltd., March 2013.
2. R.T. Morrison & R.N. Boyd, Organic Chemistry, 6th Edition, Pearson Education Pvt Ltd., Singapore, 2003
3. P.S. Kalsi, Stereo Chemistry Conformation and Mechanism, New Age Publishing Ltd., New Delhi, 2002.
4. Bhupinder Mehta, Manju Mehta, Organic Chemistry, Prentice Hall of India private ltd., New Delhi, 2008.
5. I.L. Finar, Organic Chemistry, Pearson Education Pvt. Ltd., Vol. I & II, 6th Edition, Singapore, 2002
6. F. A. Carey & R. J. Sundberg. Advanced Organic Chemistry, Part A and B, Springer; 5th edition (May 27, 2008)

16CH2003 ATOMIC STRUCTURE, THERMODYNAMICS AND ELECTROCHEMISTRY**Credits: 3:0:0****Objective:**

To illustrate

- The basics of Quantum Chemistry
- The principles of chemical thermodynamics and electrochemistry
- The importance of Phase Rule

Outcome:

The student will be able to

- Understand the importance of Quantum Chemistry
- Know the importance of Thermodynamics and Electrochemistry
- Understand the significance of Phase rule

Course Description:

Atomic Structure — Quantum Theory of Radiation – Photoelectric effect – Bohr Theory – Dual Character of Electron – Heisenberg Uncertainty Principle – Quantum Mechanics – Postulates - Schrodinger equation – Quantum Number - First Law of Thermodynamics – Heat Capacity – Second Law – Entropy - Chemical Equilibrium – The Vant Hoff reaction isotherm – LeChatlier Principle – Electrochemistry – Specific, Equivalent and Molar Conductances – Kohlraush Law – Applications – Electrode Potential – Nernst Equation – Applications -Phase Rule – Gibbs Phase Rule –One component Systems - Triple point

Reference Books:

1. B.R. Puri, L.R. Sharma and Madan S. Pathania, "Principles of Physical Chemistry", Vishal Publishing Co., Jalandhar, 2008
2. Peter Atkins, "Elements of Physical Chemistry", OUP Oxford, 6th edition, 2012
3. Samuel H. Maron and Carl F. Prutton, "Principles of Physical Chemistry", fourth edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, reprinted in 2009
4. Un Dash, Op Dharmarha and P.L. Soni, "Text book of Physical Chemistry", Sultan Chand & Sons, New Delhi, 2011
5. A.K Chandra, "Introduction to Quantum Chemistry", Tata McGraw Hill, New Delhi, 1997 (recent edition)
6. J. C. Kuriacose and J.Rajaram, "Thermodynamics for students of chemistry", 3rd Edition, Shoban Lal Nagin Chand & Co., Jalandhar, 1999 (recent edition)
7. Samuel Glasstone, "An introduction to electrochemistry" Atlantic Publishers, 2007

16CH2004 CHEMISTRY OF TRANSITION AND INNER-TRANSITION ELEMENTS

Credits:3:0:0

Course Objectives:

- To impart knowledge about transition metal inorganic chemistry.
- To explain the various theories of coordination chemistry.
- To illustrate the importance of f-block elements and their applications

Course outcomes:

The students will

- Know the properties of transition metal compounds.
- Understand the theory behind the formation of coordination complexes
- Know the importance of inner transition elements

Course Description:

Transition metals –Color and magnetic properties - Coordination compounds – Nomenclature – Ligands - Isomerism – Werner's theory – Shapes of d orbitals – Valence bond Theory – Crystal Field theory – Coordination Geometries - Effect of crystal field splitting - Jahn-Teller distortion – Charge Transfer Transition – Stability - Chelate and macrocyclic Effects- Organometallic Chemistry - Ferrocene - Catalysts– Zeigler Natta Catalyst – Inner transition elements - Electronic and Magnetic properties - Lanthanide contraction

Reference Books:

1. Lee J. D, "Concise Inorganic Chemistry", Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Shriver and Atkins, "Inorganic Chemistry", Oxford University Press, New Delhi, India, 4th edition, 2009.
3. Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
4. W. H. Madan, G. D. Tuli, R. D.Madan, "Selected Topics in Inorganic Chemistry", S. Chand & Company Ltd, Reprint 2009.

16CH2005 – REACTION MECHANISM AND HETEROCYCLIC CHEMISTRY

Credits: 3:0:0

Objective:

- To discuss various types of reaction mechanisms
- To introduce the chemistry of heterocyclic compounds

Outcome:

- Get a thorough knowledge on organic reaction mechanisms
- Get knowledge on the preparation and properties of heterocycles

Course Description:

Substitution reactions – Aliphatic nucleophilic - S_N1 and S_N2 mechanisms – Aromatic nucleophilic - S_NAr mechanism – Benzyne mechanism – Aliphatic Electrophilic - S_E1 and S_E2 mechanisms – Aromatic Electrophilic - Arenium ion mechanism – Neighboring group participation - Hammett equation - Elimination reactions – E_1 , E_2 mechanisms - Addition reactions – Heterocyclic Chemistry – One hetero atom - Pyrrole, Furan, Thiophene – Two hetero atom – Pyrazole, Imidazole, Thiazole – Reactions and properties.

Reference Books:

1. Michael B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 7th edn., Wiley Student Edition, John Wiley & Sons Asia Pvt. Ltd., March 2013.
2. F. A. Carey & R. J. Sundberg, Advanced Organic Chemistry, Part A and B, 5th edition (May 27, 2008)
3. R.T.Morrison & R.N.Boyd, Organic Chemistry, 6th Edition, Pearson Education Pvt Ltd., Singapore, 2003
4. S. H. Pine, Organic Chemistry, 5th edn., McGraw-Hill, 1987
5. Raj.K. Bansal, "Heterocyclic Chemistry", New Age International Publishers, 4th Edition, Reprint, 2009.

16CH2006 SURFACE CHEMISTRY AND CHEMICAL KINETICS**Credits: 3:0:0****Objective:**

- To illustrate the fundamental properties of liquid state and liquid crystals
- To impart the knowledge on the principles of colloidal state and surface chemistry
- To demonstrate the significance of kinetics and Catalysis

Outcome:

The students will understand

- The basics of Liquid state and Liquid Crystals
- The importance of Colloidal substances and surface chemistry and their applications
- The importance of Kinetics and Catalysis

Course Description:

Liquid State – Properties – Surface Tension – Surface Energy – Liquid Crystals – Thermotropic and Lyotropic – Vapor Pressure – Temperature Diagram – Colloidal State – Types and Properties – Sols - Electrophoresis – Electro-osmosis – Emulsion – Gels – Surfactants – Micelles – Adsorption – Types – Langmuir, Freundlich and BET Isotherms – Techniques for Investigating Surfaces – Elementary Treatment – Kinetics – Order and Molecularity – First and Second Order Reactions – Arrhenius Equation – Catalysis – General Characteristics – Types – Enzyme Catalysis

Reference Books:

1. B.R. Puri, L.R. Sharma and Madan S. Pathania, "Principles of Physical Chemistry", Vishal Publishing Co., Jalandhar, 2008
2. Peter Atkins, "Elements of Physical Chemistry", OUP Oxford, 6th edition, 2012
3. Samuel H. Maron and Carl F. Prutton, "Principles of Physical Chemistry", fourth edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 1965 (reprinted in 2009)
4. I.N. Levine, "Physical Chemistry", 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007
5. Un Dash, Op Dharmarha and P.L. Soni, "Text book of Physical Chemistry", Sultan Chand & Sons, New Delhi, 2011
6. K.J. Laidler, "Chemical Kinetics", 3rd Edition 1997, Benjamin-Cummings. Indian reprint – Pearson, 2009
7. A.W. Adamson, "Physical Chemistry of Surfaces", 5th edition, Wiley, 1997 (recent edition)

16CH3001 RESEARCH METHODOLOGY

Credits: 3:0:0

Course Objective:

- To equip the students to undertake thorough literature survey
- To impart knowledge on scientific writing and scientific communication.
- To create an awareness about the good lab practices and scientific ethics.

Course Outcome:

The student will be able to

- Understand the principle of literature survey
- Prepare scientific reports
- Follow good lab practices and scientific ethics

Course Description:

Literature survey – Chemical abstracts – Dictionary of compounds – Chemical databases – Chemoinformatics and Data mining -Hand books – Lab data management – Documentation – Scientific honesty – Scientific ethics - Journals and other form of publications – Impact Factor and Citation Index – Report writing and preparation of thesis – Technical writing – Article writing – Scientific communication - IPR - Good Lab Practices - Chemical Lab safety – Storage, handling and disposal of hazardous chemicals and radioactive materials – MSDS – Safety measures during emergency – Encountering accidents

Reference Books

1. C. R. Kothari, Research Methodology: Methods & Techniques, New Age International Publishers, 3rd Edition, 2013
2. R. Panneerselvam, Research Methodology, PHI learning Pvt. LTD, 2014
3. J. R. Dean, A.M. Jones, D. Holmes, R. Reed, J. Weyers and A Jones, Practical Skills in Chemistry, 2nd Edition Prentice Hall, 2011.
4. F Abdul Rahim Thesis writing: Manual For all Researchers, New Age International 2007
5. Margret Cargill, Patrick O'Connor Writing Scientific Research Articles: Strategy and Steps, Wiley 2009.
6. Benjamin, Hazardous Waste Management: Reducing the Risk, Goldman Press 2013
7. A. Keith Furr, CRC Handbook of Laboratory Safety, 5th Edition, CRC Press 2000 b
8. Andre Picot, P. Grenouillet. Safety in the Chemistry and Biochemistry Laboratory, Wiley-VCH, 1995.
9. Dr. Kristin Shrader-Frechette, Ethics of Scientific Research, Rowman & Littlefield Publishers, 1994

16CH3002 MOLECULAR AND MATERIALS SELF ASSEMBLY

Credits: 3:0:0

Objective:

- To explain the formation of self assembly in nanomaterials
- To distinguish molecular and materials self-assembly

Outcome:

- Able to understand the forces behind the formation of self assembly in nanomaterials
- Have the knowledge on the bottom-up approach based on self assembly

Course Description:

Self-assembly – Molecular vs Material Self Assembly – Hierarchical Assembly – Directing Self Assembly - Self-assembled monolayers – Soft lithography – SAM Registration - Layer-by-layer (LbL)

self assembly – Electrostatic Superlattices – Organic Polyelectrolyte Multilayers – LbL MEMS, LbL films, LbL assembly- Non-Electrostatic Layer by Layer Assembly - Nanorod, Nanotube, Nanowire self-assembly - Nanocluster self-assembly - Self-assembling block copolymers

References:

1. G. A. Ozin and A. C. Arsenault, “Nanotechnology: A chemical Approach to nanomaterials” RSC Publishing, 2005
2. Zhong Cao G, “Nanostructures and Nanomaterials: Synthesis, Properties and Applications”, Imperial College Press, London, United Kingdom, 2004.
3. Nanotechnology, G.B. Sergeyev, Elsevier, 2007.
4. Core Concepts on supramolecular chemistry and nanotechnology, Jonathan Steed, Wiley Eastern Publishers, 2006
5. Nano: The essentials, T. Pradeep, McGraw Hill Publishers, 2007.
6. Supramolecular chemistry –Fundamentals and applications advanced textbook, Katsuhiko Ariga · Toyoki Kunitake, Springer-Verlag, 2000.
7. D. Vollath, Nanomaterials: An Introduction to Synthesis, Properties and Applications, Springer, 2011.

LIST OF SUBJECTS

Sub Code	Name of the Subject	Credits
15CH2001	Polymer Science and Technology in Medicine	3:0:0
15CH2002	Bio-Ceramic Materials in Medicine	3:0:0
15CH2003	Chemistry in Everyday Life	3:0:0
15CH3001	Chemical Kinetics and Photochemistry	3:1:0
15CH3002	Chemical Bonding and Nuclear Chemistry	3:0:0
15CH3003	Organic Reaction Mechanism and Stereochemistry	3:1:0
15CH3004	Quantum Chemistry and Group Theory	3:1:0
15CH3005	Coordination Chemistry	3:1:0
15CH3006	Molecular Spectroscopy	3:0:0
15CH3007	Chemical Thermodynamics and Electrochemistry	3:0:0
15CH3008	Organometallic, Bioinorganic and Solid State Chemistry	3:1:0
15CH3009	Synthetic Methodology and Natural Products	3:0:0
15CH3010	Qualitative and Quantitative Inorganic Analysis Lab	0:0:4
15CH3011	Qualitative and Quantitative Organic Analysis Lab	0:0:4
15CH3012	Physical Chemistry Lab	0:0:4
15CH3013	Modern Instrumental Analysis Lab	0:0:2
15CH3014	Preparative Inorganic Chemistry Lab	0:0:2
15CH3015	Synthetic Organic Chemistry Lab	0:0:2
15CH3016	Instrumental Methods of Analysis	3:0:0
15CH3017	Main Group Chemistry	3:0:0
15CH3018	Synthetic Reagents and Concerted Reactions	3:0:0
15CH3019	Spectroscopic Methods for Structural Elucidation	3:0:0
15CH3020	Supramolecular Chemistry and Green Chemistry	3:0:0
15CH3021	Applied Electrochemistry	3:0:0
15CH3022	Materials Chemistry	3:0:0
15CH3023	Biomolecular Chemistry	3:0:0
15CH3024	Organotransition Metal Chemistry	3:0:0
15CH3025	Cheminformatics	3:0:0
15CH3026	Environmental Electrochemistry	3:0:0
15CH3027	Molecular Machines and Materials	3:0:0
15CH3028	Self Organization and Self-assembly in Nanostructures	3:0:0

15CH2001 POLYMER SCIENCE AND TECHNOLOGY IN MEDICINE

Credits: 3:0:0

Course Objective

- To enlighten the basic understanding of polymers and composites
- To impart knowledge on processing and the fabrication of polymeric materials
- To acquire knowledge on the bio-medical applications of polymers and its composites

Course Outcome

- Students would be familiar with the fundamental concepts and technology of polymer
- They would also acquire the knowledge on polymeric nano-composites
- They would be able to formulate and develop the polymer composite materials for bio-medical applications

Course Description:

Basic concepts of polymer – selection of monomers - classification and structure property relationship of polymers - polymer solutions - Principles of polymerization – polymerization techniques – Polymer characterization – microstructure, thermal and elastic behavior -Compounding and fabrication of polymer – polymer testing – Polymer composites and its types – filler matrix interaction in conventional composites – Introduction and applications of polymer nano-composites - Various types of polymeric materials - biodegradable polymers, biomedical polymers, conducting polymers - Limitations of polymeric materials

Reference Books :

1. V R Gowariker, N V Viswanathan and Jayadev Sreedhar, Polymer Science, New Age International Publishers, New Delhi 2008.
2. Arie Ram, Fundamentals of Polymer Engineering (Kindle Edition) Springer 1997.
3. K. Holmberg, B. Jonsson, B. Kronberg, B. Lindman, Surfactants and Polymers in Aqueous Solution Wiley 2004.
4. John D. Wright, Nico A.J.M. Sommerdijk Sol-Gel Materials: Chemistry and Applications CRC 2000
5. Takashi Kato Liquid Crystalline Functional Assemblies and Their Supramolecular Structures Structure and Bonding, Springer 2008
6. Lyklema J, Fundamentals of Interface and Colloid Science –Academic Press, Vol- 4 Academic press 2005
7. Martin Prutton Introduction to Surface Physics –, Oxford University Press (1994).
8. KiichiTakemoto, Raphael M. Ottenbrite, and MikiharuKamachi Functional Monomers and Polymers, Second Edition ,CRC 1997.
9. George Odian Principles of Polymerization Wiley-Interscience; 4 edition 2004 .
10. J. Kahovec .I.meisel ,C.S.Kniep Polymers in Medicine Wiley VCH 2001

15CH2002 BIO-CERAMIC MATERIALS IN MEDICINE

Credits: 3:0:0

Course Objectives :

- To teach the fundamentals of various bio-materials
- To impart knowledge on processing and application of ceramic materials, bioactive glasses and glass ceramic materials
- To highlight the knowledge on bio-coatings and its relevance in medical field

Course Outcome :

- The students would understand various applications of ceramic materials in the medical field.
- The students would be able to formulate and fabricate various bio-ceramic materials for bio-medical applications
- To have a complete knowledge about the various calcium phosphates based ceramic materials along with the preparation, properties and applications.

Course Description :

Materials in medicine: Implant areas – dental, orthopedic. Implant materials – Body reaction to the implant materials – Chemistry of calcium phosphate bio ceramics – Calcium phosphate bone cements – Surface active glasses, bioactive glass – interfacial bonding - High strength bioactive glass ceramics – Bioactive Composites - Importance of bioactive coatings. Hydroxyapatite coated metal implants – coating methods, characterization and properties.

Reference Books :

1. Yamamura T, Hench L.L and Wilson J, CRC Handbook of Bioactive Ceramics, Vol. I & II, CRC Press, Boca Raton, 1990.
2. Park J.B, Biomaterials: An Introduction, Plenum Press, New York, 1979.
3. Bonfield V, Hastings C.H and Tanner K.E (eds.), Bioactive Ceramics, Vol4, Butterworth – Heinemann Ltd., Oxford, 1991.
4. Hans Bach, Low Thermal Expansion Glass Ceramics, Springer, 1995.
5. Hench L.L and Ethridge E.C, Biomaterials: An Interfacial Approach, Academic Press, New York, 1982.
6. Joon Park, Bioceramics-Properties, Characterization and Applications, Springer Publications, 2008
7. Tadashi Kokubo, Bio-Ceramic & Their Applications, Woodhead Publications, 2008
8. Bikramjit Basu, Dharendra, S.Katti, Ashok and A Joham, Advanced Biomaterial, Fundamentals, Processing and Applications, Wiley & Sons Inc, 2009
9. Heimo O. Ylaner, Bioactive Glasses - Materials, Properties and Applications, Woodhead Publishing Materials, 2011.

15CH2003 CHEMISTRY IN EVERYDAY LIFE

Credits: 3:0:0

Course Objectives :

- To introduce to the students about the chemistry connections of everyday life.
- To relate what the student studies in the subjects to practical life.

Course Outcome :

- The students will know the practical aspects of chemistry in day-to-day life.
- The students will think innovative and develop application oriented products.

Course Description:

Drugs and Diseases-Causes, Sign and Symptoms of Polio, Diabetes, AIDS, Cancer- Vaccination-Protein Misfolding and disease—Banned Drugs and its effect-Structure based Antibiotics and Antipyretics, Common drugs-Chemistry of Paints, Ice cream, Explosives, Hair dye- Advantages and Disadvantages with structure of monoglutamate (Aginomotto), Caffeine and Theobromine (in chocolates), Docosahexanoic acid (in fish), Alpha tocopherol (in body lotions), Aspartame (Artificial Sweetener)- Chemical Phenomena-Seashells vary in color- Water does not relieve the burning sensation of chilly-Sniffing dogs detect explosives and bombs-Flesh of Fish smells different from other meat-Cotton is highly water absorbent but dries slowly-Food adulteration-Fast food and organic food-Cholesterol (LDL and HDL)- Molecules of Emotion (Adrenaline, Dopamine, Epinephrine, Serotonin, and Oxytocin).

Reference Books:

1. Karukstis K.K., and Hecke G.R.V., “Chemistry connections: the chemical basis of everyday phenomena” Elsevier Science and Technology books, 2nd edition, 2003.
2. Grace Ross Lewis, “1001 Chemicals in everyday products”, John Wiley and sons, 3rd edition, 2001.
3. www.listverse.com/2007/10/04/top-10-incurable-diseases/
4. www.bama.ua.edu/
5. www.foodproductdesign.com
6. www.angelfire.com/linux/chemistryofpaint/
7. www.ssrsi.org/sr1/weapon.explode.htm
8. Paul Engel, “Pain-free Biochemistry”, Wiley – Blackwell publishers, 2009.

15CH3001 CHEMICAL KINETICS AND PHOTOCHEMISTRY

Credits: 3:1:0

Course Objectives :

- To understand the Dynamics of Chemical Kinetics, Catalysis, Surface Chemistry & Photochemistry.

Course Outcome :

- Students will acquire a good knowledge on the chemical kinetics, unimolecular and bimolecular reactions, fast reactions, Catalysis, Surface chemical reactions and Photochemistry of atoms and molecules.

Course Description :

Rate law – Kinetics of rate equations - Complex and Fast reactions – Collision theories – Arrhenius theory of reaction rates – Theory of absolute reaction rates – Study of kinetics of stopped flow techniques – Flash photolysis – Shock tubes – Kinetic isotope effects – Hammett relationship – Taft equation – Related Problems - Acid – Base catalysis – Enzyme catalysis – Theory and applications – Mechanism of heterogeneous catalysis - Adsorption of gases by solids – Langmuir, Freundlich and BET isotherms – Absorption and emission of radiation – Theories Laser – Franck Condon principle – Physical properties of electronic excited state – Resonance emission – Photosensitization and Chemiluminescence – Chemical actinometry - Problems

Reference Books :

1. Laidler K.J., “Chemical Kinetics”, Harper and Row, New York, 3rd Edition, 2008.
2. Rajaram J & Kuriakose, J.C., “Kinetics and mechanism of chemical transformation”, McMillan India Ltd., New Delhi, 2011.
3. Adamson, A.W., “Physical Chemistry of Surfaces”, Wiley, 6th edition, 1997.
4. Rohatgi Mukherjee K. K., “Fundamentals of photochemistry”, New Age International Pvt. Ltd., New Delhi, 2009.
5. Atkins P.W., “Physical Chemistry”, Oxford University Press, 8th edition, 2006.
6. Kalidas, C. “Chemical Kinetic Methods: Principles of Relaxations Techniques and application”, New Age International (P) Ltd, Chennai, 2005.
7. Levine I.N., “Physical Chemistry”, Tata Mc Graw Hill, NY, 2007.

15CH3002 CHEMICAL BONDING AND NUCLEAR CHEMISTRY

Credits: 3:0:0

Course Objectives :

- To explain the theory of acids and bases and non-aqueous solvents.
- To discuss the various types of chemical bonding.
- To discuss nuclear chemistry and their application in various fields.

Course Outcome :

- Students will have thorough knowledge of theory of acids and bases
- The students will understand the theories of chemical bonding.
- The students will know the importance of nuclear chemistry and its applications

Course Description :

Periodicity - Bronsted and Lewis acids and Bases – HSAB – Non-aqueous Solvents - Leveling Effect – Liquid Ammonia – Sulfuric acid – Hydrofluoric Acid – Sulfur dioxide – Dinitrogen tetroxide - Ionic Bonding – Lattice energy – Born Lande Equation – Born Haber Cycle – Fajan's rule – Limiting Ratio – Covalent Bond – VB Theory – Hybridization – MO Theory of Diatomic Molecules – VSEPR Theory – Fluxionality – Ion-dipole Interaction – Hydrogen Bonding — Nuclear Stability – Nuclear Fission – Nuclear Fusion – Radioactive Detectors - Nuclear Reactions - Neutron Activation Analysis – Carbon and Rock Dating –Applications of Tracers

Reference Books:

1. Lee J. D, "Concise Inorganic Chemistry", Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
3. Sharpe A.G. "Inorganic Chemistry", Dorling Kindersley (India) Pvt. Ltd, 2nd impression, 2008.
4. Satyaprakash, Tuli G. D, Basu S. K & Madan R. D, "Advanced Inorganic Chemistry" Vol I and II, S. Chand and Company Ltd, NewDelhi, India, Reprint: 2009.
5. Mido Y, Taguchi S, Sethi M.S & Iqbal S. A, "Chemistry in Aquous and Non-aqueous Solvents", Discovery Publishing House, New Delhi, 2003
6. Arnikar H. J, "Essentials of Nuclear Chemistry", New Age International Publishers Ltd., New Delhi, India, 4th edition, 2007.

15CH3003 ORGANIC REACTION MECHANISM AND STEREOCHEMISTRY

Credits: 3:1:0

Course Objectives :

- To enable the student to understand the stereochemistry of organic reactions
- To explain the mechanism and molecular rearrangements of organic reactions.

Course Outcome :

- Students can carry out organic reactions with proper understanding and knowledge of mechanism and orientation changes.

Course Description :

Inductive, electromeric and resonance effect - Hyperconjugation - Reactive intermediates- Generation, stability & reactions of Carbanions - Carbocation – Carbenes – Nitrenes - Radicals and Ylids – Aromaticity - Nucleophilic and electrophilic substitution Reactions - Additions to multiple bonds - Elimination reactions - Principles of stereochemistry, Conformational analysis, isomerism and chirality - Projection structure of stereoisomers – Fischer and Newmann – DL, RS and EZ notations - Stereoselectivity and stereospecificity - Problems

Reference Books :

1. Jerry March, “Advanced Organic Chemistry”, Wiley Eastern Limited, New Delhi, 4th edition, 2008.
2. Bahl. B.S. and Arun Bahl, “A Text book of Organic Chemistry”, S. Chand & company Ltd., New Delhi, Reprint, 2011.
3. Peter Sykes, “A Guidebook to Mechanism in Organic Chemistry”, Longman Press, London and New York, Reprint, 2006.
4. Ernest. L. Eliel, “Stereochemistry of carbon compounds”, Tata-McGraw Hill, New Delhi, 22nd Reprint 2009.
5. Nasipuri. D. “Stereochemistry of organic compounds – Principles and applications”, New Age international, 2nd edition, 2002.
6. Kalsi. P.S. “Stereochemistry Conformation and Mechanism”, New Age International Publishers, New Delhi, 6th Edition, Reprint, 2005.
7. Finar. I.L., “Organic Chemistry, Volume 1”, Doorling Kindersley (Indian), 6th Edition, 5th impression, 2008.
8. Raj K. Bansal, “Organic reaction mechanism”, Tata McGraw Hill, New Delhi, 4th Edition, 2005.
9. Carey. F.A. “Organic Chemistry”, McGraw Hill, Inc., 2nd edition, 1992.
10. Morrison and Boyd, “Organic Chemistry”, United States of America, 3rd edition, 1992.
11. Carey, F.A, and Sundberg. R. J, “Advanced Organic Chemistry Part – A”, Plenum Press, 2007.

15CH3004 QUANTUM CHEMISTRY AND GROUP THEORY

Credits: 3:1:0

Course Objectives :

- To study the importance of quantum chemistry
- To understand the applications of group theory to atoms and molecules.

Course Outcome :

- Students acquire a good knowledge on the fundamentals of quantum chemistry and the practical applications of group theory.

Course Description :

The failures of classical mechanism –black body radiation – Uncertainty principle – Schrodinger equations – Harmonic oscillator – Rigid rotor – Angular momentum – Related Problems - Variation and perturbation theory – Slater detrimental wave functions – Born Oppenheimer approximation – LCAO, MO and VB treatments – Huckel theory of linear conjugated systems –Woodward Hoffman rules - Molecular symmetry and operations - Cartesian coordinate system - Properties of a group – Group Multiplication tables – Molecular point groups – Great orthogonality theorem and its applications – Symmetries of normal modes of vibration in non - linear molecules – Symmetry selection rules for vibrational spectra - M.O and electronic spectra – Hybridization schemes - Problems.

Reference Books :

1. Chandra, A.K. “Quantum Chemistry” Tata McGraw –Hill Pvt. Ltd., New Delhi, 4th Edition, 2002.
2. Donald A McQuarrie, “Quantum Chemistry”, Viva Books, New Delhi, 2008.
3. Hanna, M.W., “Quantum Mechanics in Chemistry”, Addition Wisley, London, 3rd edition, 1981.
4. Swarnalakshmi S. “A Simple Approach to Group Theory in Chemistry” Universities Press, 2009.
5. Raman, K.V. “Group theory and its applications to chemistry”, Tata Mac Graw Hill, 2004.
6. Cotton F.A. “Chemical application of group theory”, Wiley India Pvt. Ltd., New Delhi, India, 3rd edition, 2009.
7. Carter R.L., Molecular Symmetry and Group Theory, John Wiley & Sons, NY, 2005.

15CH3005 COORDINATION CHEMISTRY

Credits: 3:1:0

Course Objectives :

- To discuss the Bonding, Spectra, Magnetism and Reaction Mechanism in Coordination Chemistry
- To understand the importance of f-block elements and their applications

Course Outcome :

- The Students will understand the structure, bonding and reaction mechanism in coordination complexes
- The students will understand the chemistry of lanthanides and actinides

Course Description :

Ligands – Formation of Complexes – Bonding theories - VB Theory – Crystal Field Theory – CFSE – Factors Affecting $10Dq$ – MO Theory – Electronic Spectra – Term Symbols – Problems - Orgel Diagram – Tanabe Sugano Diagram – Jahn-Teller Effect – CT Spectra –Magnetic Properties – Isomerism - Chelate and Macrocyclic Effects – Stability Constant – Problems -Substitution in Square Planar and Octahedral Complexes – Trans Effect – Thermodynamic and Kinetic Stability – Outer and Innersphere Reactions – Marcus Theory –Nature of Bridging Ligand – Lanthanide Contraction – Separation of Lanthanides and Actinides - Transactinides

Reference Books:

1. Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
2. Purcell K. F & Kotz J. C., "Inorganic Chemistry" Cengage Learning, New Delhi, India, Reprint, 2010.
3. Greenwood N. N. & Earnshaw A, "Chemistry of the Elements", Reed Elsevier India Private Ltd, Gurgaon, India, 2nd edition, Reprinted 2010.
4. Miessler G. L & Tarr D. A., "Inorganic Chemistry", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 3rd Edition, 2009.
5. Gopalan R, Ramalingam V, Concise Coordination Chemistry, Vikas Publishing House Pvt. Ltd, 2001
6. Cotton F. A & Wilkinson G, "Advanced Inorganic Chemistry", 6th edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.
7. Jordan R. B, "Reaction Mechanisms of Inorganic and Organometallic Systems", Oxford University Press, New York, USA, 3rd Edition, 2007.
8. Satyaprakash, Tuli G. D, Basu S. K & Madan R. D, "Advanced Inorganic Chemistry" Vol I and II, S. Chand and Company Ltd, NewDelhi, India, Reprint: 2009.
9. Shriver and Atkins, " Inorganic Chemistry", Oxford University Press, New Delhi, India, 4th edition, 2009.
10. Figgis B. N. & Hitchman M. A, "Ligand Field Theory and Its Applications", Wiley-VCH Verlag GmbH & Co, Weinheim, Germany, 2000.

15CH3006 MOLECULAR SPECTROSCOPY

Credits: 3:0:0

Course Objectives :

- To understand the principles of Molecular Spectroscopy
- To discuss the principles of Emission Spectroscopy
- To understand the importance of Mossbauer Spectroscopy

Course Outcome :

- Students will know the principles of Rotation, Vibration and Electronic Spectroscopy
- The students will know the importance of NMR and ESR Techniques.
- The students will know the principles of Mossbauer and Photoelectron Spectroscopy

Course Description :

Electromagnetic Radiation – Rotational and Vibrational spectroscopy of diatomic and polyatomic molecule – Principles - 3N-6(5) Rule - Fermi resonance – Raman Spectroscopy – Mutual exclusion principle – Electronic Spectroscopy of Diatomic and Polyatomic Molecule - Transition moment integral – Predissociation – Fluorescence Spectroscopy – Principles – Photoelectron Spectroscopy – UPS – XPS – Auger Electron Spectroscopy – NMR Spectroscopy – Theory – Relaxation Processes – ¹H NMR – ESR Spectroscopy – g-factor - spectra of simple organic radicals and first row transition metals – zero field splitting– kramer’s degeneracy - Mossbauer spectroscopy – Principles- Isomer Shift, Quadrupole effect and Hyperfine splitting

Reference Books :

1. Fundamentals of Molecular Spectroscopy. C. N. Banwell and E. M. McCash, Tata McGraw-Hill publishing.
2. Molecular Spectroscopy. I. N. Levine, Wiley Interscience Publication.
3. Drago R. S, Physical Methods for Chemists, 2nd Revised edition, n Saunders (W.B.) Co Ltd;
4. Molecular Spectra & Molecular Structure. G. Herzberg, Van Nostrand Reinhold Company
5. Satya Narayana D. N, “Vibrational Spectroscopy Theory and Applications”, New Age International Publishers, New Delhi, 2004.
6. Satya Narayana D. N, “Electronic Absorption Spectroscopy and Related Techniques”, Universities Press (India) Ltd, Hyderabad, 2001.
7. Lakowicz J. R, “Principles of fluorescence spectroscopy”, Springer Science+Business Media, New York, USA, 3rd editon, 2006.
8. Principles of Ultraviolet Photoelectron Spectroscopy, J. W. Rabalais, John Wiley & Sons.
9. Satya Narayana D.N., “Magnetic Resonance Spectroscopy ESR, NMR, NQR“, I. K. International, New Delhi, 2009
10. Graybeal J. D., Molecular Spectroscopy., McGraw Hill.
11. Hollas J. M., Modern Spectroscopy. John Wiley & Sons.

15CH3007 CHEMICAL THERMODYNAMICS AND ELECTROCHEMISTRY

Credits: 3:0:0

Course Objectives :

- To know about classical & statistical thermodynamics.
- To understand the fundamental and applied concepts of electrochemistry

Course Outcome :

- Students acquire a good understanding of the basic principles of thermodynamics and electrochemistry.

Course Description :

Laws of thermodynamics and its limitation – Activity – Activity coefficient – Fugacity – Concepts of probability and Maxwell Boltzmann distribution – Relationship between entropy and thermodynamic probability systems with degeneracy – Sackur–Tetrode equation – The Bose–Einstein’s and Fermi–Dirac statistics – Heat capacity of solids – Debye and Einstein models – Irreversible thermodynamics – steaming potential – the Dorn effect – Theories of electrical double layers – Electrode kinetics – Butler Volmer Equation - Hydrogen overpotential

Reference Books :

1. Atkins P.W., “Physical Chemistry”, Oxford University Press, 8th edition, 2006.
2. Glasstone S., “Thermodynamics for Chemists”, East West Press Pvt. Ltd., New Delhi, 2005.
3. Levine I.N., “Physical Chemistry”, Tata Mac Graw Hill, NY, 2007.
4. N.D. Smith, “Elementary Statistical Thermodynamics”, Plenum Press, New York, 1984.
5. Samuel Glasstone, “An Introduction to Electrochemistry”, Maurice Press, 2007.
6. John O'M. Bockris, Amulya K. N. Reddy, “Modern Electrochemistry”, Vol. I and II, Plenum Publishing, 2008.

15CH3008 ORGANOMETALLIC, BIOINORGANIC AND SOLID STATE CHEMISTRY

Credits: 3:1:0

Course Objectives :

- To discuss the Structure, Reactions and Catalysis in Organometallic Chemistry
- The Bioinorganic Chemistry of elements will be discussed
- To understand the importance of inorganic photochemistry and Solid State Chemistry

Course Outcome :

- The Students will understand the importance and applications of Organometallic chemistry, Bioinorganic Chemistry, Inorganic Photochemistry and Solid State Chemistry

Course Description:

18 Electron Rule – Problems - Chemistry of Metal carbonyl, Nitrosyl, Alkyl, Carbene, Carbyne, Allyl and Arene complexes - Metallocenes – Fluxionality – Reactions – Catalysis - Hydrogenation, Carbonylation, Hydroformylation, Wacker Process and Zeigler-Natta Catalysis – Inorganic Photochemistry - Photosubstitution and Photoredox reactions – Ligand Photoreactions – Ruthenium Polypyridine complexes – Solar energy Conversion – Essential and Trace elements in Biological Systems – Bioinorganic Chemistry of Fe, Co, Cu, Mn and Zn – Enzymes – Model Complexes - Platinum anticancer drugs – Biomaterials - Crystal Systems – Defects – Band Theory of Solids – Structures of Compounds of types AX, AX₂ and ABX₃

Reference Books:

1. Huheey J. E, Keiter E. A & Keiter R. L, “Inorganic Chemistry – Principles of structure and reactivity”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
2. Shriver and Atkins, “Inorganic Chemistry”, Oxford University Press, New Delhi, India, 4th edition, 2009.
3. Porterfield W. W, “Inorganic Chemistry A Unified Approach”, Reed Elsevier India Private Ltd, Gurgaon, India, 2nd Edition, Reprinted 2009.
4. Purcell K. F & Kotz J. C., “Inorganic Chemistry” Cengage Learning, New Delhi, India, Reprint, 2010.
5. Cotton F. A & Wilkinson G, “Advanced Inorganic Chemistry”, 6th edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.
6. Gupta B. D & Elias A. J, “Basic Organometallic Chemistry”, CRC Press, New Delhi, India, 2010.
7. Greenwood N. N. & Earnshaw A, “Chemistry of the Elements”, Reed Elsevier India Private Ltd, Gurgaon, India, 2nd edition, Reprinted 2010.
8. K. Hussain Reddy, BIOINORGANIC CHEMISTRY, New Age International Ltd, 2003
9. Bertini I, Gray H. B, Lippard S. J & Valentine J. S, “Bioinorganic Chemistry”, Viva Books Private Ltd, New Delhi, India, 2007.
10. West R, “Solid State Chemistry and its Applications”, Wiley India Pvt. Ltd, New Delhi, India, 2007.

15CH3009 SYNTHETIC METHODOLOGY AND NATURAL PRODUCTS

Credits 3:0:0

Course Objectives :

- To enable the student to understand Modern Synthetic Methods using Reagents, Heterocycles and its allied natural products, (c) the modern methods for molecular fashions applied in pharmaceutical industry.

Course Outcome :

- Students will be aware of Heterocyclic compounds and its medicinal use; they will get the knowledge about the molecular fashions in the pharmaceutical industry through the modern reactions and reagents.

Course Description :

Modern Synthetic methods and reagents – Coupling Reactions – Reagents – NBS, DDQ, DCC, Gilmann Reagent - Introduction to multi-component reactions. Heterocyclic Nomenclature – Structure, Preparation, Properties and Reactions of Pyrazole, Imidazole, Pyridazine, and Pyrimidines. General Methods of Structure elucidation of Alkaloids, Terpenoids, Steroids, and anthocyanidines. Chemistry of Vitamins and Carbohydrates-Introduction to Amino acids, Proteins and Nucleic acids.

Reference Books:

1. Smith M. B., Organic Synthesis, 3rd Edition, Wave Functions Inc. 2010.
2. Carruthers, W.; Coldham, I. Modern Methods of Organic Synthesis, 04th Edition Cambridge University Press, 2004.
3. Joule, J. A. and Mills K. Heterocyclic Chemistry, 05th Edition, Wiley, 2010.
4. Agarwal. O.P, “Chemistry of natural products, Vol.1 & 2”, Goel publishing house, 36th Edition, 2009.
5. Raj.K. Bansal, “Heterocyclic Chemistry”, New Age International Publishers, 4th Edition, Reprint, 2009.
6. Finar. I.L., “Organic Chemistry”, Volume 2, Doorling Kindersley (Indian), 6th Edition, 5th Impression 2008.
7. Gurdeep R. Chatwal, “Organic Chemistry of Natural Products”, Himalaya Publishing Home, New Delhi, 5th & Enlarged Edition, 2008.
8. Lehninger Principles of Biochemistry 5th edition, 2008 - Nelson, D. L. and M. M. Cox. (W. H. Freeman & Co.).
9. Organic Chemistry (5th Edn.) Robert. T.Morrison & N. Boyd. Hill edition.

15CH3010 QUALITATIVE AND QUANTITATIVE INORGANIC ANALYSIS LAB

Credits: 0:0:4

Course Objectives :

- To provide the students a competence in the laboratory skills required for accurate and precise chemical analysis.
- The students will know the theoretical basis of qualitative inorganic analysis containing common and less common ions.

Course Outcome :

- The student will gain the laboratory skills to estimate quantitatively by using complexometric and redox titrations
- The student can confirm the presence of less common and common ions in the mixtures using semimicro analysis.

Course Description :

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

Reference Books :

1. Mendham J., Denney R. C., Barnes J. D. and Thomas M. J. K., "Vogel's Textbook of Quantitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, Seventh impression 2008.
2. Ramanujam V. V., "Inorganic semimicro qualitative analysis", 3rd edition, The national publishing company, Chennai, India, reprinted 2008.
3. Svehla G., "Vogel's Textbook of Qualitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression 2008.

15CH3011 QUALITATIVE AND QUANTITATIVE ORGANIC ANALYSIS LAB

Credits: 0:0:4

Course Objectives :

- To enrich the knowledge of Organic Laboratory skills for estimation and analysis of Organic mixture.

Course Outcome :

- Students acquire the knowledge of estimation and analysis of Organic Compounds
- The student can characterize the unknown compound using functional group Analysis.

Course Description :

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

Reference Books:

1. A.I. Vogel – "Text book of practical organic chemistry", 5th Ed. ELBS, London, 1989
2. B.B. Dey and M.V. Sitharaman, "Laboratory manual of Organic Chemistry" Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
3. Daniel R. Paleros, "Experimental Organic Chemistry" John Wiley & Sons, Inc., New York, 2000
4. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, "Text book of Practical Organic Chemistry", LBS, Singapore, 1994
5. S.M. Khopar, "Basic concepts of Analytical Chemistry", John Wiley & Sons, 1984
6. Gnanapragasam N.S., Ramamurthy G, "Organic Chemistry Lab Manual", revised edition, S. Viswanathan printers and publishers Pvt. Ltd., Chennai, Reprinted 2011.

15CH3012 PHYSICAL CHEMISTRY LAB

Credits: 0:0:4

Course Objective:

- To carryout simple chemical reaction which would be monitored by Electrical and Non-Electrical experimental studies.

Course Outcome:

- The analytical skill will be improved by pursuing electrical experiments like Conductometry, Spectrophotometry, Potentiometry.
- The basic knowledge could be understood thoroughly regarding the velocity of the reaction, distribution properties and adsorption studies.

Course Description:

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

Reference Book

1. Svehla G., "Vogel's Textbook of Qualitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, fifth impression 2008.

15CH3013 MODERN INSTRUMENTAL ANALYSIS LAB

Credits: 0:0:2

Course Objective:

- To carryout simple chemical reaction which would be monitored by Electroanalytical and Spectrophotometric Techniques

Course Outcome:

- The student will be exposed to various analytical techniques like Conductometry Potentiometry, Spectrophotometry and X-ray Diffraction

Course Description:

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

Reference Book

1. Mendham J., Denny R. C., Barnes J. D. and Thomas M. J. K., "Vogel's Textbook of Quantitative Chemical Analysis", 6th edition, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, Seventh impression 2008.

15CH3014 PREPARATIVE INORGANIC CHEMISTRY LAB

Credits: 0:0:2

Course Objectives :

- To provide the students an appreciation for the preparation and Characterization of Inorganic Complexes.

Course Outcome :

- The student will gain the laboratory skills to prepare the inorganic complexes,
- The student will be able to characterize the inorganic complexes using IR and UV Spectroscopy

Course Description:

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

Reference Books :

1. Gopalan R, Ramalingam V, Concise Coordination Chemistry, Vikas Publishing House Pvt. Ltd, 2001
2. Allcock, H, R., "Inorganic Syntheses", Volume 25, John Wiley & Sons, New York, USA, 1989

15CH3015 SYNTHETIC ORGANIC CHEMISTRY LAB

Credits: 0:0:2

Course Objectives :

- Employ various reaction types to synthesize organic compounds and characterize them using Spectra.

Course Outcome :

- Understanding of the reaction conditions for various organic reactions
- The student can able to analyze the purity of the compound using Thin Layer Chromatography and interpret the spectroscopic data of the organic compounds

Course Description :

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

Reference Books :

1. A.I. Vogel – "Text book of practical organic chemistry", 5th Ed. ELBS, London, 1989
2. B.B. Dey and M.V. Sitharaman, "Laboratory manual of Organic Chemistry" Revised by T.R. Govindachari, Allied Publishers Ltd., New Delhi, 4th Revised edition, 1992
3. Daniel R. Palleros, "Experimental Organic Chemistry" John Wiley & Sons, Inc., New York, 2000
4. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, "Text book of Practical Organic Chemistry", LBS, Singapore, 1994
5. S.M. Khopar, "Basic concepts of Analytical Chemistry", John Wiley & Sons, 1984

15CH3016 INSTRUMENTAL METHODS OF ANALYSIS

Credits: 3:0:0

Course Objectives :

- To understand the principles of Instrumentation Techniques
- To understand the applications of various analytical techniques

Course Outcome :

- Students will know the principles of various types of chromatographic techniques.
- The students will know the principles of Thermal methods, Atomic Spectroscopy and X-ray Diffraction.
- The students will know the application of instrumental techniques in various fields

Course Description:

Data Analysis – Principles of Titrations – Instrumental Techniques – Classification – Modern Analytical Techniques- Chromatography - Principles and applications of Liquid column, Solid/liquid, Liquid/liquid, Ion exchange, HPLC and Gas chromatography - Atomic absorption and emission spectroscopy- ICP-AES - X-ray diffraction Methods – Instrumentation — Diffraction pattern – Structure factor – Reliability factor - Applications – Surface Characterization Techniques – SEM - TEM - Thermal Methods - Water analysis - Food analysis - Body Fluid analysis - Process Instruments – Automation Strategy –Chemical Sensors – Automatic Chemical Analysers – Laboratory Robot

Reference Books:

1. Willard H, Merrit L, Dean J. A. & Settle F.A., “Instrumental methods of chemical analysis”, CBS Publishers and Distributors Pvt. Ltd, New Delhi, 7th edition, 1986.
2. Skoog D. A, West D. M, Holler F. J & Crouch S. R, “Fundamentals of Analytical Chemistry”, Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.
3. Day R. A.& Underwood A. L., “Quantitative Analysis”, 6th Edition, Printice Hall of India Pvt Ltd, New Delhi, 2006
4. G.D. Chritiain. Analytical Chemistry Wiley
5. Srivatsava A. K. & Jain P. C, “Chemical Analysis”, S. Chand Publications, New Delhi, 3rd edition, 1997.
6. Chatwal G. R & Anand S. K, “Instrumental Methods of Chemical Analysis”, Himalaya Publishing House, Mumbai, India, 5th Edition, Reprint 2011.
7. **Valcarcel**, Miguel, Principles of Analytical Chemistry, Springer, 2000.
8. G. Sharma, B K Chaturvedi, Richard E. Wolfe, Basic Analytical Chemistry, DK publishers, 2011
9. Zhou W, Wang Z. L, “Scanning Microscopy for Nanotechnology: Techniques and Applications”, Springer, New York, USA, 2006.
10. R.P. Braun, Introduction to Instrumental Analysis, McGraw Hill

15CH3017 MAIN GROUP CHEMISTRY

Credits: 3:0:0

Course Objective:

- To understand the structure and bonding in Main group Compounds
- The chemistry of Inorganic Polymers
- To understand the bonding in Inorganic cages and clusters

Course Outcome:

- The Students will understand the structure and bonding in main group Chemistry
- The students will know the importance of inorganic polymers
- The students will understand the structure and bonding in inorganic cages and clusters.

Course Description:

Alkali and alkaline earth metals - Crown ether complexes and cryptands – Compounds of Beryllium - Polymorphism of Carbon, Phosphorus and Sulfur – Carbides – Silicates - Oxides and oxyacids of Se and Te - Interhalogens - Xenon compounds - Homocyclic inorganic systems - $p\pi-p\pi$ and $p\pi-d\pi$ bonding - Inorganic Polymers – Classification - Chemistry of B-O compounds and B-N compounds - Silicones, Polyphosphazene and $(\text{SN})_x$ - Coordination Polymers - Metal-organic frameworks - Boron hydrides – styx numbers – Heteroboranes – Carboranes – Metal Clusters - $d\pi-d\pi$ bonding – Examples

Reference Books:

1. Huheey J. E, Keiter E. A & Keiter R. L, “Inorganic Chemistry – Principles of structure and reactivity”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
2. Greenwood N. N. & Earnshaw A, ”Chemistry of the Elements”, Reed Elsevier India Private Ltd, Gurgaon, India, 2nd edition, Reprinted 2010.
3. Purcell K. F & Kotz J. C., “Inorganic Chemistry” Cengage Learning, New Delhi, India, Reprint, 2010.
4. Shriver and Atkins, “ Inorganic Chemistry”, Oxford University Press, New Delhi, India, 4th edition, 2009.
5. Cotton F. A & Wilkinson G, “Advanced Inorganic Chemistry”, 6th edition, Wiley India (P.) Ltd, New Delhi, India, First Reprint 2007.
6. Driess M. & Nöth H, “Molecular Clusters of the Main Group Elements”, Wiley-VCH Verlag GmbH & Co, Weinheim, Germany, 2004.
7. Chandrasekhar V, “Inorganic and Organometallic Polymers” Springer-Verlag Berlin, Heidelberg Germany, 2005
8. Henderson W, “Main Group Chemistry”, Royal Society of Chemistry, United Kingdom, 2000.
9. Chivers T & Manners I, “Inorganic Rings and Polymers of the p-Block Elements”, Royal Society of Chemistry, United Kingdom, 2009.
10. Archer R. D, “Inorganic and Organometallic Polymers”, John Wiley and Sons, New York, USA, 2001.

15CH3018 SYNTHETIC REAGENTS AND CONCERTED REACTIONS

Credits 3:0:0

Course Objective:

- To enable the student to understand the principles of organic synthesis, Reagents used in organic synthesis (c) Photochemical, Pericyclic, and different Molecular rearrangements.

Course Outcome:

- Students can make use of different reagents in organic synthesis and they can do it in different pathways.

Course Description:

Organic name reactions and reagents based on Oxidation and Reduction - Pericyclic reactions - Electrocyclic, cycloaddition, sigmatropic, Chelotropic, Ene reactions – Photochemistry - Basic principles. Photochemistry of alkenes, carbonyl compounds, and arenes – Photo-oxidation and photo-reduction – Retrosynthesis – The disconnection approach – Synthons, One & Two group C-X and C-C disconnections, Functional group inter-conversion, transposition for Amino- and Alkene- Retro strategies.

Reference Books :

1. Stuart Warren, "Organic Synthesis – The disconnection approach" – A John Wiley and Sons, Ltd., 2nd Edition, reprint, 2010.
2. Jagadamba Singh and Jaya Singh, "Photochemistry and Pericyclic Reactions", New Age International Publishers, New Delhi, 3rd Revised Edition, Reprint, 2011.
3. Carey, F.A, and Sundberg. R. J, "Advanced Organic Chemistry Part – B: Reactions and Synthesis", Plenum Press, 2008.
4. Gurdeep R. Chatwal, "Reaction Mechanism and Reagents in Organic Chemistry", Himalaya Publishing House, New Delhi, 2007.
5. Finar. I. L, "Organic Chemistry", Volume 2, Doorling Kindersley (Indian), 6th Edition, 2008.
6. Hassner. A & Stumber. C, "Organic Synthesis based on name reactions", Pergamon Press, 2002.
7. Ahluwalia. V. K, and Rakesh Kumar Parashar, "Organic Reaction Mechanisms", Narosa Publishing House, New Delhi, 4th Edition, 2011.
8. Gilchrist. T. L, & Storr. R.C, "Organic reaction orbital symmetry", Cambridge university press, 1979.
9. Jerry March, "Advanced Organic Chemistry – Reactions, Mechanisms and structure", John Wiley & Sons, 4th Edition, 2008.
10. Mukherji. S. M, and Singh. S.P, Reaction Mechanism in Organic Chemistry, Macmillan Publishers, 3rd Edition, Reprinted, 2010.
11. Normon and Coxon J.M. Principals of Organic Chemistry, 3rd edition Chapman and Hall 1993.
12. Coxon. J.M, and Halton. B, "Organic Photochemistry", Cambridge University Press, London, 1st Paper back edition, 2011.

15CH3019 SPECTROSCOPIC METHODS FOR STRUCTURE ELUCIDATION

Credits: 3:0:0

Course Objective:

- To apply the principles of Molecular Spectroscopy to Organic Molecules
- To Characterize the organic molecule using various spectroscopic technique
- To derive the structure of the molecule using the spectroscopic techniques

Course Outcome:

- Students will apply the principles of organic UV-Visible and IR spectroscopy
- To characterize Molecules using NMR and Mass spectrometry techniques
- The students will derive the structure of the organic molecule using the provided data

Course Description:

UV-visible spectroscopy -Woodward-Fieser rules - Principles of ORD and CD – Cotton effect – Octant rule – Axial haloketone rule –IR spectroscopy — Fundamental vibrations and overtone - Finger print region – NMR Spectroscopy - Chemical shift - Spin-spin coupling — Second order spectra -Simplification of complex spectra - NOE- ^1H - ^1H COSY spectroscopy - ^{13}C NMR - Operating frequency – Decoupling –DEPT spectra — Introduction to ^{19}F and ^{31}P spectroscopy - Mass spectrometry - Principles – Instrumentation – Molecular ion peak – Base peak — McLafferty rearrangement – Metastable ions – Structure Elucidation problems

Reference Books:

1. R. M. Silverstein, F. X. Webster, D. J. Kiemle, Spectrometric identification of organic compounds, 7th edition, John Wiley, 2005.
2. Organic Spectroscopy, W. Kemp, 3rd edition, Macmillan, 2011.
3. D. H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, mcgraw Hill, 6th edition 2007.
4. D. L. Pavia and G. M. Lampman Spectroscopy 4th Edition, Brooks Cole, 2012.
5. P. S. Kalsi, Spectroscopy of Organic Compounds, 6th edition, New age international, 2004.

15CH3020 SUPRAMOLECULAR CHEMISTRY AND GREEN CHEMISTRY

Credits: 3:0:0

Course Objectives :

- The students will learn the supramolecular constructs of current importance.
- Information on concepts of modern chemistry which aids the students get motivated and prepared to do research after their masters.
- A knowledge on synthesizing and assembling molecular structures of different shapes and dimensions.

Course Outcome :

- The students will know the selectivity in formation of supramolecular chemistry and catalysis.
- They will understand the importance of green chemical pathways in reactions and their applications.

Course Description :

Definition – introduction to supramolecular chemistry – lock and key fit – induced fit model – chelate effect – binding constant: methods – kinetic and thermodynamic selectivity – host molecules – molecular self assembly – Macrocyclics vs. Acyclic hosts – molecular machines and switches – ladders, polygons, and helices – supramolecular catalysis – solid catalysts – pore diffusion – environmental catalysis – twelve principles of green chemistry – atom economy – supercritical carbon dioxide – water as solvent – solvent-free synthesis

Reference Books :

1. Jonathan Steed, David Turner, Carl Wallace, Core Concepts in Supramolecular and Nanochemistry, John Wiley & Sons, 2007.
2. V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, Second Edition, CRC Press, 2012.
3. I. Chorkendorff, J. W. Niemantsverdriet, Concepts of Modern Catalysis and Kinetics, Second Edition, Wiley-VCH Publishers, 2007

15CH3021 APPLIED ELECTROCHEMISTRY

Credits: 3:0:0

Course Objectives :

- Understand the basic concepts of electroanalytical techniques
- To gain familiarity with applications of electrochemistry
- Build confidence and knowledge to deal independently with electrochemical problems

Course Outcome :

- Students acquire a good knowledge on the fundamentals and applications of electrochemistry

Course Description:

Electrodes – Transducers – Macro and Microelectrodes - Polarography – Tast Polarography – Cyclic Voltammetry – Normal pulse and Differential Pulse Voltammetry – Tafel Plot - AC Voltammetry – Impedance Spectroscopy - Spectroelectrochemistry - Corrosion – Theories of corrosion processes – Passivation of metals – Corrosion of monitoring methods and corrosion prevention - Electroplating of copper, chromium, zinc and gold – Anodizing – Electroforming – Electrocatalysis – Electrocatalysis in reactions involving absorbed species — Lithium-ion batteries – Fuel Cells – Photoelectrochemical cells - Recent Advances

Reference Books :

1. Bard & Faulkner, Electrochemical Methods: Fundamentals And Applications, Second Edition
2. Fritz Scholz, Electroanalytical Methods - Guide To Experiments And Applications, 2nd Ed, Springer-Verlag Berlin Heidelberg 2010
3. Joseph Wang, Analytical Electrochemistry, Third Edition 2006 John Wiley & Sons,
4. Vijay G. Singh, Applied Electrochemistry, Nova Science Publishers, 2010
5. John O'M Bockris, Amulya K. N. Reddy, Maria E. Gamboa-Adeco, "Modern Electrochemistry Vol.2 Part 1", Springer Science & Business Media, 2000
6. Raj Narayan, "An Introduction to metallic corrosion and its prevention", Oxford & IBH, 1983
7. Schlesinger, "Modern Electroplating", John Wiley, 2002
8. Jocek Lipkowski and Phil N. Ross, "Electrocatalysis", John Wiley & Sons, 1998
9. Thomas Reddy, "Linden's Handbook of Batteries" 4th Edition, McGraw-Hill, 2010

15CH3022 MATERIALS CHEMISTRY

Credits: 3:0:0

Course Objectives :

- To explain the synthesis, characterization and properties of materials.
- To demonstrate the applications of materials in various fields

Course Outcome :

- The students will get knowledge on the various types of materials and their synthetic strategy
- The student will understand the applications of material chemistry

Course Description :

Structure of Solids – Types – General Methods of Synthesis – Direct Synthesis – Solution Methods - Chemical Deposition – Transition Metal oxides – Metal nitrides – Chalcogenides - Characterization – Diffraction, Microscopic and Spectroscopic Techniques - Electrical, Optical and Magnetic properties – Carbon materials - Fullerenes - Application – Energy storage in solids – Catalysis – Porous materials - Recent Advances

Reference Books:

1. A.R. West, Solid State Chemistry and its Applications, (1984) John Wiley & Sons, Singapore.
2. C.N R. Rao and J. Gopalkrishnan, New Directions in Solid State Chemistry, (1997) Cambridge Univ. Press.
3. B. Viswanathan, Structure and Properties of Solid State Materials, (2006), Narosa Publishing House Pvt. Ltd. New Delhi.
4. T. V. Ramakrishnan and C.N.R. Rao, Superconductivity Today, (1992) Wiley Eastern Ltd., New Delhi.
5. P. Ball, Designing the Molecular World: Chemistry at the Frontier, (1994) Princeton Univ. Press.
6. William D. Callister, Fundamentals of materials science and engineering, (2001) Ed. 5, John Wiley & sons.

15CH3023 BIOMOLECULAR CHEMISTRY

Credits: 3:0:0

Course Objectives :

- To discuss the structure and functions of biomolecules
- To understand the influence of biomolecules in bodily processes.
- The student will be exposed to separation and classification of large molecules.

Course Outcome :

- The students will get knowledge about the structure, properties and action of biomolecules.

Course Description :

Amino acids and Proteins - Structure, synthesis, separation and purification techniques - Nucleic acids – Purines – Pyrimidines – DNA – RNA - DNA Synthesis – Carbohydrates – Furanose- Pyranose – Glycoproteins - Proteoglycans - Fatty Acids - Lipids – Types – Enzymes – Classification - Catalysis - Mechanism And Kinetics, Metabolism - Reaction Pathways - Bioenergetics - Cellular Energy- Oxidation Of Carbon Fuels - Receptors - Metabolic Pathways - TCA Cycle - Mitochondrial Electron Transport Chain - Amino Acid Metabolism

Reference Books :

1. H.F. Gilbert, Basic concepts in biochemistry, , McGraw Hill, Ed. 2, 2002
2. David L. Nelson, Michael M. Cox, Lehninger's Principles of biochemistry, Ed. 4, 2002
3. J.M. Berg, J.L. Tymoczko, L. Stryer, Biochemistry, ,5th Ed, W.H. Freeman & Co., 2004
4. Lynne B. Jorde, Biochemistry notes, Kaplan Inc., 2002
5. G. N. Wilson, Biochemistry, McGraw Hill co., 2002

15CH3024 ORGANOTRANSITION METAL CHEMISTRY

Credits: 3:0:0

Course Objectives :

- To discuss the Structure and bonding in various transition metal organometallic compounds
- To understand the reaction mechanism in organometallic reactions
- To know the recent advances in Bioorganometallic Chemistry and the applications of catalysts in organic Synthesis and Polymer Chemistry

Course Outcome :

- The Students will understand the importance of organometallic chemistry,
- To use the organometallic catalysts in various fields.

Course Description :

18 electron rule – π -acceptor and π -donor ligands - M-M bond in bimetallic complexes – Reactions - Oxidative addition - π -bond metathesis – Insertion and Extrusion Reactions – Reactions of Coordinated Ligands – Synthesis and Properties of Metal carbonyls - Metal-alkyls and Metal-hydride complexes - Carbene and Carbyne complexes - π -Complexes of mono and polyenes – Sandwich complexes – Catalysis – Hydrogenation – Transformations of Alkenes and Alkynes – C-H activation and functionalization of alkanes and arenes – Carbonylation and carboxylation – Heterogeneous Catalysis – Application in organic synthesis and Polymer Chemistry - Introduction to aqueous organometallic chemistry - Bioorganometallic Chemistry

Reference Books :

1. Didier Astruc, Organometallic Chemistry And Catalysis Springer-Verlag Berlin Heidelberg 2007
2. Robert H. Crabtree, Organometallic Chemistry of the Transition Metal, Wiley
3. Ferenc Joó, Aqueous Organometallic Catalysis, Kluwer Academic Publishers, 2002
4. Jiro Tsuji, Transition Metal Reagents and Catalysts: Innovations in Organic Synthesis. John Wiley & Sons, Ltd, 2000
5. Roderick Bates, Organic Synthesis Using Transition Metals (Postgraduate Chemistry Series) – Wiley-Blackwell; 2nd Edition, 2012

15CH3025 CHEMINFORMATICS

Credits: 3:0:0

Course Objectives :

- The graphical way of representation of chemical structures will be discussed
- The Concepts of Molecular Descriptors and Structure - activity relationship will be discussed
- Similarity Methods will be discussed

Course Outcome :

- The students gain knowledge on representation of chemical structures and the importance of QSAR and its use

Course Description :

Cheminformatics: Definition and scope – Representation of 2D molecular structures –Structure searching – Substructure searching – Reaction database - Representation of Patents – 3D representation – Experimental and theoretical 3D databases– 3D pharmacophores– Pharmacophore mapping – Applications – Molecular Descriptors – Descriptors calculated from 2D and 3D representations –Data verification and manipulation – Principal Component Analysis - Quantitative Structure-Activity Relationship – Deriving QSAR Equation – Similarity based on 2D fingerprints – Maximum Common Subgraph similarity –Cluster Analysis – Introduction to High-Throughput Screening Data

Reference Books :

1. Andrew R. Leach, Valerie J. Gillet, An introduction to chemoinformatics, Springer, 2005.
2. Johann Gasteiger, Thomas Engel, Chemoinformatics, Wiley-VCH, 2003
3. Handbook of Chemoinformatics, Johann Gasteiger, Wiley-VCH 2003.
4. B.A. Bunin, J. Bajorath, B. Siesel, G. Morales, Chemoinformatics: theory, practice and products, Springer, 2007
5. Richard G. Brereton, Chemometrics Data Analysis for the Laboratory and Chemical Plant, John Wiley & sons, 2003.
6. H. Holtje, W. Sippl, D. Rognan, G. Folker, Molecular modeling, Wiley-VCH, 2003.

15CH3026 ENVIRONMENTAL ELECTROCHEMISTRY

Credit: 3:0:0

Course objectives :

Student will learn on topics linking environmental issues such as

- Environmental phenomena,
- Environmental protection, remediation
- Manmade environmental damages, with electrochemical phenomena.

Course Outcome :

- The students will be exposed to basics in electrochemistry, and
- Electrochemically oriented environmental issues.

Course Description :

Principles of electrolyte solutions-reactions at the electrode-solution interface the electrical double layer, Gouy-Chapman-Stern theory for the structure of the electrical double layer-. electrochemical kinetics-Electron-transfer through the interface- Tafel equation - Electrokinetics-electroosmosis-Helmholtz-Smoluchowski equation- Electrochemical reactors- Environmentally-related electrochemical issues-Electrochemical methods for water and wastewater purification- fuel cells and bioelectrochemistry for cleaner energy, electrocoagulation.

Reference Books :

1. J. Koryta, J. Dvorak, L. Kavan "Principles of Electrochemistry", John Wiley Publishers, 1993.
2. S. Glasstone, Textbook of Physical Chemistry, Macmillan, Bombay, India, 2nd edition, 1974.
3. Duncan A MacInnes, "The principles of Electrochemistry", Reinhold publishing corporation, 1998.
4. Bockris & Reddy, "Modern Electrochemistry", Springer, Volumes 1 & 2, 1973.
5. K Scott, "Electrochemical Reaction Engineering", Academic Press, London 1991.
6. P. Delahay, Double Layer and Electrode Kinetics", USA: Wiley-Interscience, 1965.
7. C. A. C. Sequeira, "Environmental oriented electrochemistry", Elsevier 1994.
8. Christos Comninellis, Marc Doyle, Jack Winnick, "Energy and electrochemical processes for a cleaner environment: proceedings" by Electrochemical Society, International Society of Electrochemistry, Electrochemical society Etats-Unis Energy technology division, Electrochemical Society Meeting. - Science - 2001.

15CH3027 MOLECULAR MACHINES AND MATERIALS

Credits: 3:0:0

Course Objectives :

- The students will learn the advanced concepts and the molecular nanotechnology of the future viz., molecular machines and switches.
- Information on modern chemistry which aids the students get motivated and prepared to do research after their masters.
- Imparting knowledge on the conceptual foundations of the possible near future inventions of miniature molecular devices.

Course Outcomes :

- The students will understand the working principles of molecular machines and materials and the ways of assembling new molecular machines.
- They will learn the structure, function, and applications of molecular machines, switches, and devices.

Course Description :

Molecular machines – concept of a mechanical bond – threading followed by stoppering protocol and clipping protocol in the synthesis of rotoxanes – slippage and ring shrinkage – solvophobicity driven templation – application – light driven molecular motors – molecular motors operating on surfaces – Molecular electronics – Molecular logic – types and functions – potential applications – rotors and motors on surfaces – the challenge of unidirectional molecular rotation – Molecular devices – molecular ammeter – molecular keypad lock

Reference Books :

1. Jean-Pierre Sauvage, Pierre Gaspard, From Non-covalent Assemblies to Molecular Machines, Wiley-VCH, 2011.
2. Ben Feringa, Molecular Switches, Wiley-VCH, 2001.
3. Manfred Schliwa, Molecular Motors, Wiley-VCH, 2003.

15CH3028 SELF ORGANIZATION AND SELF-ASSEMBLY IN NANOSTRUCTURES

Credits: 3:0:0

Course Objectives :

- The students will learn the structural chemistry of popular nanoconstructs of current importance.
- Information on modern chemistry which aids the students get motivated and prepared to do research after their masters.
- A knowledge on the scaling laws of nanochemistry.

Course Outcomes :

- The students will know the selectivity in formation of molecular and materials self-assembly and the factors governing it.
- They will learn the structure, function, and applications of nanochemistry in developing new ideas related to medicine and energy applications.

Course Description :

Core concepts of nanochemistry – Self organization vs. Self-assembly – pattern formation - surface, size, shape, defects, self-assembly, and bio-nano interface – five faces of nanochemistry: gold, polydimethylsiloxane, cadmium selenide, iron oxide, carbon – self-assembled monolayers – layer-by-layer self-assembly – self-assembly of nanoparticles, nanorods and tubes – bioinspiration in nanochemistry.

Reference Books :

1. Ludovico Cademartiri, Geoffrey A. Ozin, Concepts of Nanochemistry, 2009, Wiley-VCH
2. Geoffrey A. Ozin, A.C. Arsenault, Nanochemistry: A Chemical Approach to Nanomaterials, RSC Publishing, 2005.
3. Zhong Gao, Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, Imperial College Press, London, UK, 2004.
4. John. A. Pelesko, Self Assembly: The Science of Things That Put Themselves Together, Chapman & Hall/CRC, 2007.

LIST OF SUBJECTS

Subject Code	Name of the Subject	Credits
14CH1001	Applied Chemistry	3:0:0
14CH1002	Applied Chemistry Lab	0:0:2
14CH1003	Environmental studies	3:0:0
14CH2001	Basic Inorganic Chemistry	3:0:0
14CH2002	Transition metal and Coordination chemistry	3:0:0
14CH2003	Advanced Inorganic Chemistry	3:0:0
14CH2004	Qualitative analysis and inorganic preparations lab	0:0:2
14CH2005	Titrimetric Analysis And Gravimetric Analysis Lab	0:0:2
14CH2006	Basic Organic Chemistry	3:0:0
14CH2007	Aliphatic and Aromatic Chemistry	3:0:0
14CH2008	Basic Reaction Mechanism	3:0:0
14CH2009	Organic Qualitative Analysis Lab	0:0:2
14CH2010	Organic Preparations Lab	0:0:2
14CH2011	Thermodynamics and Kinetics	3:0:0
14CH2012	Electrochemistry, Catalysis and Colloidal Chemistry	3:0:0
14CH2013	Photochemistry, Nuclear Chemistry and Corrosion	3:0:0
14CH2014	Physical Chemistry Lab – I	0:0:2
14CH2015	Physical Chemistry Lab – II	0:0:2
14CH2016	Chemistry for Civil Engineers	3:0:0
14CH2017	Chemistry for Mechanical and Aerospace Engineers	3:0:0
14CH2018	Chemistry for Electrical and Electronics Engineers	3:0:0
14CH2019	Chemistry for Computer Engineers	3:0:0
14CH2020	Chemistry for Biologists	3:0:0
14CH2021	Chemistry for Food Science Engineers	3:0:0
14CH2022	Structural Chemistry for Biologists	3:0:0
14CH2023	Applied Nanochemistry and Next Generation Materials	3:0:0
14CH3001	Polymer Chemistry	3:0:0
14CH3002	Nanochemistry	3:0:0
14CH3003	Nanotechnology for Energy Applications	3:0:0
14CH3004	Analytical Chemistry	3:0:0
14CH3005	Chemical Approach to Nanomaterials	3:0:0
14CH3006	Medicinal Chemistry	3:0:0
14CH3007	Supramolecular Chemistry	3:0:0
14CH3008	Corrosion Science and Engineering	3:0:0
14CH3009	Nanotechnology for Medicinal Applications	3:0:0
14CH3010	Polymers for Nanotechnology	3:0:0
14CH3011	Technical Textiles	3:0:0
14CH3012	Metals in Biology	3:0:0

14CH1001 APPLIED CHEMISTRY

Credits: 3:0:0

Objective:

- To understand problems associated with hard water and treatment methods.
- To learn about fabrication of polymers, industrially important polymers and their bio-degradability.
- To know about calorific value of fuels, methods to improve anti-knocking characteristics, bio-fuels and flue gas analysis.
- To have understanding about construction and working of batteries, corrosion – types and control methods.
- To impart the basic aspects of inorganic engineering materials.

Outcome:

- To suggest methods to minimize problems related to hard water in industrial operations.
- To select and use eco-friendly fuels and biodegradable polymers for industrial and domestic purpose.
- To use appropriate methods to minimize corrosion of metals.

Course Description:

Water Technology – Sources of Water – Softening of hard Water – High polymers – Classification – Types – Industrial Polymers – Biodegradable Polymer – Fuels – Classification – Solid Fuels – Liquid Fuels – Gaseous Fuels – Biofuels – Electrochemistry – Nernst Equation – Electrochemical cells – Batteries – Corrosion –Engineering Materials – Refractories – Abrasives – Insulators – Lubricants

Reference Books:

1. Jain P. C, Monica Jain, “A text book of engineering chemistry”, Dhanapat Rai publications, New Delhi, 12th edition, 2006.
2. Subha Ramesh, Vairam, Anandhan, “Engineering Chemistry”, Wiley India Pvt. Ltd., New Delhi, 2011
3. Gowrikar V. R, Viswanathan N. V, Jaydev Sreedhar, “Polymer Science”, New Age International Pvt. Ltd., New Delhi, 2000.
4. Agarwal C. V, “Chemistry of Engineering materials”, C.V. Tara Book Agency, 1982.
5. Shashi Chawla, “A text book of engineering chemistry”, Dhanapat Rai publications, New Delhi, 8th edition, 2008.

14CH1002 APPLIED CHEMISTRY LAB

Credits: 0:0:2

Objective:

- To train the students in gaining hands on experience to handle various applied chemistry laboratory techniques.

Outcome:

- The students can apply their theoretical applied chemistry knowledge in practical applications

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14CH1003 ENVIRONMENTAL STUDIES

Credits: 3:0:0

Objective:

- To acquire knowledge of elements of environment, it's need & importance.
- To know about pollution problems and green technology.
- To develop a sense of responsibility about the role of students in fostering the idea of learning to live in harmony with nature.
- To create an awareness about the major environmental issues for a sustainable development.

Outcome:

- At the end of this course the students are expected to understand the importance of environment, the effect of technology on the environment and ecological balance
- To make the students sensitive to the environment problems in every professional endeavor in which they participates.

Course Description:

Environment - Definition, Scope And Importance , Renewable And Non-Renewable Resources – Natural Resources– Ecosystem – Energy Flow - Biodiversity — Values -Hot-Spots – Various types of Pollution – Nuclear Hazards – Solid Waste Management -From Unsustainable To Sustainable Development – Urban Problems Related

To Energy – Water Conservation–Environmental Ethics — Environment Protection Acts—Population Growth and Explosion— HIV/AIDS –Role Of Information Technology– Disaster Management

Reference Books:

1. Deeksha Dave, “Environmental Studies”, Cengage Learning India Pvt Ltd, New Delhi – 2011
2. Raman Shivakumar, “Introduction Environmental science and Engineering”, Tata Mc Graw Hill, 2010.
3. Bharucha Erach, “Text book on environmental studies” For Undergraduate Courses of all Branches of Higher Education, University Grants Commission, New Delhi, 2004.
4. Abnubha Kaushik, Kaushik C.P., “Perspectives in Environmental Studies” New Age International Publishers, Third Edition, 2009.
5. Sharma B.K. “Environmental Chemistry” Comprehensive covering the UGC Syllabus, 11th Edition, Goel Publishing House, Meerut, Eleventh Edition, 2007.

14CH2001 BASIC INORGANIC CHEMISTRY

Credits: 3:0:0

Objective:

- To explain the importance of atomic structure and chemical bonding.
- To get thorough knowledge about various kinds of bonding in inorganic chemistry
- To expose to theory of acids and bases.

Outcome:

- Students will have the knowledge of atomic structure
- The students will know the basis of various types of bonding .
- The students will have a complete understanding of acid base theory

Course Description:

Atomic structure – Dual Nature of electrons - Bohr theory – Shraodinger equation – Hund’s rule - Types of Bonds – Ionic bond – radius ratio – Ionic compounds of type AX, AX₂ – Born Lande equation – Defects – Metallic bond – Properties– Superconductivity – Born Haber cycle – Covalent bond - Lewis theory -VSEPR Theory-VB theory– σ and π bonds. Molecular Orbital theory- LCAO method–diatomic molecules -Acids and Bases - Bronsted Lowry and Lewis theory – Acids and Bases - Hard and Soft acids and bases - Applications

Reference Books:

1. Lee J. D, “Concise Inorganic Chemistry”, Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Madan R. D, “Modern Inorganic Chemistry”, S. Chand and Company Ltd, New Delhi, India, 3rd edition, 2011.
3. Sharpe A.G. “Inorganic Chemistry”, Dorling Kindersley (India) Pvt. Ltd, 2nd impression, 2008.
4. W. H. Madan, G. D. Tuli, R. D.Madan, “Selected Topics in Inorganic Chemistry”, S. Chand & Company Ltd, Reprint 2009.
5. Huheey J. E, Keiter E. A & Keiter R. L, “Inorganic Chemistry – Principles of structure and reactivity”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.

14CH2002 TRANSITION METAL AND COORDINATION CHEMISTRY

Credits: 3:0:0

Objective:

- To explain the various theories of coordination chemistry
- To explain the nomenclature and isomerism in coordination compounds
- To get thorough knowledge about transition metal inorganic chemistry

Outcome:

- The students will know the properties of transition metal compounds
- Students will have the complete understanding of formation of coordination complexes
- The students will know the importance of crystal field theory

Course Description:

Transition metals –Properties –variable oxidation state color -magnetic properties- size - Difference between the first row & the other two rows – catalytic properties - Coordination compounds – Nomenclature - Werner's theory – effective atomic number - shapes of d orbital – Valence bond Theory – Crystal Field theory–Octahedral Complex-effect of crystal field splitting - John-Teller distortion – square planar and Tetrahedral complexes- – MO theory – chelates Isomerism

Reference Books:

1. Lee J. D, "Concise Inorganic Chemistry", Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Shriver and Atkins, "Inorganic Chemistry", Oxford University Press, New Delhi, India, 4th edition, 2009.
3. Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
4. W. H. Madan, G. D. Tuli, R. D.Madan, "Selected Topics in Inorganic Chemistry", S. Chand & Company Ltd, Reprint 2009.
5. Sharpe A.G. "Inorganic Chemistry", Dorling Kindersley (India) Pvt. Ltd, 2nd impression, 2008.

14CH2003 ADVANCED INORGANIC CHEMISTRY

Credits: 3:0:0

Objective:

- To explain the importance and properties of f-block elements.
- To explain the fundamentals of organometallic and bioinorganic chemistry
- To expose to inorganic cpolymer chemistry

Outcome:

- Students will have the thorough knowledge of chemistry of f-block elements
- The students will know the importance oforganometallic chemistry and bioinorganic chemistry.
- The students will know the applications of important inorganic polymers

Course Description:

F block elements – separation - Electron structure —oxidation state - properties – color and spectra - lanthanide contraction - Uranium extraction – Nuclear fission - Organometallics - metal carbonyls - ferrocene – catalysis - Zeigler Natta catalyst – Bio inorganic chemistry of Iron, Cobalt, Copper and Zinc (Introductory concepts only) – Hemoglobin -Main group Chemistry - Allotropy of carbon- graphite and Diamond - Classification of Silicates – Cement - Ceramics- Glasses- Inorganic polymers – Silicones- phosphazenes – (SN)x.

Reference Books:

1. Lee J. D, "Concise Inorganic Chemistry", Wiley India (P.) Ltd, New Delhi, India, 5th edition, Reprint 2009.
2. Shriver and Atkins, "Inorganic Chemistry", Oxford University Press, New Delhi, India, 4th edition, 2009.
3. Huheey J. E, Keiter E. A & Keiter R. L, "Inorganic Chemistry – Principles of structure and reactivity", Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
4. W. H. Madan, G. D. Tuli, R. D.Madan, "Selected Topics in Inorganic Chemistry", S. Chand & Company Ltd, Reprint 2009.
5. Sharpe A.G. "Inorganic Chemistry", Dorling Kindersley (India) Pvt. Ltd, 2nd impression, 2008.

14CH2004 QUALITATIVE ANALYSIS AND INORGANIC PREPARATIONS LAB

Credits: 0:0:2

Objective:

- To provide the students an appreciation for the synthesis of Inorganic Complexes.
- To provide the students a competence in the laboratory skills required for accurate and precise chemical analysis.
- The students will know the theoretical basis of qualitative inorganic analysis containing common and less common ions.

Outcome:

- The student will gain the laboratory skills to synthesize the inorganic complexes
- will be confident in analyzing the mixtures containing common and less common ions using semimicro analysis
- Their separation skills will be improved

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14CH2005 TITRIMETRIC ANALYSIS AND GRAVIMETRIC ANALYSIS LAB

Credits: 0:0:2

Objective:

- To enrich the knowledge of estimation through titrimetric
- To gain some insights towards gravimetric skills
- To improve the Quantitative analytical skills

Outcome:

- Students acquire the knowledge of acidimetry and permanganometry,
- They understand the importance of iodometry, complexometry and dichrometry
- They can estimate any compound by gravimetry.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14CH2006 BASIC ORGANIC CHEMISTRY

Credits: 3:0:0

Objective:

- The student will get rudimentary ideas on chemical structure
- Versatile knowledge about the formula of organic Molecules.
- The student will have an idea about stereoisomerism and conformation in chemical structure and properties of molecules.

Outcome:

- The students will get the understanding on the structural basics of organic compounds
- They will understand the nomenclature of Organic compounds
- To Understand the stereoisomerism and conformation of organic molecules

Course Description:

Classification and Nomenclature of organic and heterocyclic compounds – Electrophiles and nucleophiles – Carbocation and Carbanion, Free radicals, Arynes - Inductive effect and field effect – Hyperconjugation –

Tautomerism - Substitution reactions, Addition reactions, Elimination reactions, Rearrangement reactions – Kinetic and thermodynamic control - Stereoisomerism – Cis-trans isomerism – E, Z nomenclature – Optical isomerism – Absolute configuration – R, S nomenclature – Cahn, Ingold, Prelog nomenclature - conformation and configuration – Conformation of ethane and cyclohexanes

Reference Books:

1. Bhupinder Mehta, Manju Mehta, Organic Chemistry, Prentice Hall of India private ltd., New Delhi, 2008.
2. Nasipuri, stereochemistry of organic compounds: principles and applications, New Academic Science Limited, 2012
3. O.D. Tyagi, M. Yadav, A Text Book of Organic Chemistry, Anmol Publishing Ltd., New Delhi, 2009
4. P.S. Kalsi, Stereo Chemistry Conformation and Mechanism, New Age Publishing Ltd., New Delhi, 6th Edition, 2005.
5. Jerry March, Advanced Organic Chemistry, Willey, 6th Edition, Newyork, 2007
6. I.L. Finar, Organic Chemistry, Pearson Education Pvt. Ltd., Vol. I & II, 6th Edition, Singapore, 2002
7. R.T. Morrison & R.N. Boyd, Organic Chemistry, 6th Edition, Pearson Education Pvt Ltd., Singapore, 2003

14CH2007 ALIPHATIC AND AROMATIC CHEMISTRY

Credits: 3:0:0

Objective:

- The student will be exposed to ideas about Aliphatic and aromatic compounds, their preparation and chemical properties.
- The student will learn about some common organic reactions
- To have an idea about the molecular rearrangements.

Outcome:

- The students will get knowledge on the reactions of carbonyl and nitrogen containing compounds
- They gain the knowledge about the molecular rearrangements
- They gain insights about features of commonly used name reactions

Course Description:

Aliphatic carbonyl compounds – Aliphatic nitrogen containing compounds – Aromatic aldehydes and ketones – Aromatic carboxylic acids – mono and dicarboxylic acids - Aromatic nitrogen containing compounds – Azines - Arenediazonium salts – Aldol, Perkin, Dieckman condensations – Reimer-Tiemann, Grignard reactions – Gattermann reaction, Friedel-Crafts reaction, Wittig reaction, Clemmensen reduction, Baeyer-Villiger reaction, Fries reaction, Stevens, Benzil-benzilic acid rearrangement, Curtius rearrangement, Hoffmann rearrangements

Reference Books:

1. Bhupinder Mehta, Manju Mehta, Organic Chemistry, Prentice Hall of India private ltd., New Delhi, 2008.
2. O.D. Tyagi, M. Yadav, A Text Book of Organic Chemistry, Anmol Publishing Ltd., New Delhi, 2009
3. Jerry March, Advanced Organic Chemistry, Willey, 6th Edition, Newyork, 2007
4. F. A. Carey & R. J. Sundberg. Advanced Organic Chemistry, Part A and B, 5th Edition. 2007.
5. Wamser & Harris, Fundamentals of Organic Reaction Mechanisms, John Wiley (1990).
6. R.T.Morrison & R.N.Boyd, Organic Chemistry, 6th Edition, Pearson Education Pvt Ltd., Singapore, 2003

14CH2008 BASIC REACTION MECHANISM

Credits: 3:0:0

Objective:

- Chemical reactions, which are mostly used to synthesize compounds of various types, and their mechanism, are discussed.
- Distinguishing the types of reactions and their mechanism will give an idea of the structural requirements of reactions of a particular type.

- The student will be able to write a reaction by explaining which bonds are broken and in what order.

Outcome:

- The students will get a thorough knowledge on the operating in the reactions of organic compounds and mechanism.
- Learn to identify the reaction mechanism
- Students can design new organic reactions based on the knowledge about reaction mechanism

Course Description:

The S_NAr mechanism – illustration with an example - benzyne mechanism – illustration with an example - S_N1 and S_N2 mechanisms – illustration with an example - neighboring group participation – Examples - Arenium ion mechanism – illustration with an example - Hammett equation – S_E2 mechanism – illustration with an example - S_E1 mechanism – illustration with an example - Addition reactions - illustration with an example - Elimination reactions – mechanism – illustration with an example - E_1 , E_2 mechanisms - illustration with an example -

Reference Books:

1. Jerry March, Advanced Organic Chemistry, Wiley, 6th Edition, Newyork, 2007
2. F. A. Carey & R. J. Sundberg. Advanced Organic Chemistry, Part A and B, 5th Edition. 2007.
3. S.M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, Macmillan Publishers, India Limited, Reprinted, 2010
4. R.T.Morrison & R.N.Boyd, Organic Chemistry, 6th Edition, Pearson Education Pvt Ltd., Singapore, 2003
5. S. H. Pine, Organic Chemistry, 5th edn., McGraw-Hill, 1987
6. Wamser & Harris, Fundamentals of Organic Reaction Mechanisms, John Wiley (1990).

14CH2009 ORGANIC QUALITATIVE ANALYSIS LAB

Credits: 0:0:2

Objective:

- Enable to identify the functional group of the organic compound
- To obtain the practical skills in setting up of an organic reaction
- To prepare small organic molecules as derivatives

Outcome:

- Knowledge of systematic analysis of an organic compound
- The students will have the knowledge of identifying the functional groups of the organic compounds
- They will equip themselves in the preparation of simple organic compounds and understand their mechanism

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14CH2010 ORGANIC PREPARATIONS LAB

Credits: 0:0:2

Objective:

- Employ various reaction types to prepare organic compounds
- To train themselves in setting up of an organic reaction
- To have knowledge about handling the chemicals and laboratory scale preparations

Outcome:

- Understanding of the reaction conditions for various organic reactions
- They will equip themselves in the preparation of simple organic compounds
- They understand the mechanism of the reactions

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14CH2011 THERMODYNAMICS AND KINETICS

Credits: 3:0:0

Objective:

- To study the physical properties of solids
- To get thorough knowledge about the principles of chemical thermodynamics
- To study the chemical equilibrium and the chemical kinetics of reactions

Outcome:

- To know the physical characteristics of solids
- To understand the thermodynamic principles
- To understand the concepts of chemical equilibrium and chemical kinetics

Course Description:

The solid state – Crystal systems – Liquid crystals – Chemical thermodynamics – Thermodynamic processes – First law of thermodynamics – Thermochemistry – Second law of thermodynamics – Carnot's theorem – Maxwell's relations – Chemical Equilibrium – Spontaneous reactions – The van't Hof reaction – Heterogeneous equilibria – Chemical Kinetics – Overview of first, second, third and zero order reactions – Kinetics of fast reactions – Flow methods for fast reactions - Pulse methods – Flash photolysis – Pulse radiolysis .

Reference Books:

1. B.R. Puri, L.R. Sharma and Madan S. Pathania, "Principles of Physical Chemistry", Vishal Publishing Co., Jalandhar, 2008
2. J. C. Kuriacose and J.Rajaram, "Thermodynamics for students of chemistry", 3rd Edition, Shoban Lal Nagin Chand & Co., Jalandhar, 1999 (recent edition)
3. Un Dash, Op Dharmarha and P.L. Soni, "Text book of Physical Chemistry", Sultan Chand & Sons, New Delhi, 2011
4. Samuel H. Maron and Carl F. Prutton, "Principles of Physical Chemistry", fourth edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 1965 (reprinted in 2009)
5. K.J. Laidler, "Chemical Kinetics", 3rd Edition 1997, Benjamin-Cummings. Indian reprint – Pearson, 2009
6. C. Kalidas, "Chemical Kinetic Methods: Principles of Relaxations Techniques and application", New Age International (P) Ltd, Chennai, 1996 (recent edition)
7. M.J. Piling and P.W. Seakins, "Reaction Kinetics", Oxford University Press, 2nd edition, 1996 (recent reprint)

14CH2012 ELECTROCHEMISTRY, CATALYSIS AND COLLOIDAL CHEMISTRY

Credits: 3:0:0

Objective:

- To study the fundamental concepts of electrochemistry
- To study the principles of quantum chemistry and surface chemistry
- To study colloidal chemistry and phase equilibria

Outcome:

- To get a basic knowledge about electrochemistry
- To understand the theory involved in quantum chemistry and surface chemistry
- To come to know about the colloidal solutions and phase equilibria of one and two component systems

Course Description:

Electrochemistry – Kohlrausch's law – Activity coefficients of electrolytes – The Nernst equation – Quantum Chemistry – The Compton effect – Schrödinger equation – Antisymmetry and Pauli's exclusion principle – Aufbau principle – Born Oppenheimer approximation – LCAO, MO and VB treatments of hydrogen molecule - Catalysis and surface chemistry – Enzyme catalysis – The Michaelis-Menten equation – Colloidal Chemistry – Emulsion – Osmosis – Phase rule - One component system – Two component system – Solid solutions.

Reference Books:

1. Samuel Glasstone, "An introduction to electrochemistry" Atlantic Publishers, 2007
2. B.R. Puri, L.R. Sharma and Madan S. Pathania, "Principles of Physical Chemistry", Vishal Publishing Co., Jalandhar, 2008
3. A.K Chandra, "Introduction to Quantum Chemistry", Tata McGraw Hill, New Delhi, 1997 (recent edition)
4. A.W. Adamson, "Physical Chemistry of Surfaces", 5th edition, Wiley, 1997 (recent edition)
5. Un Dash, Op Dharmarha and P.L. Soni, "Text book of Physical Chemistry", Sultan Chand & Sons, New Delhi, 2011
6. Peter Atkins, "Elements of Physical Chemistry", OUP Oxford, 6th edition, 2012
7. I.N. Levine, "Quantum Chemistry", Pearson Education Inc., 2003 (recent edition)

14CH2013 PHOTOCHEMISTRY, NUCLEAR CHEMISTRY AND CORROSION

Credits: 3:0:0

Objective:

- To study the fundamental concepts of photochemistry
- To study the principles of radiochemical reactions
- To study the applied concepts of electrochemistry

Outcome:

- To get a basic knowledge about photochemical reactions
- To understand the concepts of radiochemistry and its applications
- To understand the advanced applications of electrochemistry

Course Description:

Photochemistry – Laws – Quantum yield – Photosensitized reactions – Photophysical processes – Fluorescence – Phosphorescence – Chemiluminescence – Nuclear Chemistry – Radioactivity – Detection and measurement of radioactivity – Half life - Nuclear reactions – Nuclear Reactor – Hydrogen bomb - Advanced Electrochemistry – Battery technology – Battery characteristics – Classical batteries – Modern batteries – Lithium cells/ Batteries - Corrosion of metals – Types of corrosion – Factors affecting corrosion – Passivation of metals - Metal finishing – Types of metal finishing.

Reference Books:

1. K.K. Rohatgi-Mukherjee, "Fundamentals of Photochemistry", New Age International (P) Ltd., 2006
2. Angelo Albini, "Photochemistry – Vol. 38", Royal Society of Chemistry, 2011
3. Giridhar Sharma, "Advanced Electrochemistry", Campus Books International, 2010
4. Thomas Reddy, "Linden's Hand Book of Batteries", McGraw Hill Professional, 2010
5. E. McCafferty, "Introduction to Corrosion Science, Springer, 2010
6. Milan Paunovic, "Modern Electroplating ", 5th Edition, Wiley, 2010
7. M. Sharon, "Nuclear Chemistry", Ane Books Pvt. Ltd., 2009

14CH2014 PHYSICAL CHEMISTRY LAB – I

Credits: 0:0:2

Objective:

- To train the students on instrumental methods of analysis
- To carryout experiments on chemical kinetics
- To get an basic idea about electrochemistry

Outcome:

- Understand the principle and working of various instrument methods of analysis.
- To apply the principle of chemical kinetics
- To apply the knowledge in measuring real samples

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14CH2015 PHYSICAL CHEMISTRY LAB – II

Credits: 0:0:2

Objective:

- To do experiments based on phase rule and absorption.
- To do experiments based spectrophotometry
- To gain some idea in distribution coefficient and equilibrium constant

Outcome:

- To apply principles of absorption, phase rule, distribution coefficient and equilibrium constant
- To understand applications of spectrophotometry
- To apply the knowledge in measuring real samples

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14CH2016 CHEMISTRY FOR CIVIL ENGINEERS

Credits: 3:0:0

Objective:

- To understand the application of composites as building materials
- To familiarize the student with various types of testing and treatment of water and sewage
- To impart the basic knowledge of chemical composition of building materials
- To learn the application of organic binders and paints

Outcome:

- Students will have the knowledge of chemistry concepts of building materials, organic binders and road marking paints
- Students will have complete understanding of the testing and treatment methods of water and sewage

Course Description:

Water quality analysis – pH, Total dissolved solids, Total suspended solids, Hardness, Determination of Na, K, Fe, Sulphate, chloride, fluoride, phosphate, silica content, BOD, COD- Sewage – constituents of sewage – aerobic and anerobic oxidation – primary, secondary and tertiary treatment – cement – classification- manufacturing process- decay of cement- Portland cement – plaster of paris-porcelain – properties and applications- Composites – constituents – types – application – fibre reinforced composites and its types –nanocomposites – organic coatings – paints – formulation of paints-failure-varnishes-lacquersc - special paints –adhesives – adhesive action – factors influencing adhesive strength

Reference Books:

1. Jain P.C. and Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Co. (P) Ltd., New Delhi, 2010.
2. Shashi Chawla, "Text book of Engineering Chemistry", Dhanpat Rai & Co. (Pvt.), Ltd., New Delhi, 2008.
3. N.Manivasakam, "Physico-chemical examination of water sewage and industrial effluents" Pragati Prakashan, 1996
4. S.S. Dara, A text book of engineering Chemistry I and II, 4th revised edition, S. Chand and co, 1994.

14CH2017 CHEMISTRY FOR MECHANICAL AND AEROSPACE ENGINEERS**Credits: 3:0:0****Objective:**

- To explain the fundamentals of Protective coatings and surface chemistry
- To get thorough knowledge about Composite materials and Alloys

Outcome:

- The students will know the phase rule and composition behind the various metal alloys
- Students will have the complete understanding of fabrication of polymer composites

Course Description:

Phase rule – Two component alloy system - Surface Chemistry – Adsorption - Classification – Application – Langmuir adsorption Equation – Polymers – Structure-properties correlations – Important organic and inorganic polymers – Fabrication of Polymer Composites- Composites – Constituents – Types – FRC – Metallurgy –Steps – Alloys –Heat treatment of steel - Electroplating – Characterization – Methods - Paint

Reference Books:

1. P. C. Jain and Monika Jain, "Engineering Chemistry" Dhanpat Rai Publishing Company (P) Ltd, New Delhi, India, 15th Edition, 2009
2. Gowrikar V. R, Viswanathan N. V, Jaydev Sreedhar, "Polymer Science", New Age International Pvt. Ltd., New Delhi, 2000.
3. Subha Ramesh, Vairam, Anandhan, "Engineering Chemistry", Wiley India Pvt. Ltd., New Delhi, 2011.
4. Agarwal C. V, "Chemistry of Engineering materials", C.V. Tara Book Agency, 1982.
5. Palanna O. G, "Engineering Chemistry", Tata McGraw Hill Education pvt., Ltd., New Delhi, 2009.

14CH2018 CHEMISTRY FOR ELECTRICAL AND ELECTRONICS ENGINEERS**Credits: 3:0:0****Objective:**

- To know the significance of electromagnetic radiation and its interaction
- To understand the basic concepts about the photochemistry
- To know the importance of semiconductors and device fabrication
- To study the superconducting materials, lithography and energy storage devices
- To know about new generation materials used in LEDs and in other applications

Outcome:

- Students will have the wide spectrum of knowledge in electromagnetic radiation, photochemical reaction and its applications.
- The students will understand basic concepts of semiconductor, superconductors and LEDs.

Course Description:

Electromagnetic radiation – Absorption spectrophotometer instrumentations – Introduction to low energy radio waves – Laws of Photochemistry – Quantum efficiency – Photosensitization – Luminescence – LASER – Solar energy conversion – Semiconductors – Types – Devices – Superconductors – Fullerenes – Lithography – Graphene based energy storage devices – Signal transduction – Light emitting diode materials and devices – Polymers with piezoelectric, pyroelectric properties – Nano-materials – Catalysis, photovoltaic and medicine.

Reference Books:

1. Jain P.C. and Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Co. (P) Ltd., New Delhi, 2010.
2. G. Cao "Nanostructures and Nanomaterials", Imperial College Press, London, 2008.
3. P.R. Puri, L. R. Sharma and Madan S. Pathania, "Principles of Physical Chemistry", Vishal Publishing Co., Delhi, 2008.
4. R.J. Young and P.A. Lovell, "Introduction to polymers", Rebika Press Pvt. Ltd., New Delhi, 2004.
5. K. Kalantar-zadeh and B. Fry, "Nanotechnology – Enabled Sensors", Springer, New York, 2010.

14CH2019 CHEMISTRY FOR COMPUTER ENGINEERS

Credits: 3:0:0

Objective:

- To know about fundamentals of materials chemistry and various classes of materials
- To study the characterization of materials by analytical techniques
- To know about photolithography and its applications

Outcome:

- The students will know the basics of materials chemistry
- The students will understand the application of materials in diversified fields

Course Description:

Fundamentals of materials chemistry – various classes of materials – solids – metals – semiconductors – superconductors – alloys – composite materials – characterization of materials – Instrumentation – X-ray Diffraction, UV-visible, microwave, IR and Raman spectrophotometer – Introduction to optical fiber and organic light emitting diode materials - Photolithography – Polymers with piezoelectric, pyroelectric and ferroelectric properties – Inorganic light emitting materials and devices – Synthesis, properties and their applications – Inorganic based nanomaterials and their potential applications in areas such as catalysis, photovoltaics and medicine.

Reference Books:

1. Harry R. Allcock, "Introduction to Materials Chemistry", John Wiley & Sons, New Jersey, 2008
2. Shashi Chawla, "A Text Book of Engineering Chemistry", Dhanpat Rai & Co., Delhi, 2008
3. Jain P.C. and Monica Jai, "Engineering Chemistry", Dhanpat Rai Publishing Co. (P) Ltd., New Delhi, 2010
4. Garry S. May and Simon M. Sze, "Fundamentals of Semiconductor Fabrication", John Wiley & Sons, Inc., 2004
5. William D Callister, Jr., "Materials Science and Engineering- An Introduction" Sixth Edition, John Wiley & Sons, New York, 2003

14CH2020 CHEMISTRY FOR BIOLOGISTS

Credits: 3:0:0

Objective:

- To have a thorough knowledge in preparing solutions for analytical testing
- To get an idea about the applications of the chromatography and microscopy
- To enable the students to understand the concepts in physical and chemical processes in living systems
- To provide an introduction to the basic analytical tools needed for experiments in Biology.

Outcome:

- The students will have the fundamental ideas on preparation of solution which are essential for wet analytical science
- They will understand the applications of microscopy and chromatography
- They gain some rudimentary ideas on solutions, colloids, and surfaces which are essential for wet analytical science

Course Description:

Mole concept. Principle of volumetric analysis acidity, alkalinity and buffer solutions - Free energy, enthalpy and entropy. Energetics of Metabolism and ATP cycle – Chemical potential – Gibbs Duhem equation – Statements and applications of distribution laws (without derivation) – Physical significance - Adsorption- Langmuir and Freundlich isotherms. BET equation (no derivation) and its application to surface area measurement. Sols (reversible and irreversible), Emulsions and Emulsifiers, Association colloids (micelles), Gels - Applications of colloids - Paper, thin-layer, gel-filtration, ion-exchange, affinity and High-Performance Liquid Chromatography (HPLC). Principles of Light, confocal, fluorescence and electron microscopy

Reference Books:

1. R. Gopalan, S. Sundaram, Allied Chemistry, Sultan Chand and Sons (1995).
2. Nelson, D.L. and Cox, M.M. (2005); Lehninger, Principles of Biochemistry, fourth edition, W.H. Freeman and company, N.Y. USA.
3. B. R. Puri, L. R. Sharma, and M. S. Pathania, Principles of Physical Chemistry, 37th Edition (1998), Shoban Lal Nagin Chand & Co., Jalandhar.
4. M. J. Sienko and R.A. Plane, Chemistry - Principles and properties, International Student Edition, 1995.
5. Voet, D and Voet, J.G, (2009) Biochemistry, John Wiley and Sons, N.Y. USA.
6. Bozollo JJ, Russell LD, Electron Microscopy, Edition II, Jones and Bartlett Publishers, Inc., Printed in India.

14CH2021 CHEMISTRY FOR FOOD SCIENCE ENGINEERS

Credits: 3:0:0

Objective:

- To get an understanding about the chemistry involved in Foods and Dyes
- To have a thorough knowledge in preparing solutions for analytical testing of Food
- To get an idea about the applications of the chromatography and microscopy

Outcome:

- Students will understand the chemistry involved in modern foods and drinks
- They will have a knowledge about the pigments and dyes used in day today life
- Student will have an introduction to the basic analytical tools needed for experiments in Biology.

Course Description:

Mole concept - Principle of volumetric analysis acidity, alkalinity and buffer solutions – Mushroom cultivation – fast foods - Production of bread, bun and biscuits – soft drinks – alcoholic beverages – Nitrogen Preservation and packing of fruit juices – Coconut water – Natural pigments – Carotenoids - Anthocyanin – Chlorophyll – synthetic dyes, types and detection - Paper, thin-layer, gel-filtration, ion-exchange, affinity and High-Performance Liquid Chromatography (HPLC). Principles of Light, confocal, fluorescence and electron microscopy

Reference Books:

1. R. Gopalan, S. Sundaram, Allied Chemistry, Sultan Chand and Sons (1995).
2. Nelson, D.L. and Cox, M.M. (2005); Lehninger, Principles of Biochemistry, fourth edition, W.H. Freeman and company, N.Y. USA.
3. Swaminathan M. Text Book on Food chemistry, Printing and Publishing Co., Ltd., Bangalore. 1993.
4. Mudambi. R. Sumathi, and Rajagopal, Fundamentals of Foods and Nutrition, M.V., Wiley Eastern Ltd., Madras.

5. M. J. Sienko and R.A. Plane, Chemistry - Principles and properties, International Student Edition, 1995.
6. Seema Yadav. Food Chemistry, Anmol publishing (P) Ltd, New Delhi
7. Voet, D and Voet, J.G, (2009) Biochemistry, John Wiley and Sons, N.Y. USA.

14CH2022 STRUCTURAL CHEMISTRY FOR BIOLOGISTS

Credits: 3:0:0

Objective:

- This course will cater to the students learning Biology-related subjects as their main course, in providing them knowledge of the chemical structures of biomolecules and molecules involved in biochemical pathways.

Outcome:

- The student will be able to systematically name organic and biomolecules, identify them, and understand the importance of these molecules in biological pathways.
- They can understand the structural requirement of molecules and drugs in achieving physiological functions and pharmacological actions.
- Molecular mechanisms taught in biology will be better understood, through a chemistry approach with a newer vista.

Course Description:

Atom models – Hybridization of orbitals – Types of bonds – van der Waals' force and Hydrogen bonding – VSEPR theory – Electronegativity, electron affinity, dipole moment – electronic and steric effects – Nomenclature of organic compounds. Stereoisomerism. Carbohydrates: classification, structure – ring structure of glucose. Structure of vitamins A, B, B₂, B₆, C, D, E, and K. Amino acids: classification with examples – Proteins: classification and structure. Enzymes: Fischer's and Koshland's theories – Michaelis–Menton plot. Structure of DNA – types of RNA – tertiary structure. Drugs: lead compound, prodrugs and soft drugs, pharmacophores – drug receptors – absorption, distribution, metabolism, and elimination – drug resistance – antibiotics, antipyretics, analgesics, hypnotics, and anti-neoplastics.

Reference Books:

1. O. D. Tyagi, M. Yadav, A Text Book of Organic Chemistry, Anmol Publishing Ltd., New Delhi, 2009.
2. Gurdeep R. Chatwal & M. Arora, Organic Chemistry of Natural Products, Vol. I & II, Himalaya Publishing House, 4th Edition, New Delhi, 1999.
3. Ashutosh Kar, Medicinal Chemistry, New Age International Publishers, New Delhi, 2007.
4. I. L. Finar, Organic Chemistry, Pearson Education Pvt. Ltd., Vol. I & II, 6th Edition, Singapore, 2002.
5. R. T. Morrison & R. N. Boyd, Organic Chemistry, 6th Edition, Pearson Education Pvt. Ltd., Singapore, 2003.

14CH2023 APPLIED NANO CHEMISTRY AND NEXT GENERATION MATERIALS

Credits: 3:0:0

Objective:

- The course will cover several key aspects of applied nanomaterials namely their synthesis, characterization, processing, and applications

Outcome:

- The students will know the various types of nanomaterials
- Students will have the complete understanding of properties and applications of nanomaterials

Course Description:

Introduction – Nanomaterials – Fabrication – Top-down, Bottom-up methods of generation – Metallic and Semiconductor Nanoparticles - Nanorod – Nanowire – Nanotube – Thin film — Epitaxy – Special nanomaterials –

Carbon nanotubes – Fullerenes – Inorganic nanocomposites – AFM – STM – TEM – Physical methods – Photolithography – Soft lithography – Properties – Optical – Electrical – Magnetic – Applications of Nanomaterials.

Reference Books:

1. G.Cao, “Nanostructures and Nanomaterials-Synthesis, Properties and Applications”, Imperial College Press, London, 2008
2. M.A.Shah and T. Ahnmed, “Principles of Nanoscience and Nanotechnology”, Narosa Publishing House, New Delhi, 2010.
3. Atkins, Overton, Rourke, Weller, Armstrong, “Shriver & Atkins Inorganic Chemistry”, 4th Edition, Oxford University Press, New Delhi, 2010
4. Daniel L. Schodek, Paulo Ferreira, Michael F. Ashby, “Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers and Architects” Butterworth-Heinemann Ltd, UK, 2009

14CH3001 POLYMER CHEMISTRY

Credits: 3:0:0

Objective:

- To acquire knowledge about the basic principles of polymers
- To understand the moulding processes of polymers
- To understand the applications of polymers

Outcome:

- To get a basic knowledge about polymers
- To know their properties and various fabrication techniques
- To comprehend polymer nanocomposites and their applications

Course Description:

Basic concepts of polymers – Polymerization reactions – Polymer solutions – Principles and mechanisms of polymerization – Co-polymeization – Polymer properties -Molecular weight determination - Tg, Tm and their relationships – Elastic effect of polymers -Polymerization processes and fabrication of plastics - Moulding processes – Injection, compression, blow moulding, extrusion moulding, thermoforming - Introduction to conducting polymers and composites - Filler-matrix interaction - Surface treatment on nano-fillers – Applications of polymer nano-composites.

Reference Books:

1. V.R. Gowariker, N.V. Viswanathan, N.V.Jayadev Sreedhar, “Polymer Science”, I edition, New Age International Publishers Pvt. Ltd., New Delhi, 2008.
2. G.S. Misra, “Introductory Polymer chemistry”, New Age International Pvt. Ltd., 2008
3. Anil Kumar and Rakesh K. Gupta, “Fundamentals of polymer engineering” Tata McGraw Hill Publication Ltd., New Delhi, 2003 (revised and expanded edition)
4. R.J. Young, P.A. Lovell, “Introduction to polymers” Stanley Thomas Publishers, London, 2000
5. P. Bahadur, “Principles of polymer science”, Alpha Science International Ltd., 2nd Edition, 2005.
6. G. Odian, “Principles of Polymerisation”, IV Edition, Wiley Student Edition, New Delhi, 2007.
7. M.G. Arora, M. Singh and M.S. Yadav, “Polymer Chemistry” II revised Edition, Anmol Publications Pvt. Ltd., 2003

14CH3002 NANO CHEMISTRY

Credits: 3:0:0

Objective:

- To acquire the basic knowledge about nanochemistry
- To study the synthetic techniques of nanomaterials
- To study the applications of nanomaterials

Outcome:

- To know the processes involved in zero-dimensional, one-dimensional and two-dimensional nanomaterials
- To understand the methodologies to synthesize special nanomaterials
- To understand the characterization techniques

Course Description:

Basic concepts of nanochemistry – Self assembly of materials – Zero-Dimensional Nanostructures: Nanoparticles – Synthesis of semiconductor nanoparticles – Synthesis of oxide nanoparticles – One-Dimensional Nanostructures: Nanowires – Types – Electrospinning – Lithography - Two-Dimensional Nanostructures: Thin films – Physical vapour deposition (PVD) – Evaporation, molecular beam epitaxy (MBE) – Chemical vapor deposition (CVD) – Atomic layer Deposition (ALD) - Special Nanomaterials - Carbon Fullerenes and carbon nanotubes - Nanocomposites and nanograined materials.

Reference Books:

1. Guozhang Gao, “Nanostructured & Nanomaterials – Synthesis, Properties and & Applications”, Imperial College Press, London, 2004
2. C. Brechignac, P. Houdy and M. Lahmani, “Nanomaterials and Nanochemistry, Springer, 2008
3. Kenneth J. Klabunde, Gleb B. Sergeev, “Nanochemistry”, Elsevier, NY, 2006
4. C.N.R. Rao, “The Chemistry of Nanomaterial: Synthesis, properties and applications, Volume I and II, Springer, 2006
5. Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press, 2005
6. Patrick Solomon, “A Handbook on Nanochemistry”, Dominant Publishers and Distributors, New Delhi, 2008
7. A.K. Haghi and M.R. Saboktakin, “Modern Nanochemistry: Synthesis, properties and applications, Vol. 2”, Nov Science Publishers Inc., 2013

14CH3003 NANOTECHNOLOGY FOR ENERGY APPLICATIONS

Credits: 3:0:0

Objective:

- To acquire the basic knowledge about energy sources
- To study the electrochemical devices
- To study the principles of fuel cells and nuclear energy devices

Outcome:

- To know the chemistry and application of nanotechnology for energy sources
- To specifically understand the role of nanomaterials in solar cells, electrochemical devices, hydrogen storage and nuclear power devices
- To understand the applications of energy devices

Course Description:

Introduction to Energy Sources - Basic principle and operation of renewable energy resources - Nanotechnology for solar power - Nanotechnology for electrochemical devices - Lithium-ion batteries – Fuel cells – Characterization and evaluation of nanomaterials for proton exchange membrane fuel cells (PEMFC), Biofuel cells (BFC) solid oxide fuel cells (SOFC) - Nanotechnology for hydrogen storage materials - Development of hydrides for nanomaterials - Nanotechnology for Nuclear Power - Ni-Cr-Mo alloys for nuclear engineering – Nanocatalysis- Radiation protection materials – nanostructured Boron steels.

Reference Books:

1. Vaughn Nelson, “Introduction to Renewable Energy”, CRC Press, 2011
2. Atul Tiwari, Rabah Boukherroub and Maheshwar Sharon, “Solar Cell Nanotechnology”, Wiley, 2013
3. Yaser Abu-Lebeh and Isobel Davidson, “Nanotechnology for Lithium-ion batteries”, Springer, 2012
4. Nitaigour Premchand Mahalik, “Micromanufacturing and Nanotechnology”, Springer, 2006

- Robert A Varin, Tomasz Czujko, Zbigniew S. Wronski, "Nanomaterials for solid state hydrogen storage", Springer, 2009
- Ann Maczulak, "Renewable Energy : Sources and methods", Infobase publishing, 2010
- John P. Reece, "New Nanotechnology Research", Technology & Engineering, 2006

14CH3004 ANALYTICAL CHEMISTRY

Credits: 3:0:0

Objective:

- To explain the importance of various analytical techniques used in chemistry
- To understand the principles of various analytical techniques
- To understand the applications of various analytical techniques

Outcome:

- Students will know the principles of various types of chromatographic separation techniques.
- The students will know the importance of electromagnetic spectrum.
- The students will apply the various spectroscopic techniques for structure elucidation of small molecules

Course Description:

Chromatography – Principles and applications of paper chromatography –thin layer chromatography -Liquid column, Solid/liquid, Liquid/liquid, Ion exchange and Gas chromatography- Electromagnetic spectrum – Infra red spectroscopy –Theory – Finger print region – Electronic spectroscopy – Principles –Woodward-Fieser rules – applications – ¹H NMR spectroscopy –Theory – FT NMR - Chemical shifts in NMR – Reference compounds – Solvents for NMR - Coupling constant in NMR - AX, AMX and ABX systems - Applications

Reference Books:

- Chatwal G. R & Anand S. K, "Instrumental Methods of Chemical Analysis", Himalaya Publishing House, Mumbai, India, 5th Edition, Reprint 2011.
- Kalsi P. S, "Spectroscopy of Organic Compounds", New Age International Publishers, New Delhi, 6th Edition, 2004.
- Skoog D. A, West D. M, Holler F. J & Crouch S. R, "Fundamentals of Analytical Chemistry", Cengage Learning India Pvt. Ltd, New Delhi, India, 8th Edition, 2004.
- Srivatsava A. K. & Jain P. C, "Chemical Analysis", S. Chand Publications, New Delhi, 3rd edition, 1997.
- Willard H, Merrit L, Dean J. A. & Settle F.A., "Instrumental methods of chemical analysis", CBS Publishers and Distributors Pvt. Ltd, New Delhi, 7th edition, 1986.
- Valcarcel, Miguel , Principles of Analytical Chemistry, Springer, 2000.
- G. Sharma, B K Chaturvedi, Richard E. Wolfe, Basic Analytical Chemistry, DK publishers, 2011

14CH3005 CHEMICAL APPROACH TO NANOMATERIALS

Credits: 3:0:0

Objective:

- Soft lithographic patterning on the basis of chemistry will be discussed.
- The theory of materials preparation with soft building blocks and large building blocks will be taught to the students.
- The question of how chemistry uses bioinspiration for material preparation will be addressed.

Outcome:

- The student will get a thorough knowledge of molecular and material self assembly
- The students will know the importance of soft lithography
- The students will know the importance of bioinspired materials

Course Description:

Molecular vs Materials self assembly — Self Assembled Monolayer- Soft Lithography – PDMS stamp – Sub 100 nm Soft lithography –Dip Pen Nanolithography – soft patterning of hard magnets – Enzyme DPN - Nanocluster self assembly- nanocrystal, nanoparticle, and nanocluster- Water soluble nanoclusters - Biomaterials —bioinspired materials – viral cage synthesis of nanoclusters – Polynucleotide directed nanocluster assembly —Self-assembling nanorods – Nanorod devices – Nanowire sensors – illustration with examples.

Reference Books:

1. G. A. Ozin and A. C. Arsenault, “Nanotechnology: A chemical Approach to nanomaterials” RSC Publishing, 2005
2. Zhong Cao G, “Nanostructures and Nanomaterials: Synthesis, Properties and Applications”, Imperial College Press, London, United Kingdom, 2004.
3. Nanotechnology, G.B. Sergeev, Elsevier, 2007.
4. Core Concepts on supramolecular chemistry and nanotechnology, Jonathan Steed, Wiley Eastern Publishers, 2006
5. Nano: The essentials, T. Pradeep, McGraw Hill Publishers, 2007.
6. Supramolecular chemistry –Fundamentals and applications advanced textbook, Katsuhiko Ariga · Toyoki Kunitake, Springer-Verlag, 2000.
7. D. Vollath, Nanomaterials: An Introduction to Synthesis, Properties and Applications, Springer, 2011.

14CH3006 MEDICINAL CHEMISTRY

Credits: 3:0:0

Objective:

- To equip the students with a thorough understanding of different aspects of pharmaceutical chemistry
- To make them understand about the enzyme kinetics
- To gain some insights about the drug design

Outcome:

- After finishing this course, the student will be able to understand and apply the design and synthetic approaches used in pharmaceutical chemistry
- They will have the knowledge of enzyme kinetics
- They will be trained to design some small organic drug molecules

Course Description:

Introduction to drug design - Physical and chemical factors associated with biological activities - Classification of drugs based on structure or pharmacological basis with examples – Pro drugs and soft drugs – Enzymes and enzyme inhibitors – Ligand-receptor theories – Proteins, lipids, and nucleic acids as drug targets – Effect of pH, pKa, and polarity on drug solubility – Ideal requirement of a drug – sources of drug plant and animal origin, synthetic and semisynthetic drug – Mechanism of Drug Action - Therapeutic index and therapeutic ratio - Five classic steps in the design of a new drug – Factors affecting drug development.

Reference Books:

1. Ashutosh Kar, “Medicinal Chemistry” New Age International Publishers, 5th Revised and Expanded edition, 2010.
2. Richard B. Silverman, “The Organic Chemistry of Drug Design and Drug Action”, 2nd Edition, Academic Press, Reprinted, 2010.
3. Rama Rao Nandella, “Principles of Organic Medicinal Chemistry” New Age International Publishers, New Delhi, Reprint, 2008.
4. Gareth Thomas “Fundamentals of Medicinal Chemistry”, London, Reprint, 2003.
5. David A. Williams, William O. Foye, Thomas L. Lemke, Lippincott Williams & Wilkins, Foye's Principles of Medicinal Chemistry, Philadelphia, 5th edition, 2002.
6. Donald J. Abraham, David P. Rotella, “Burger's Medicinal Chemistry, Drug Discovery and Development, 8 Volume Set, John Wiley & Sons Ltd., 7th Edition, 2003.

7. Graham L. Patrick, "An introduction to Medicinal Chemistry", Oxford university Press, 1995.

14CH3007 SUPRAMOLECULAR CHEMISTRY

Credits: 3:0:0

Objective:

- As the students have known the structural and functional basics of building blocks of supramolecular structures, he/she will now be taught how to build up such structures.
- A knowledge on the driving forces of supramolecular structure formation will be given to the student.
- The student will be exposed to ideas on the types of supramolecules based on structure and the chemistry behind host-guest assembly..

Outcome:

- The students will know the selectivity in supramolecule formation and various factors affecting it
- The students will know the complete understanding of solution host-guest chemistry
- The students will know the various types of supramolecular architectures

Course Description:

Definition – Supramolecular interactions -Selectivity — Lock and key principle – induced fit model – cooperativity – chelate effect – Preorganisation – Binding constant –Kinetic and thermodynamic selectivity - Solution host-guest chemistry – Macrocyclic vs acyclic host — Cation binding – Anion Binding -Neutral molecule binding – Self assembly – Definition – Biological self assembly – Ladders – Polygons –helices – Rotoxanes – Catenanes – Knots – Solid state supramolecules – Zeolites – Clathrates – Coordination polymers – Applications

Reference Books:

1. Jonathan Steed, David Turner, Carl Wallace, Core concepts in Supramolecular Chemistry and nanochemistry, John Wiley & sons, 2007.
2. Jean-Marie Lehn, Supramolecular Chemistry, RCS pubs., 2005
3. Supramolecular chemistry –Fundamentals and applications advanced textbook, Katsuhiko Ariga · Toyoki Kunitake, Springer-Verlag, 2000.
4. Nano: The essentials, T. Pradeep, McGraw Hill Publishers, 2007.
5. Nanochemistry, G.B. Sergeyeve, Elsevier, 2007.
6. G. A. Ozin and A. C. Arsenault, "Nanochemistry: A chemical Approach to nanomaterials" RSC Publishing, 2005
7. Zhong Cao G, "Nanostructures and Nanomaterials: Synthesis, Properties and Applications", Imperial College Press, London, United Kingdom, 2004.

14CH3008 CORROSION SCIENCE AND ENGINEERING

Credits: 3:0:0

Objective:

- To improve both the fundamental knowledge of the students about the corrosion of Materials.
- To introduce various types of corrosion
- The knowledge of the contemporary concepts for corrosion processes of metallic materials will be thought.

Outcome:

- Students will know the various types of corrosion
- The students will know the thermodynamics and kinetics of corrosion
- To know the corrosion prevention methods

Course Description:

The technology & evaluation of corrosion - Electrochemical mechanisms of corrosion of metals - Concentration polarization and diffusion — Thermodynamics of corrosion – Corrosion kinetics – Types of corrosion - Corrosion cells - Partial corrosion reactions - Corrosion of materials in natural environments - Localized corrosion damages and materials failure - Methods for protection of materials - Corrosion control and monitoring – Corrosion inhibitors – Corrosion under organic coatings - AC impedance – High temperature oxidation

Reference Books:

1. M. G. Fontana “Corrosion engineering”, Mc Graw Hill, New York, 1997
2. L. L. Shreir, R. A. Jerman, G. T. Corrosion Metal Environment Reactions” eds. Burstein, Butterworths, London, 1994
3. D. Gabe “Principles of Metal Surface Treatment and Protection”, Merlin Books, London, 1993
4. Denny A. Jones, Principles and Prevention of Corrosion, 2nd Ed., Prentice-Hall, Inc., 1996
5. E. McCafferty, Introduction to Corrosion Science, Springer, 2010
6. R. Winston Revie, Herbert H. Uhlig, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, Fourth Edition, John Wiley & Sons, Inc. 2008
7. McCafferty, Edward, Introduction to Corrosion Science, Springer, 2010.

14CH3009 NANOTECHNOLOGY FOR MEDICINAL APPLICATIONS

Credits: 3:0:0

Objective:

- To provide an introduction and involvement of Nano-scale formulated molecules/materials in the Medicinal Applications
- To provide the basic knowledge of nano-sized molecules in diagnostic applications.
- To explain the importance of nano-fabrication for therapeutic application, in addition to theragnostics applications

Outcome:

- Students will have the knowledge of nano-sized designs for various medicinal applications
- Loading and delivery of nano drugs through liposomal drug delivery
- Students will know the techniques of internalization with the help of vector and receptor strategy.

Course Description:

Nano formulations and measurement of size based system - liposomal, polysomal approach – nano sized drugs for Diagnostics, Therapeutic – *In-vivo* - Clinical Applications – Nano fabrications for Theragnostics Applications. Potential nano scale materials and molecules for internalization and its techniques – Activation technology through Nano molecules and its potential applications – Receptor and Vector approaches with nano molecules, Drug Targeting approaches with nano molecules - Cellular Labeling approaches with nano molecules

Reference Books:

1. Arun Kumar, Heidi M. Mansour, Adam Friedman, Eric R. Blough, Nano Medicine in Drug Delivery, CRC Press, 2013.
2. Ajay Kumar Mishra, Nanomedicine for Drug Delivery and Therapeutics, Wiley Publishers, 2013.
3. Challa S. S. R. Kumar, Biomimetic and Bioinspired Nanomaterials, Wiley Publishers, 2010.
4. Harry F. Tibbals, Medical Nanotechnology and Nanomedicine, 2010,
5. Robert A. Freitas Jr. *Nanomedicine*, Volume IIA: Biocompatibility by Lardes Biosciences Publishers, 2003.
6. Kewal K. Jain, The Handbook of Nanomedicine, Humana Press, 2008.
7. Coombs RRH, Robinson DW. Nanotechnology in Medicine and the Biosciences, 1996, ISBN 2-88449-080-9.

14CH3010 POLYMERS FOR NANOTECHNOLOGY

Credits: 3:0:0

Objective:

- To teach the basic knowledge about the polymers
- To study the concept of nanotechnology applied in polymer technology
- To have an basic idea about the nano composites

Outcome:

- Students would be able to understand the basic concepts of the polymers.
- They would be able to formulate and develop new polymer nano-composites for various industrial applications
- They would be trained in the fabrication of Polymer nano composites

Course Description:

Introduction to material – metal, polymer and ceramic- Conventional composite –particle filled, long and short fibre and fabric reinforced- Introduction to Nanocomposites - advantages and limitations of nano-fillers; surface treatment on nano-fillers- Fabrication of polymer nano-composites - compounding and moulding techniques - Tribology of polymer nanocomposite – Introduction to friction, wear and lubrication; advantages of polymers over metal; tribology of conventional polymer composites; tribology of polymer Nanocomposites- Influence of the size of the reinforcing filler on the wear mechanism-Applications of polymeric Nanocomposites in various fields

Reference Books:

1. Paulo Davim, J. (Ed.), "Tribology of Nanocomposites", Materials Forming, Machining and Triobology Series, Paulo Davim, J. (Ed.), Springer, 2013.
2. Paipetis, A. S. And Kostopoulos, V. (Ed.), "Carbon Nanotube Enhanced Aerospace Composite Materials", Solid Mechanics and its Applications Series, Gladwell, G. M. L. (Ed.), Springer 2013.
3. Mai, Y. W. And Yu, Z. Z., "Polymer Nanocomposites", Woodhead Publishing Ltd., Cambridge, England, 2006.
4. Peter C LeBaron, Wang Z. and Pinnavaia, T. J., "Polymer layered silicate Nanocomposites: an overview", "Applied Clay Science", vol.15, pp11-29, 1999.
5. Ma, P, Siddiqui, N. A., Marom, G. And Kim, J, "Dispersion and functionalisation of carbon nanotubes for polymer based Nanocomposites: a review", Composites: Part A, vol. 41, pp 1345- 1367 2010.
6. Anil Kumar and Rakesh K. Gupta, "Fundamentals of polymer engineering" Tata McGraw Hill Publication Ltd., New Delhi, 2003 (revised and expanded edition)
7. R.J. Young, P.A. Lovell, "Introduction to polymers" Stanley Thomas Publishers, London, 2000

14CH3011 TECHNICAL TEXTILES

Credits: 3:0:0

Objective:

- To impart basic knowledge on fibre science
- To make the students understand the processing of textiles
- To make the students realize the need for smart textiles

Outcome:

- The student will acquire basic knowledge on fibre science
- The student will understand the interaction of fibres with dyes and finishes.
- The student will realize the need for nanotechnology in the field of textile chemistry (smart textiles)

Course Description:

Introduction to natural and synthetic fibres – properties and processing – preparation, mercerization, dyeing, printing and finishing – coatings and laminates, Chemical modification of fibres and fabrics for different end uses – Chemistry of dyes and intermediates, Testing of textile materials for various mechanical and structural properties -

Smart textiles – self-cleaning fabrics, antibacterial finish with nano particles, anti shrink, wrinkle free, flame retardant, conductive textiles, textile based sensors, medical textiles, wound care materials, water proof and breathable fabrics, geotextiles.

Reference Books:

1. S. P. Mishra, A Textbook of Fibre Science and Technology, New Age Publishing Ltd., New Delhi, 2000.
2. J. E. Booth, Principles of Textile Testing, Chemical Pub. Co., 1969.
3. J. E. McIntyre, Synthetic Fibres: Nylon, Polyester, Acrylic, Polyolefin, CRC Press, 2005
4. Choudhary, Textile Preparation and Dyeing, Science Publishers, USA , 2006.
5. Elliot B. Grover ,Handbook of Textile Testing and Quality Control, **Textile Book** Publishers (Interscience), New York, 1960
6. Venkatraman, Chemistry of synthetic dyes, Academic press, London, 1971.
7. A R. Horrocks, Hand book of Technical textiles, Wood Head Publishing Ltd., USA, 2004.

14CH3012 METALS IN BIOLOGY

Credits: 3:0:0

Objective:

- To explain the importance of role of metals in biology
- To get thorough knowledge about various function of metals in various real system
- To expose the students to model compounds

Outcome:

- The students will know the importance of trace elements in biology
- Students will have the knowledge functions of metals in various real systems
- The students will know about mimicking nature for the benefit of mankind

Course Description:

Inorganic composition of cells – Trace elements in biology – Bioinorganic chemistry of iron -Dioxygen binding, transport and storage – Electron transfer – Ferredoxins – Rubridoxins – cytochromes - Blue copper proteins – bioorganometallic chemistry - Hydrogenases – Hydrogen energy - Vitamin B12 and B12 coenzymes – enzymes classification - Zinc, Iron and Magnesium enzymes - Molybdenum and tungsten enzymes - Nitrogen cycle - Medicinal Chemistry – Anticancer drugs – examples - Antibiotics and drugs – examples - Imaging

Reference Books:

1. Huheey J. E, Keiter E. A & Keiter R. L, “Inorganic Chemistry – Principles of structure and reactivity”, Dorling Kindersley (India) Pvt. Ltd, New Delhi, India, 4th edition, 2009.
2. Shriver & Atkins, “Inorganic Chemistry”, Oxford University Press, New Delhi, India, 4th edition, 2009.
3. Greenwood N. N. & Earnshaw A, ”Chemistry of the Elements”, Reed Elsevier India Private Ltd, Gurgaon, India, 2nd edition, Reprinted 2010.
4. K. Hussain Reddy, BIOINORGANIC CHEMISTRY, New Age International Ltd, 2003
5. Bertini I, Gray H. B, Lippard S. J & Valentine J. S, “Bioinorganic Chemistry”, Viva Books Private Ltd, New Delhi, India, 2007.
6. Stephen j. Lippard;jeremy m. Berg, principles of bioinorganic chemistry, panima publishing corporation, 2005
7. Hanson, Graeme; Berliner, Lawrence (Eds.), Metals in Biology, Springer, 2010

APPLIED PHYSICS

LIST OF NEW COURSES

S.No	Course Code	Course Title	Credits
1	21PH0001	Physics Bridge Course for Engineering	3:0:0
2	21PH1001	Physical Electronics	2:0:0
3	21PH1002	Physical Electronics Lab	0:0:1
4	21PH1003	Applied Physics for Robotics	3:0:0
5	21PH1004	Applied Physics for Robotics Lab	0:0:1

21PH0001 PHYSICS BRIDGE COURSE FOR ENGINEERING

Credits: 3:0:0

Course Objectives:

1. To introduce physics concepts and theorems to students from arts and vocational background
2. To demonstrate the various physics experiments that form the pillars of modern engineering and technology
3. To make the students understand the use of physics concepts for solving engineering problems

Course Outcomes:

The students will be able to

1. Understand the fundamental concepts of gravitation and matter
2. Remember the theories and laws with respect to heat and thermodynamics
3. Apply the physics formulas related to waves and oscillations to find solutions to engineering problems
4. Appraise the basic laws of electricity and magnetism
5. Demonstrate the basic ideas in the field of optics and photonics
6. Solve the problems related to modern physics

Module 1: Gravitation, Properties of Matter

Kepler's Laws for Planetary Motion - Newton's Law of Gravitation - Gravitational Field And Potential - Variation of Acceleration Due to Gravity - Heliocentric System over Geocentric System - Recent Developments in Gravitation and Astrophysics - Inter Atomic or Intermolecular Forces in Matter - Stress, Strain and Elastic Modulus - Surface Tension - Viscosity - Properties of Fluids and their Applications

Module 2: Heat and Thermodynamics

Heat, Work and Temperature - Ideal Gas Laws - Specific Heat Capacity - Newton's Law of Cooling - Stefan's Law and Wien's Law - Thermodynamic Equilibrium - Internal Energy - Zeroth and First Laws of Thermodynamics - Thermodynamic Processes - Second Law of Thermodynamics - Carnot Engine and Refrigerator - Third Law of Thermodynamics

Module 3: Waves and Oscillations

Oscillatory Motion - Simple, Angular and Linear Harmonic Motion - Combination of Springs - Simple Pendulum - Expression of Energy - Types of Oscillation - Free, Damped, Maintained and Forced Oscillations - Resonance - Waves and their Types - Velocity of Transverse Waves and Longitudinal Waves - Velocity of Sound Waves - Progressive Waves - Superposition Principle, Interference of Waves, Beats and Standing Waves

Module 4: Electricity and Magnetism

Flow of Charges in a Metallic Conductor - Ohm's Law - Kirchhoff's Laws - Wheatstone's Bridge and its Applications - Electric Power and Electric Energy - Heating Effect - Joule's Law - Thermoelectric Effects - Seebeck Effect - Peltier Effect - Thomson Effect - Magnetic Properties - Classification of Magnetic Materials - Hysteresis - Magnetic Effects of Electric Current - Biot-Savart's Law - Applications

Module 5: Optics

Light as a Ray and a Wave - Behaviour and Propagation of Light - The Wave Nature of Light - The Particle Nature of Light - Reflection, Refraction and Interference - Diffraction - Polarization - Dispersion - Birefringence - Mirrors, Lenses, Prisms - Optical Instruments - Microscope, Telescope - Magnification and Resolving Power

Module 6: Modern Physics

Electron Emission and its Types - Photoelectric Effect - Quantization of Energy - Photo Cell and its Applications - The Particle Nature of Radiation - The Wave Nature of Matter - de Broglie Equation - de Broglie Wavelength of Electron - Davisson and Germer Experiment - Construction and Working of Scanning Electron Microscope

Text Books

1. Arthur Beiser, Shobhit Mahajan, Rai Choudhury, *Concepts of Modern Physics*, Sixth Edition, McGraw Hill Education (India) Private Limited. 2020
2. H.S. Mani and G.K. Mehta, *Introduction to Modern Physics*, Affiliated East-West Press Pvt. Ltd. 2017
3. H.C. Verma, *Concepts of Physics*, Volume 1 and 2, Bharathi Bhawan publishers. 2018

- Halliday, Resnick and Walker, *Principles of Physics*, Wiley publishers. 2015

21PH1001 PHYSICAL ELECTRONICS

Credits 2:0:0

Course Objectives

The course aims

- To acquire knowledge on the fundamentals of semiconductors
- To explain the characteristics of semiconductor junctions and MOS structures
- To understand about the acoustics and ultrasonics.

Course outcome

Students will be able to

- Remember the fundamentals of semiconducting physics
- Understand the principle and operation of semiconductor junctions
- Demonstrate the MOS structures.
- Analyse the application of acoustics in construction and acoustic design.
- Ability to explore the application of ultrasonics in various fields.
- Understand about the renewable energy sources and devices.

Module: 1: Introduction to semiconductor Physics

(5 Hours)

Review of quantum mechanics, Electrons in periodic lattices, E-k diagrams, Quasiparticles in semiconductors, electrons, holes and phonons. Boltzmann transport equation and solution in the presence of low electric and magnetic fields - mobility and diffusivity; Carrier statistics; Continuity equation, Poisson's equation and their solution; High field effects: velocity saturation, hot carriers and avalanche breakdown.

Module 2: Semiconductor junctions

(5 Hours)

Schottky, homo- and hetero-junction band diagrams and I-V characteristics, and small signal switching models; two terminal and surface states devices based on semiconductor junctions.

Module 3: MOS structures

(5 Hours)

Semiconductor surfaces; The ideal and non ideal MOS capacitor band diagrams and CVs; Effects of oxide charges, defects and interface states; Characterization of MOS capacitors: HF and LF CVs, avalanche injection; High field effects and breakdown-Characterization of semiconductors: Four probe and Hall measurement; CVs for dopant profile characterization; Capacitance transients and DLTS.

Module 4 : Acoustics

(5 Hours)

Classification of sound – Characteristics of musical sound – Absorption Coefficient – Reverberation Time Sabine's Formula – Factors affecting the acoustics of a buildings and their remedies.

Module 5: Ultrasonics (5 Hours)

Production of ultrasonic waves; Magnetostriction and Piezoelectric Methods - Applications of Non-Destructive Testing (NDT) of materials – Flaw detection – Measurement of velocity in liquids.

Module 6: Green Energy Physics

(5 Hours)

Solar energy; Energy conversion by photovoltaic principle – Solar cells – Wind Energy; Basic components and principle of wind energy conversion systems – Ocean energy; Wave energy; Wave energy conversion devices

Text books

- Shatendra Sharma, Engineering Physics, Pearson (2018)
- Allen Mottershead, Electronic Devices and Circuits, Prentice Hall of India (2008)

References

- Jacob Milliman, Milliman's Electronic Devices and Circuits, 3rd edition, Tata McGraw-Hill (2010)
- S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).
- J. P. McKelvey, introduction to Solid State and Semiconductor Physics, Harper and Row and John Weather Hill, 1966.
- E. H. Nicollian and J. R. Brews, MOS Physics and Technology, John Wiley, 1982.
- K. K. Ng, Complete Guide to Semiconductor Devices, McGraw Hill, 1995.
- D.K. Schroder, Semiconductor Material and Device Characterization, John Wiley, 1990.
- C. T. Sah, Fundamentals of Solid-State Electronic Devices, Allied Publishers and World Scientific, 1991.
- E. F. Y. Waug, Introduction to Solid State Electronics North Holland, 1980.

21PH1002 PHYSICAL ELECTRONICS LAB

Credits 0:0:1

Course Objectives

The course aims

1. To acquire knowledge on the fundamentals of semiconductors
2. To explain the characteristics of electronic devices for applications in integrated circuit technology
3. To understand about the Lasers, acoustics and optical devices.

Course outcome

Students will be able to

1. Remember the fundamentals of semiconducting materials
2. Understand the principle and operation of semiconductor devices
3. Demonstrate the application of optical devices in communications.
4. Analyse the application of acoustics in construction and acoustic design.
5. Ability to explore the application of solar cells and diodes.
6. Understand about the renewable energy sources and devices.

List of experiments

1. LED and Laser
2. Solar Cell
3. Resistivity by four probe method (virtual lab)
4. Attenuation and Numerical aperture measurement – Fibre Optics
5. Characteristics of Zener Diode- Forward and Reverse bias
6. Characteristics of PN diode
7. Halfwave and fullwave rectifier using PN diode
8. Characteristics of JFET
9. Characteristics of bipolar junction transistor
10. Verification of logic gates AND, OR, NOT
11. NAND and EX-OR gates
12. Hall effect experiment

21PH1003 PHYSICS FOR ROBOTICS ENGINEERS

Credits: 3:0:0

Course Objectives

1. To acquire knowledge on linear momentum and rigid body mechanics
2. To impart knowledge on the concept of stress, strain and elasticity
3. To provide an insight into the theory and applications of lasers and fiber optics.

Course outcome

The student will be able to

1. Apply Newtonian Mechanics to solve problems.
2. Demonstrate the ability to solve the problems based on modulus of elasticity
3. Analyze rigid body mechanics using transformations
4. Apply the fundamentals laws concerning Oscillations.
5. Discuss about the concepts of lasers and its applications.
6. Relate the application of fibre optics in optic devices

Module: 1 Newtonian Mechanics: (8 Hours)

Momentum, Force, Newton's laws, applications- conservation of momentum, impulse, center of mass. Work and Energy: integration of the equation of motion – work energy theorem, applications – gradient operator – potential energy and force, - energy diagrams – law of conservation of energy.

Module 2: Elasticity and Elastic Constants (8 Hours)

Introduction – Stress and strain – Hooke's law – Three types of Elasticity – Rigidity modulus – Young's modulus – Bulk modulus – Relation connecting elastic constants – Poisson's Ratio – Torsional pendulum

Module 3: Rigid Body Mechanics (8 Hours)

Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum about a point of a rigid body in planar motion; Euler's laws of motion, their independence from Newton's laws, and their necessity in describing rigid body motion; Examples.

Module 4: Oscillations (7 Hours)

Oscillatory Systems – Potential Energy Function and Restoring Force – Linear Harmonic Oscillations – Equation of Motion – Simple Pendulum – Physical Pendulum – Damped Harmonic Oscillations – Forced Vibrations – Chaos – Coupled Oscillations.

Module 5: Lasers (7 Hours)

Components of Laser – Principle of Laser Action – Properties of Laser – Spontaneous Emission and Stimulated Emission – Einstein's coefficients – Population inversion – Types of lasers – concepts of LIDAR Industrial applications of laser – Holography.

Module 6: Fiber optics (7 Hours) Propagation of Light in Optical Fibers – Numerical Aperture and Acceptance Angle – Types of Optical Fibers – Splicing – Power Losses in Optical Fibers – Fiber Optic Communication Systems – Fiber Optic Sensors – Fibre endoscope.

Text Books

1. Introduction to Mechanics, R. K. Verma, Universities Press, 2019
2. Engineering Physics, D.K. Bhattacharya and Poonam Tandon, New Delhi: Oxford University Press, 2017
3. Engineering Physics, Shatendra Sharma and Jyotsna Sharma, New Delhi: Pearson India Education Services Pvt. Ltd., (2019)

Reference Books

1. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition
2. Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman, Pearson Education, New Delhi (2018), Fourteenth Edition.
3. Engineering Physics, R.K. Gaur and S.L. Gupta, New Delhi: Dhanpat Rai Publications (P) Ltd. (2008)

21PH1004 PHYSICS LABORATORY FOR ROBOTICS ENGINEERS

Credits: 0:0:1

Course Objective:

The course aims to

1. To acquire knowledge about properties of matter and fiber optics.
2. To acquire knowledge on thermal and crystal physics.
3. To impart knowledge on quantum physics and wave equation

Course outcome

The student will be able to

1. Demonstrate the basics of properties of matter and its applications.
2. Understand the advanced physics concepts of quantum theory and its application in microscope
3. Acquire knowledge on the concepts of waves and oscillations and its applications
4. Understand the basics of crystals their structures and different crystal growth techniques
5. Acquire adequate knowledge on the concepts of thermal properties of materials and their applications in expansion joints and heat exchangers
6. Relate the application of fiber optics in optical devices

List of experiments

1. Young's Modulus – Non-Uniform bending
2. Rigidity Modulus – Torsional Pendulum
3. Melde's string – Oscillations
4. Particle size determination – LASER diffraction
5. Refractive index of a prism – Spectrometer
6. Wavelength of Mercury spectrum – Diffraction grating – Spectrometer
7. Attenuation and Numerical aperture measurement – Fibre Optics
8. Radius of Curvature – Newton's rings
9. Thickness measurement – Single Optic Lever
10. Thermal conductivity of a bad conductor – Lee's Disc
11. Demonstration of SEM, AFM, DSC, DTA, XRD, UV-VIS spectrometer

PHYSICS

LIST OF NEW COURSES (2020)

S.No	Course Code	Name of the Course	Credits
1.	20OP2001	Physical and Geometrical Optics I	3:1:0
2.	20OP2002	General Anatomy and General Physiology	3:0:0
3.	20OP2003	Principles of Lighting	3:0:0
4.	20OP2004	Basic Biochemistry	3:0:0
5.	20OP2005	Physical and Geometrical Optics Lab	0:0:3
6.	20OP2006	Physical and Geometrical Optics II	3:1:0
7.	20OP2007	Computer Programming	3:0:0
8.	20OP2008	Nutrition	3:0:0
9.	20OP2009	Hospital Procedures	0:0:3
10.	20OP2010	Computing and Computer Applications	0:0:3
11.	20OP2011	Optometric Optics I	3:0:0
12.	20OP2012	Ocular Diseases I	3:0:0
13.	20OP2013	Visual Optics I	3:0:0
14.	20OP2014	Ocular Anatomy and Ocular Physiology	3:0:0
15.	20OP2015	Pathology and Microbiology	3:0:0
16.	20OP2016	Visual Optics Lab I	0:0:2
17.	20OP2017	Clinics Lab I	0:0:2
18.	20OP2018	Optometric Optics II	3:0:0
19.	20OP2019	Ocular Diseases II	3:0:0
20.	20OP2020	Visual Optics II	3:0:0
21.	20OP2021	Optometric Instrumentations	3:0:0
22.	20OP2022	Optometric Instrumentations Lab	0:0:3
23.	20OP2023	Visual Optics lab II	0:0:3
24.	20OP2024	Clinics Lab II	0:0:3
25.	20OP2025	Clinical Examination of Visual System	3:0:0
26.	20OP2026	Clinical Psychology	3:0:0
27.	20OP2027	Low Vision Aids	3:0:0
28.	20OP2028	Dispensing Optics	3:0:0
29.	20OP2029	Binocular Vision	3:0:0
30.	20OP2030	Low Vision Aids Lab	0:0:2
31.	20OP2031	Dispensing Optics Lab	0:0:2
32.	20OP2032	Glaucoma	3:0:0
33.	20OP2033	Pediatric Optometry and Geriatric Optometry	3:0:0
34.	20OP2034	Contact Lens	3:0:0
35.	20OP2035	Occupational Optometry	3:0:0
36.	20OP2036	Systemic Diseases	3:0:0
37.	20OP2037	Clinics and Special Clinical Lab I	0:0:3
38.	20OP2038	Clinics and Special Clinical Lab II	0:0:3
39.	20PH3001	Classical Mechanics	3:1:0
40.	20PH3002	Statistical Mechanics and Thermodynamics	3:1:0
41.	20PH3003	Mathematical Physics I	3:1:0
42.	20PH3004	Semiconductor Physics	3:1:0
43.	20PH3005	Quantum Mechanics I	3:1:0
44.	20PH3006	Mathematical Physics II	3:1:0

45.	20PH3007	Spectroscopy-I	3:1:0
46.	20PH3008	Electromagnetic Theory	3:1:0
47.	20PH3009	Quantum Mechanics II	3:1:0
48.	20PH3010	Spectroscopy-II	3:1:0
49.	20PH3011	Nuclear and Particle Physics	3:1:0
50.	20PH3012	Solid State Physics	3:1:0
51.	20PH3013	Physics of Nanomaterials	3:0:0
52.	20PH3014	Fabrication and Testing of Thin Film Devices	3:0:0
53.	20PH3015	Solid State Batteries	3:0:0
54.	20PH3016	Quantum Computing in AI	3:0:0
55.	20PH3017	Astronomy and Astrophysics	3:0:1
56.	20PH3018	Radiation Physics	4:0:0
57.	20PH3019	General Physics Lab I	0:0:2
58.	20PH3020	General Physics Lab II	0:0:2
59.	20PH3021	Advanced Physics Lab I	0:0:2
60.	20PH3022	Advanced Physics Lab II	0:0:2
61.	20PH3023	Computational Physics Lab	0:0:2
62.	20PH3024	Materials Characterization Lab	0:0:2
63.	20PH3025	Radiation Treatment and Planning	4:0:0
64.	20PH3026	Medical Radiation Dosimetry	4:0:0
65.	20PH3027	Solid State Ionics	4:0:0

LIST OF NEW COURSES for I.B.Tech Engineering (2020-2021 BATCH)

S.No.	Course Code	Name of the Course	Credits			
			L	T	P	C
1	20PH1001	Elements of Physics in Aviation	3	0	0	3
2	20PH1002	Applied Physics Lab for Aerospace Engineering	0	0	2	1
3	20PH1003	Applied Physics for Bio-Medical Engineering	3	0	0	3
4	20PH1004	Applied Physics Lab for Bio-Medical Engineering	0	0	2	1
5	20PH1005	Applied Physics for Civil engineering	3	0	0	3
6	20PH1006	Applied Physics Lab for Civil engineering	0	0	2	1
7	20PH1007	Applied Physics for Computer Science Engineering	3	0	0	3
8	20PH1008	Applied Physics Lab for Computer Science Engineering	0	0	2	1
9	20PH1009	Applied Physics for Electrical and Computer Engineering	3	0	0	3
10	20PH1010	Applied Physics Lab for Electrical and Computer Engineering	0	0	2	1
11	20PH1011	Physical Electronics	2	0	0	2
12	20PH1012	Physical Electronics Lab	0	0	2	1
13	20PH1013	Applied Physics for Mechanical Engineering	3	0	0	3
14	20PH1014	Applied Physics Lab for Mechanical Engineering	0	0	2	1
15	20PH1015	Physics for Robotics Engineers	3	0	0	3
16	20PH1016	Physics Laboratory for Robotics Engineers	0	0	2	1
17	20PH1017	Applied Physics for Biotechnology Engineering	2	0	2	3
18	20PH1018	Applied Physics for Food Process operations	2	0	0	2
19	20PH1019	Applied Physics for Food Process operations lab	0	0	3	1.5
20	20PH1020	Application of Engineering Materials	3	0	0	3

20OP2001 PHYSICAL AND GEOMETRICAL OPTICS I

Credits 3:1:0

Course Objectives:

1. To illustrate the working of various laws related to optical phenomenon.
2. To enlighten the students about the various optical parameters such as Interference, Diffraction and Polarisation and its functions in analytical instruments
3. To demonstrate the advanced principles of physical optics in instruments.

Course Outcomes:

At the end of the course, the student will able to

1. Describe the usage of various theories and components of light.
2. Report the effect of interference of light on lenses.
3. Apply knowledge of combination of optical principles such as interference, diffraction, polarization in optical elements.
4. Design an optical system, component to meet desired needs of optometry.
5. Solve problems in optical physics and lens assembly.
6. Demonstrate the techniques, skills, and modern tools necessary for optical physics in analytical instruments

Module 1 LIGHT AND STIMULUS OF VISION

Nature of light-Huygens's wave theory-Einstein's quantum theory-Dual Nature theory-Properties of light-Spectrum of light-Visible light and the eye- Fechner's Law-Weber's law - Measurement of light-Radiometry-Photometry-Laws of reflection and refraction-Total internal reflection-The Ray model-Fermat's principle

Module 2 LENSES AND INTERFERENCE

Introduction: Lenses-Spherical lens-Cylindrical lens-Contact lens -Divergence and convergence of wave fronts by spherical surfaces Interference phenomena in optics-Constructive interference-Destructive interference Coherence-Spatial coherence-Temporal coherence - Applications of interference-Thomas Young's experiment -Interference in thin films- Wedge shaped thin films- Newton's rings experiment-refractive index of liquid.

Module 3 DIFFRACTION AND POLARISATION

Phenomenon of Rectilinear Propagation -Frenel's diffraction-Fraunhofer diffraction-Applied aspects of diffraction-Single slit, qualitative and quantitative-Zone plate-Circular aperture- Polarization of transverse waves-light as transverse waves Double refraction-Nicol prism - Nicol prism as an analyser -Elliptically & Circularly polarized light-Optical activity- Fresnel's experiment-Biquartz-Applications of polarized light

Module 4 SPECTRUM AND SCATTERING

Sources of spectrum: Bunsen-carbon-mercury-sodium-Emission and absorption spectra

Classification of emission spectra-Solar spectrum-Ultraviolet Spectrum-Infra red spectrum-Electromagnetic spectrum-Applied aspects-Glare effect-light reduction effect

Photo electric effect-Raman Effect-LASER

Module 5 OPTICAL INSTRUMENTS

Spectrometer-Simple and compound microscope-Telescope-Resolving power of optical instruments-Resolving power of the eye-Magnifying power of simple and compound microscope, telescope-Interferometer-Michelson interferometer-Fabry-Perot interferometer

Text Books

1. Optics: Eugene Hecht and A. R. Ganesan, Dorling Kindersely (India) (2008)
2. Optics: A. K. Ghatak, Tata McGraw Hill, (2008)
3. N.Subramanyam, Brij Lal and Dr.M.N.Avadhanulu: A text book of Optics, S.Chand & Co. (2019)

Reference Books

1. A. Bennett, The Principles of Physical Optics: An Historical and Philosophical Treatment Charles Wiley, 2008

2. Giovanni Giusfredi, Physical Optics: Concepts, Optical Elements, and Techniques, 2019
3. Ariel Lipson, Henry Lipson, and S. G Lipson, Optical Physics 2010
4. Charles A. Bennett, Principles of Physical Optics Wiley, 2008

20OP2002 GENERAL ANATOMY AND GENERAL PHYSIOLOGY

Credits 3:0:0

Course Objectives:

1. To explain the basics on the structure of human anatomy
2. To illustrate the different systems of the body and their functioning
3. To demonstrate the functions of respiratory and endocrine glands

Course Outcomes:

At the end of the course, the student will be able to

1. Recall outline on cells, their functions and membrane transportation of cells.
2. Understand the composition of blood and its function on maintaining homeostasis.
3. Elaborate the components of respiratory and cardiovascular systems.
4. Describe about the anatomical locations, structures and their physiological functions.
5. Analyse the structure and functions of nervous system and parts of brain.
6. Evaluate the functions of eye, ear and kidney.

Module 1 SYSTEMIC ANATOMY

Subdivisions of Anatomy: Regional and Systemic Anatomy-Planes of the Body-Terminology-Skeletal System-Bones of the body-Joints – Classification, Joints of the body-Muscular system-Cardiovascular System- Heart, Arteries & Veins of the Body -Lymphatic system – Lymphoid organs, Lymphatics & Lymphatic drainage of the body-Respiratory system – Upper and lower Respiratory tract, Lungs, Pleura& Muscles of Respiration-Digestive system-Reproductive system-Endocrine system-Special senses – Ear, Tongue and Nose

Module 2 HISTOLOGY

Ephithelial Tissue-Connective Tissue-Cartilage-Bone-Muscular Tissue-Cardiovascular Tissue-Lymphoid organs-Nervous System-Skin & Appendages-Exocrine glands – Salivary, Lacrimal, Mammary & Pancreas-Endocrine glands – Thyroid, Parathyroid, Pituitary & Adrenal-Eye – Cornea & Retina

Module 3 PHYSIOLOGY, BLOOD AND CARDIOVASCULAR SYSTEM

Cell structure, Body fluid compartments, Transport across cell membrane, Homeostasis, Skeletal muscle structure and properties, neuromuscular junction and muscle contraction - Composition and function of Blood, Red blood cells, erythropoiesis, anaemia, White blood cells structure and functions, Platelets and blood coagulation, plasma proteins, blood groups-Properties of cardiac muscle, origin and conduction of heart beat, cardiac cycle, ECG, cardiac output, arterial blood pressure measurement, factors affecting and factor regulating it, heart rate and its regulation

Module 4 RESPIRATION, DIGESTIVE SYSTEM AND EXCRETION

Mechanics of respiration, lung volume and capacities, transport of oxygen and carbondioxide, regulation of respiration, hypoxia and artificial respiration, Movements of GI tract, Secretions and functions of salivary glands, gastric glands, pancreas, small intestine, function of liver, absorption in the intestine - Structure of Nephron, Renal circulation, formation of urine, micturition, diuretics, normal and abnormal constituents of urine, structure and function of skin

Module 5 ENDOCRINE, REPRODUCTIVE NERVOUS SYSTEM AND SPECIAL TISSUES

All major endocrine glands, their secretion, action and regulation with hyper and hypo secretion of the glands. Spermatogenesis, male sex hormones, menstrual cycle, pregnancy and lactation, principles of contraceptive methods Structure of neuron, properties of nerve, nerve impulse conduction, synapse, receptor, spinal cord, reflex action, ascending and descending tracts, structure and function of cerebral cortex, basal ganglia, thalamus, hypothalamus, brain stem, sleep and reticular formation, autonomic

nervous system - Olfaction, gustation, Hearing and Vision-Structure, Physiology, pathways and applied aspect

Text Book

1. Textbook of Human Histology with Colour Atlas, Inderbir Singh, 4th Edn., 2011

Reference Books

1. G.J.Tortora & N.P.Anagnostakos: Principles of Anatomy and Physiology by Bryan H Derrickson, Wiley 2017
2. Donald C.Rizzo, Fundamentals of Anatomy and Physiology, 2016

20OP2003 PRINCIPLES OF LIGHTING

Credits 3:0:0

Course Objectives:

1. To impart knowledge about modern theory on light and colour
2. To demonstrate different types of light sources and illumination.
3. To illustrate concepts of lighting systems and fiber optics technology.

Course Outcomes:

At the end of the course, the student will be able to

1. Recall the basics concept of colour theory and light.
2. Identify the different kinds of sources of light.
3. Understand the illumination principles and its parameters.
4. Design lighting systems for optometric purposes.
5. Experiment with different types of lighting
6. Apply fiber optics technology in modern optical instruments.

Module 1 MODERN THEORY ON LIGHT AND COLOUR THEORY

Synthesis of light-Colour theory: Additive and subtractive synthesis of colour- Goethe's theory 7 reasoning-colour temperature-colour rendering-Factors affecting visual tasks

Module 2 LIGHT VISION AND SOURCES

Light and vision: Discomfort glare-Visual ability-relationship among lighting-visibility and task performance-Light sources: Sunlight-Modern light sources-spectral energy distribution- luminous efficiency-colour temperature-colour rendering.

Module 3 ILLUMINATION

Illumination: Luminous flux-candela-solid angle-illumination-utilization factor-depreciation factor-Illumination laws

Module 4 LIGHTING SYSTEM DESIGN

Lighting System Design: Design approach-Design process-concept of lighting design-Physical consideration and psychological consideration and types of lighting

Module 5 PHOTOMETRY AND FIBRE OPTICS

Photometry : Photometric quantities-photometers and filters-Fibre optics: Optical description-optical fiber communication -optical fibre cables.

Text Book

1. Rolf G. Kuehni, Color: An introduction to practice and principles, 3rd edition, 2012

Reference Books

1. Philip Gordon, L.C. Principles and practices of lighting design: The Art of lighting composition, 2011
2. Jack L. Lindsey, Applied Illumination Engineering, The Fairmont press, 1997
3. Kao Chen, Energy management in Illuminating Systems, 2010

20OP2004 BASIC BIOCHEMISTRY

Credits 3:0:0

Course Objectives:

1. To provide knowledge on the structure, properties and function of various biomolecules.
2. To illustrate basic structure of biomolecules in metabolic pathways.
3. To impart knowledge on the significance of these biomolecules.

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the structure, properties and biological functions of carbohydrates, lipids and proteins.
2. Acquire knowledge on nucleic acids structure, properties and functions of nucleic acids
3. Assess the significance of Vitamins and mineral functions.
4. Analyze the biomolecules and relate them with the scope of biotechnology.
5. Justify the clinical and biological significance of biomolecules.
6. Apply the photometric techniques in clinical optometry.

Module 1 CARBOHYDRATES AND PROTEINS

Properties of monosaccharide, disaccharides, polysaccharides and their biological importance
Classification and properties of Amino acids, physiological important peptides, Classification and properties of proteins, plasma proteins, structure of protein, immunoglobulins, chromatography and electrophoresis

Module 2 LIPIDS AND ENZYMES

Classification and properties of fatty acids, triglycerides, phospholipids, other compound lipids, cholesterol its derivatives and their biological significance. Definition, classification, co-enzymes, factors affecting their action, enzyme inhibition, enzymes of clinical importance

Module 3 VITAMINS AND MINERALS

Classification, functions, source, deficiency manifestations and hypervitaminoses. Calcium, Phosphorus, Sodium, Potassium, iron, selenium, iodine, copper.

Module 4 HORMONES, METABOLISM AND OCULAR BIOCHEMISTRY

Hormones basic concepts in metabolic regulation with examples, with respect to insulin Metabolism of carbohydrates, proteins and lipids-Variety aspects of the eye, viz., tears, cornea, lens, aqueous, vitreous, retina and pigment rhodopsin.

Module 5 TECHNIQUES AND CLINICAL BIOCHEMISTRY

Importance of the biochemical constituents in ocular tissues

Colloidal state, sol. Gel, emulsion, dialysis, electrophoresis, Ph buffers mode of buffer action, molar and percentage solutions, photometer, colorimetry and spectrophotometry. Radio isotopes: application in medicine and basic research-Blood sugar, urea, creatinine and bilirubin significance of their estimation

Text book

1. Talwar G.P: Text book of Biochemistry, biotechnology, allied and molecular medicine, 2015

Reference Books:

1. Hiram F Gilbert, Basic concepts in biochemistry: A student's survival guide, Mc Graw Hill, 2000
2. B.Raghu : Practical Biochemistry for Medical students, 2003 (For Practical)

20OP2005 PHYSICAL AND GEOMETRICAL OPTICS LAB

Credits 0:0:3

Course Objectives:

1. To train the students on Optical experiments to understand the basic concepts.
2. To illustrate the light and diffraction phenomena using prism experiment
3. To demonstrate the Interference principle with experiments

Course Outcomes:

At the end of the course, the student will be able to

1. Acquire the practical skills on optical measurements and instrumentation techniques.
2. Understand the concepts and principles of light through practical experiments
3. Analyze different measurements for effective understanding of the methods involved.
4. Apply the concepts and principles of light and its phenomena through practical experiments
5. Evaluate the properties of optical measurements and to bring results
6. Apply the concepts for different applications related to optics

List of experiments

1. Newton's Ring's-radius of curvature-refractive index of lens
2. Newton's Ring's-refractive index of a liquid
3. Air wedge-thickness of a wire (hair)
4. Grating-wavelength determination
5. Dispersive power of a grating
6. Grating – minimum deviation & Wavelength determination
7. Fresnel's biprism experiment
8. Thickness of thin glass plate
9. Refraction through a slab
10. I-d curve for a prism – pin method
11. Spherometer and lens gauge
12. Single optic lever
13. Double optic lever
14. Critical angle – glass and water
15. Magnifying power of a simple and a compound microscope

The faculty conducting the Laboratory will prepare a list of 10 experiments and get the approval of HoD and notify it at the beginning of each semester.

20OP2006 PHYSICAL AND GEOMETRICAL OPTICS II

Credits :3:1:0

Course Objectives:

1. To impart knowledge on the stimulus vision, focal points and prism diopters
2. To demonstrate the equivalent dioptric power of thick meniscus lens and power in different meridians .
3. To illustrate the Depth of field and depth of focus, Aberrations measurements

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the stimulus vision, spherical vision and focal points.
2. Interpret the laws of prism diopter, power, and magnification principles.
3. Demonstrate the power manipulation in thick lenses with matrix theory.
4. Apply the cylindrical and sphero-cylindrical lenses, techniques to calculate the different meridians power
5. Evaluate the motion of physical systems.
6. Apply the concept stops, pupils and ports on the optical systems to overcome the distortions

Module 1: Stimulus of vision

Laws of reflection and refraction - Total internal reflection – Problems in the Ray model - Refraction through spherical surfaces - Problems in Lenses-Spherical lens-Cylindrical lens-Contact lens -Divergence and convergence of wave fronts by spherical surfaces - Definition of dioptre -Vergence Working of spherical lenses – primary and secondary focal points

Module 2: Prism diopter:

Prentice's law – deviations- Ophthalmic prisms – thin and thick Refraction at single Spherical or plane surfaces: convex – concave – Curvature & SagittaVergence & dioptric power-Nodal points & nodal ray-

lateral magnification and angular magnification-Snell's law of refraction Thin lenses: lenses in contact- lenses separated by a distance. Two lens systems- dioptric & vergence power-(Object-image) relationships Application: calculation of image points - dioptric powers in reduced systems using vergence techniques

Module 3: Thick lenses

cardinal points - front and back vertex powers reduced system - dioptric power of equivalent lenses. Application – to calculate the equivalent dioptric power of thick meniscus lens-plano convex vertex powers- position of principal planes- Dioptric powers using reduced systems. (Matrix theory and lens matrices)

Module 4: Cylindrical and spherocylindrical lenses

location of foci-image planes-principle meridians-refraction by a cylindrical lens -calculation of power in different meridians -spherocylindrical lenses- circle of least confusion- refraction through a spherocylindrical lens- writing Rx in different forms (+cyl., -cyl., meridional)- additional spherocylinders-oblique-cylinders

Module 5: Stops, Pupils and Ports:

Entrance pupil & exit pupil (size & location) Field stop Entrance port & exit port, field of view, vignetting Depth of field and depth of focus - Aberrations: Spherical Coma Oblique astigmatism Curvature of field Distortion Chromatic. Thin prisms and Mirrors Unit of measurement (prism diopter) Prism deviation in prism Combination of thin prisms Dispersive power of prism-achromatic prisms Planar & spherical reflection in mirrors Magnification in mirrors Lens/mirror systems

Text Books:

1. N.Subramanyam & Brij Lal: A text book of Optics, S.Chand & Co 2012.

Reference Books:

1. Mirrors, Prisms & Lenses-southall, Dover 1965
2. Geometric, Physical & Visual Optics-Michael P.Kealing 2001
3. Aberrations of Optical systems-W.T.Welford Introduction to Geometrical optics-Milton 1986

20OP2007 COMPUTING AND COMPUTER APPLICATIONS

Credits:3:0:0

Course Objectives:

1. To impart knowledge on the fundamentals of computer and its interfaces.
2. To demonstrate the system hardware, software and the applications for the clinical data maintenance.
3. To illustrate the office applications suit and programming for specific applications and object oriented programming.

Course Outcomes:

At the end of the course, the student will be able to

1. Recall the history of computers and its characteristics.
2. Understand the functions of different ports in hardware and software tools
3. Apply the knowledge on office application suite for programming specific cases.
4. Interpret the functions, arrays, union, structures and pointers in C language.
5. Analyse specific clinical data required for the history of individuals
6. Evaluate the data for any specific conditions to process for further references and data processing.

Module 1. Computers:

History of computers, Definition of computers, input devices, output devices, storage devices, types of memory, and units of measurement, range of computers, generations of computers, characteristics of computers,.

Module 2. System:

Hardware, Software, system definition, Fundamentals of Networking, Internet, performing searches and working with search engines, types of software and its applications

Module 3. Office application suite

Word processor, spreadsheet, presentations, other utility tools, Fundamentals of Linux / Windows operating system, functions, interfaces, basic commands, working with the shell and other standard utilities. Language - Comparison chart of conventional language, programming languages, generations of programming languages, Compilers and interpreters, Universal programming constructs based on SDLC, Variable, constant, identifiers, functions, procedures, if while, do – while, for and other Structures.

Module 4 : Programming

Programming in C language, Data types, identifiers, functions and its types, arrays, union, structures and pointers

Module 5: Introduction to object oriented programming

c++: classes, objects, inheritance polymorphism, and encapsulation. Introduction to databases, and query languages, Introduction to Bioinformatics

Text Book

1. Microsoft office 2003 by Jennifer Ackerman Kettell, Guy Hart-Davis-2003

Reference Books

1. C Programming Tutorial (K & R version 4) Author(s): Mark Burgess
2. An introduction to GCC by Brian J.Gough, foreword by Richard M.Stallman
3. Red Hat Linux 9 bible by Christopher Negus May 2003

200P2008 NUTRITION

Credits:3:0:0

Course Objectives:

1. To impart knowledge on the Nutrition, balanced diet and menu planning.
2. To demonstrate the role of Protein Sources and functions, Essential and non-essential amino acids, Incomplete and complete proteins, and Supplementary food
3. To illustrate the fundamental Measurement and energy value of food.

Course Outcomes:

At the end of the course, the student will able to

1. Understand the importance of balanced food and food groups.
2. Classify the carbohydrates, Fats and proteins and its presence in different sources.
3. Demonstrate the role of Macro and micro minerals associated with the eye defects
4. Measure the energy value of food, Energy expenditure,
5. Calculate the total energy/calorie requirement for different age groups and diseases.
6. Recommend suitable diet plan for a specific case related to different conditions of eye

Module 1: Introduction

History of nutrition, Nutrition as science, Foods Food groups, RDA, Food guides, Food Pyramid, Balanced diet, Limitations of daily food guide, Menu planning

Module 2: Carbohydrates

Function, sources, RDA, Dietary fiber

Module 3: Proteins

Sources and functions, Essential and non-essential amino acids, Incomplete and complete proteins, Supplementary food, PEM and the eye, Nitrogen balance, Changes in the protein requirement

Module 4 : Fats

Functions and sources, Essential fatty acids, Excess and deficiency, Lipids and the eye, Energy Units of energy, Measurement and energy value of food, Energy expenditure, Total energy/calorie requirement for different age groups and diseases, Energy imbalance – obesity, starvation

Module 5: Minerals

General functions and sources, Macro and micro minerals associated with the eye, Deficiencies and excess – ophthalmic complications (e.g) Iron, calcium, Iodine, etc, Vitamins General functions, food sources,

Vitamin deficiencies and associated eye disorders with particular emphasis on vitamin 'A' 9. Antioxidant Lutein, zeaxanthin, lycopene, Monosodium Glutamate, aspartame and their role in vision

Text Book:

1. Food & Nutrition, Dr. M.Swaminathan, Vol. I & II 2018

Reference Books

1. Nutritional Ophthalmology (Nutrition, Basic and Applied Science) by Donald Stewart MC Lenon, 2nd Ed. (1980)
2. Nutritional and environmental influences on the Eye, Allen Taylor (1999)
3. Nutritional Aspects and Clinical Management of Chronic Disorders and Disease (2002)
4. Normal and Therapeutic Nutrition, Orinne H. Robinson & Narilyn R. Lawler, 1986

20OP2009 HOSPITAL PROCEDURES LAB

Credits 0:0:3

Course Objectives:

1. To impart knowledge on the hospital procedures to coordinate with different departments.
2. To demonstrate the functioning of departments such as accounts, Bio medical, front office and records.
3. To illustrate the importance of patient history, human resource and message centre connecting all the departments.

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the functioning of different departments and their role in running the hospital at ease.
2. Understand the front office procedures and data maintenance of hospital records.
3. Demonstrate the message centre connecting the departments for hassle free functioning of the hospitals.
4. Apply the computer programming knowledge in record maintenance and data retrieval for future reference.
5. Understand the data from different diagnostic tools such as angiography and so on.
6. Appraise the human resource and social work department to solve the human problems.

Practical:

1. Accounts Department
2. Laboratory
3. Bio-Medical Engineering department
4. Medical records Department
5. Correspondence
6. Stores
7. House Keeping
8. Reception
9. Computer Department
10. Fundus Fluorescein Angiography and Medical Photography
11. Human Resources Department
12. Medical Social Work Department
13. Message Centre
14. Patients Relation Department
15. Biometry Department

20OP2010 COMPUTING AND COMPUTER APPLICATIONS LAB

Credits 0:0:3

Course Objectives:

1. To impart knowledge on the fundamentals of computer and its interfaces.

2. To demonstrate the system hardware, software and the applications for the clinical data maintenance.
3. To illustrate the office applications suit and programming for specific applications and object oriented programming.

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the history of computers and its characteristics.
2. Demonstrate the functions of different ports in hardware and software tools
3. Apply office application suite for programming specific applications.
4. Program in C language, and identify the Data types, identifiers, functions and its types, arrays, union, structures and pointers
5. Program for specific clinical data required for the history of individuals
6. Retrieve the data for any specific conditions to process for further references and data processing.

Practicals:

1. Various browsers, search engines, email
2. Text document with images with multiple formatting options using a specified office package
3. Spreadsheet using a specified office package
4. Presentation on a specified topic using the specified locations
5. Shell programming-parameters
6. Shell program- regular expressions
7. C program- functions
8. C program – file handling
9. C program demonstrating the usage of user defined variables
10. Databases
11. Applications in Optometry

20OP2011 OPTOMETRIC OPTICS I

Credits 3:0:0

Course Objectives:

1. To impart knowledge on the types of optical lenses
2. To explain the various properties of optical lenses through laws of physics
3. To deliver knowledge on classification and properties of spectacle frames

Course Outcomes:

At the end of the course, the student will be able to

1. Recall the types of optical lenses
2. Understand the properties of optical lenses through laws of physics
3. Apply the knowledge on optical properties in lens manufacturing
4. Analyze the quality of lenses
5. Identify the type of spectacle frames
6. Appreciate the knowledge gained on optical lenses to solve vision problems

Module 1: Spectacle Lenses Part-1

Introduction to Spectacle Lenses: Forms of Lenses- Cylindrical and Spherocylindrical Lenses- Properties of Crossed Cylinders- Toric Lenses- Toric Transposition- Astigmatic Lenses- Axis Direction of Astigmatic Lenses- Obliquely Crossed Cylinders- Sag Formula- Miscellaneous Spectacle Lenses- Vertex Distance and Vertex Power- Tilt Induced Power- Aberrations in Ophthalmic Lenses- Fresnel Prisms- Lenses and Magnifiers.

Module 2: Spectacle lenses Part-2

Manufacture of Glass- Lens Surfacing- Principle of Surface Generation and Glass Cements.

Module 3: Lens Quality

Faults in Lens Material- Faults on Lens Surface- Inspecting the Quality of Lenses- Toughened Lenses.

Module 4: Ophthalmic Lenses

Definition of Prisms- Units of Prism Power- Thickness Difference and Base – Apex Notation- Dividing-Compounding and Resolving Prisms- Rotary Prisms and Effective Prism Power in Near Vision-Prismatic Effect- Decentration-Prentice's Rule- Prismatic Effect of Spherocylinders and Plano Cylinders- Differential Prismatic Effects.

Module 5: Spectacle Frames

Frame Types and Parts- Classification of Spectacle Frames – Material, Weight, Temple Position, Coloration; Frame Construction- Frame Measurements and Markings.

Text Book

1. T E Fannin & T Grosvenor, Clinical Optics, 1996

Reference Books

1. Mo Jalie, Principles of Ophthalmic Lenses, ABDO College of Education, Edition 3, 1984
2. A.R. Elington & H.J. Frank, Clinical Optics, Second edition, 1991

20OP2012 OCULAR DISEASES I

Credits 3:0:0

Course Objectives:

1. To impart a detailed knowledge on the anatomy of eyelids, lacrimal system, orbit, cornea, iris and pupil.
2. To explain the functioning of eyes.
3. To deliver knowledge on the different eye trauma associated with its anatomy.

Course Outcomes:

At the end of the course, the student will be able to

1. Recall the anatomy of eye.
2. Understand the functioning of eyes.
3. Apply the knowledge of eye anatomy in finding the eye tumors.
4. Analyze the quality of vision through eye anatomy.
5. Identify the type of eye tumor, conjunctiva and cornea
6. Appreciate the knowledge gained on eye anatomy in rectifying the problems in eye vision due to tumours and trauma.

Module 1: Eyelids

Eyelid Anatomy Congenital and Developmental Anomalies of the Eyelids-Blepharospasm –Ectropion-Entropion-Trichiasis and Symblepharon-Eyelid Inflammations-Eyelid Tumours- Ptosis- Eyelid Retraction -Eyelid Trauma.

Module 2: Lacrimal system

Lacrimal System-Lacrimal Pump Methods of Lacrimal Evaluation-Congenital and Development Anomalies of the Lacrimal System-Lacrimal Obstruction-Lacrimal Sac Tumors -Lacrimal Trauma-Sclera-Episcera: Ectasia and Staphyloma Scleritis-Episcleritis.

Module 3: Orbit

Orbital Anatomy-Incidence of Orbital-Abnormalities-Methods of Orbital Examination- Congenital and Developmental Anomalies of the Orbit-Orbital Tumours-Orbital Inflammations-Sinus Disorders affecting the Orbit-Orbital Trauma.

Module 4: Conjunctiva and Cornea

Inflammation: Therapeutic Principles-Specific Inflammatory Diseases; Tumours: Tumours of Epithelial Origin-Glandular and Adnexal Tumours-Tumours of Neuroectodermal Origin -Vascular Tumours-Xanthomatos Lesions-Inflammatory Lesions-Metastatic Tumours; Degenerations and Dystrophies: Definitions-Degenerations-Dynstrophies; Miscellaneous Conditions: Keratoconjunctivitis Sicca (K Sicca)-Tear Function Tests -Stevens – Johnson Syndrome -Ocular Rosacea-Atopic Eye Disorders-Benign Mucosal

Pemphigoid (BMP) – Ocular Pemphigoid-Vitamin A Deficiency-Metabolic Diseases Associated With Corneal Charges

Module 5: Iris, Ciliary body and Pupil

Congenital anomalies-Primary and secondary disease of iris and ciliary body-Tumors -Anomalies of papillary reactions; Choroid: Congenital anomalies of the choroids-Diseases of the choroid-Tumours

Text book:

1. Jack J. Kanski, Clinical Ophthalmology, Butterworths, Elsevier, 8th Ed., 2015

Reference Books:

1. SamarK Basak, Essentials Of Ophthalmology, Jaypee Brothers Medical Publishers, 2019
2. Ronald Pitts Crick, A Textbook of Clinical Ophthalmology, A Practical Guide to Disorders of the Eyes and Their Management, 2003

20OP2013 VISUAL OPTICS I

Credits 3:0:0

Course Objectives:

1. To impart knowledge on the geometric optics for the betterment of eye vision.
2. To explain the functioning of eyes through ocular structures.
3. To deliver knowledge on the refractive anomalies and their causes.

Course Outcomes:

At the end of the course, the student will be able to

1. Recall the physical laws in geometric optics.
2. Understand the optics of ocular structures.
3. Apply the knowledge of optics in measurement of optical constants of the eye.
4. Analyze the quality of vision through eye anatomy.
5. Evaluate the refractive anomalies.
6. Appreciate the knowledge gained on visual optics in treatment of eye problems.

Module 1: Review of Geometric Optics

Vergence and Power- Conjugacy, Object Space and Image Space-Sign Convention- Spherical Refracting Surface -Spherical Mirror-Catoptric Power -Cardinal Points -Magnification

Module 2: Optics of Ocular Structures

Cornea and Aqueous-Crystalline Lens-Vitreous-Curvature of the Lens and Ophthalmophakometry- Axial and Axis of the Eye

Module 3: Measurement of the Optical Constants of the Eye

Corneal Curvature and Thickness- Keratometry-Curvature of the Lens and Ophthalmophakometry-Axial and Axis of the Eye

Module 4: Refractive Anomalies and their Causes

Aetiology of Refractive Anomalies-Contributing Variabilities and their Ranges-Populating Distributions of Anomalies

Module 5 : Optical components

Optical Component Measurements -Growth of the Eye in Relation to Refractive Errors

Text Book:

1. Tunnaclyffe, Introduction to Visual Optics, 1993

Reference Books:

1. Bennett & Rabbetts, Clinical visual Optics, Elsevier, Fourth Edition, 2007
2. David O Michaels, Visual Optics & Refraction: A clinical approach, 1980

20OP2014 OCULAR ANATOMY AND OCULAR PHYSIOLOGY

Credits 3:0:0

Course Objectives:

1. To impart a detailed knowledge on the ocular physiology.
2. To explain the functioning of eyes through phenomena like torsion, deviation, muscle action etc.
3. To deliver knowledge on the crystalline lens and accommodation.

Course Outcomes:

At the end of the course, the student will be able to

1. Recall the working of eye lid, lacrimal apparatus and extra ocular muscles.
2. Understand the cornea aqueous secretion and dynamics.
3. Apply the knowledge of crystalline lens and accommodation for curing eye anomalies.
4. Analyze the quality of iris and pupil.
5. Evaluate the problems associated with retina and acuity of vision.
6. Appreciate the knowledge gained on ocular physiology in rectifying defects in colour vision.

Module 1: Eye lid, Lacrimal Apparatus & Extra-ocular muscles

Movements and Pathways; Lacrimal Apparatus : Tear Film & Composition of Tears-Tests to Assess Lacrimal Excretory Function; Extra-Ocular Muscles : Articulation of Eyeball in Socket -Mechanics of Movement-Control of Eye Movements-Diplopia-Diagnosis & Assessment-Qualification of Extra Ocular Muscle-Limitation: Measurement of Torsion-Measurement of Deviation- Measurement of Field of BSV- Measurement of Field of Muscle Action.

Module 2: Cornea- Aqueous secretion & dynamics

Biochemistry- Corneal Transparency- Innervations; Aqueous Humor & Vitreous: Aqueous Secretion & Dynamics- Maintenance of IOP- Diurnal Variations-Measurement of IOP-Molecular Structure of Vitreous & Developmental Anomalies.

Module 3: Crystalline lens & Accommodation:

Biochemistry- Glucose Metabolism- Changes in Lens Structure-Depth of Field & Depth of Focus-Accommodation: Changes- Amplitude- Accommodation & Refraction- Accommodation & Convergence-Presbyopia.

Module 4: Iris & pupil

Pupillary Reaction to Light -Measurement of Afferent Papillary Defect-Pharmacology of Pupil-Horner's Syndrome & Evaluation-Analyzing Anisocoria.

Module 5: Retina & Acuity of vision

Photichemistry of Retina-Wald's Visual Cycle-Entopic Phenomenon; Acuity of Vision: Vernier Acuity-Minimum Angle of Resolution- Principle of Measurement-Factors Affecting Visual Acuity; Visual Pathway: Optic Nerve, Chiasm & Optic Tract Visual Deprivation- Lesions of Pathway; Visual Perception: Binocular Vision- Development- Theories of Fusion- Stereoscopic Acuity- Tests for Stereopsis-Anomalies of Stereopsis- Dark Adaption; Colour Vision: Theories of Colour Vision- Defective Colour Vision- Testing for Congenital & Acquired Colour Vision Defects; Electrophysiology: Electro Retinogram-Electro Oculogram.

Text Book:

1. A.K. Khurana, Ocular Anatomy & Physiology, CBS, 2015

Reference Books:

1. Davson H, Physiology of the eye, 4th edition. 1980
2. Sir Steward Duke Elders, System of Ophthalmology, 1958

20OP2015 PATHOLOGY AND MICROBIOLOGY

Credits 3:0:0

Course Objectives:

1. To impart a detailed knowledge on diseases associated with eyes.
2. To explain the science of Hematology.

3. To deliver knowledge on the cornea and retina with the associated pathology.

Course Outcomes:

At the end of the course, the student will be able to

1. Recall the diseases associated with eyes.
2. Understand the science of hematology.
3. Understanding the pathology of cataract.
4. Apply the knowledge of morphology of bacterial cell in testing the eyes.
5. Analyze the quality of vision through basic immunology studies.
6. Identify the type of eye tumor and treatment with a thorough knowledge on pathology and microbiology.

Module 1: General Introduction

Inflammation and Repair- Ophthalmic Wound Healing- Infections: Tuberculosis-Leprosy- Syphilis- Fungus-Virus-Chlamydia; Intraocular Tumours: Retinoblastoma-Choroidal Melanoma -Optic Nerve : Normal and Tumors.

Module 2: Hematology

Anemia, Leukemia and Bleeding Disorders-Clinical Pathology-Examination of Urine and Blood Smears; Eyelid: Normal and Pathology Including Inflammations and Tumors.

Module 3: Cornea & Retina

Normal and Pathology in Degeneration and Dystrophies; Lens: Normal and Pathology of Cataract; Retina: Normal and Pathology in Inflammatory Disease- Infections; Orbit: Inflammation and Neoplasia.

Module 4: Morphology of the bacterial cell

Growth and Nutrition of Bacteria- Cultivation Methods- Identification of Bacteria- Sterilization Disinfection- Antibacterial Agents and Antibiotic Sensitivity Testing.

Module 5: Basic Immunology Bacterial Infections of the Eye-Viral Infections of the eye- Parasitic Infections of the Eye -Fungal Infections of the Eye.

Text Book:

1. Harsh Mohan, Text Book of Pathology, Jaypee Brothers Medical Publishers (P) Ltd, 2010

Reference Books:

1. Corton Kumar and Robins: Pathological Basis of the Disease, 4th edition, 1994
2. Burton G R W, Microbiology for the Health Sciences, St.Louis, J P Lippincott Co., 3rd edition, 1988
3. Apurba S Sastry , Bhat Sandhya , Essentials of Medical Microbiology, Jaypee Brothers Medical Publishers (P) Ltd. 2017

20OP2016 VISUAL OPTICS LAB I

Credits 0:0:2

Course Objectives:

1. To provide practical skill set on visual optics
2. To give hands on training on experiments on lenses, prism etc.
3. To develop skill set on hypermetropia, emmetropia etc through mathematical models

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the Purkinje images
2. Apply the knowledge on visual optics in measuring the corneal curvature and thickness
3. Appreciate the knowledge on mathematical models in eye emmetropia and hypermetropia
4. Solve problems on axial refractive hyperopia and myopia
5. Develop practical skills on lens systems and prism
6. Create new methods for testing eye vision through physics experiments

List of Experiments

1. Study of Purkinje images I and II
2. Study of Purkinje images III and IV
3. Measurement of corneal curvature
4. Measurement of Corneal thickness
5. Mathematical models of the eye –emmetropia
6. Mathematical models of Hypermetropia
7. Mathematical models of myopia
8. Conjugate points – demonstration – worked examples
9. Axial and refractive hyperopia – worked examples
10. Axial and refractive myopia – worked examples
11. Visual acuity charts
12. Effect of lenses in front of the eye
13. Effect of prisms in front of the eye
14. Vision through pinhole, slit, filters, etc

Reference Books:

1. Bennett & Rabbetts: Clinical visual Optics
2. David O Michaels: Visual Optics & Refraction (DOM)

20OP2017 CLINICS LAB I

Credits 0:0:2

Course Objectives:

1. To provide practical skill set on visual optics
2. To give hands on training on experiments on lenses, prism etc.
3. To develop skill set on hypermetropia, emmetropia etc through mathematical models

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the case sheet
2. Apply the knowledge on clinical procedures in history taking
3. Appreciate the knowledge on lensometry through practical works
4. Solve problems on visual acuity
5. Develop practical tests for phorias and tropias
6. Create new methods for Ophthalmoscopy

List of Experiments

1. Case sheet
2. History taking
3. Lensometry
4. Visual acuity
5. Tests for phorias and tropias
6. External examination
7. Slit lamp examination
8. Drugs and method of application
9. Do's and don'ts – papillary dilatation
10. Direct Ophthalmoscopy
11. Indirect Ophthalmoscopy
12. Instrumentation
13. Patients selection
14. Keratometry reading
15. Refraction
16. Fluorescent pattern

17. Overrefraction
18. Fitting of hard lenses
19. Rigid gas permeable lenses and soft lenses in refractive errors and in specialized condition

The students are made to observe the interneers initially, then gradually they are encouraged to work up a patient, and perform various examination techniques

20OP2018 OPTOMETRIC OPTICS II

Credits 3:0:0

Course Objectives:

1. To impart knowledge on the characteristics of tinted lenses
2. To illustrate the types of filters and coatings used in lenses
3. To demonstrate the mounting of lenses and its proper handling

Course Outcomes:

At the end of the course, the student will be able to

1. Define the properties and characteristics of the tinted and protective lenses
2. Describe the different types of filters used in lenses with their merits
3. Examine the reflected images and ghost images from the spectacle lenses
4. Analyse the effect of anti reflective, anti fog and anti scratch coatings on the lenses
5. Appraise on the size, shape and mounting of the lenses
6. Design and develop flawless, purpose solving spectacle lenses suitable for the patients

Module 1: TINTED LENSES

Tinted and Protective Lenses - Characteristics of Tinted Lenses - Absorptive Glasses.

Module 2: FILTERS AND OTHER LENSES

Polarizing Filters - Photochromic Filters - Reflecting Filters - Bifocal Lenses -Trifocal Lenses – Progressive Addition Lenses - Lenticular Lenses.

Module 3: IMAGES FROM LENSES

Reflections from Spectacle Lenses - Ghost Images - Reflections in Bifocals at the Dividing Line.

Module 4: COATING OF LENSES

Anti-reflection Coating – Anti Scratch Coating - Anti-fog Coating - Mirror Coating - Edge Coating - Hard Multi Coating (HMC).

Module 5: LENSES HANDLING

Field of View of Lenses - Size, Shape and Mounting of Ophthalmic Lenses - Aspherical Lenses.

Text Books:

1. M. Jalie: Principles of Ophthalmic Lenses, Edition 5, 2016
2. T. E. Fannin & T Grosvenor: Clinical Optics, 1996

Reference Books:

1. David Wilson: Practical Optical Dispensing, OTEN- DE, NSW TAFE Commission, 1999.
2. C.V. Brooks, IM Borish: System for Ophthalmic Dispensing, Second edition, Butterworth-Heinemann, USA, 1996.
3. P.C. Mukherjee: Optics For Optometry Students, JPB; First edition, 2009.

20OP2019 OCULAR DISEASES II

Credits 3:0:0

Course Objectives:

1. To provide a better understanding of ophthalmology, with reference to ocular diseases
2. To disseminate the knowledge on inflammation and complication caused in the vitreous body
3. To impart knowledge on the anterior and posterior segment trauma and blindness

Course Outcomes:

At the end of the course, the student will be able to

1. List the abnormalities, trauma and inflammation related to vitreous body
2. Discuss in detail about the retinal disorder and related diseases
3. Interpret on the background, defects and techniques involved in neuro-ophthalmology
4. Illustrate clearly on the supranuclear control of eye movements
5. Appraise on the anatomy, pathophysiology and aging process
6. Analyze on the causes, therapy and drug related to ocular diseases

Module 1: VITREOUS

Developmental Abnormalities - Hereditary Hyaloidoretinopathies - Juvenile Retinoschisis - Asteroid Hyalosis – Cholesterosis - Vitreous Haemorrhage - Blunt Trauma and the Vitreous - Inflammation and the Vitreous - Parasitic Infestations - Pigment Granules in the Vitreous - Vitreous Complications in Cataract Surgery.

Module 2: RETINA

Retinal Vascular Diseases - Diseases of the Choroidal Vasculature - Bruch's Membrane and Retinal Pigment Epithelium (RPE) - Retinal Tumors – Retinoblastoma – Phakomatoses - Retinal Vascular Anomalies - Retinal and Optic Nerve Head Astrocytomas - Lymphoid Tumors - Tumors of the Retinal Pigment Epithelium - Other Retinal Disorders - Retinal Inflammations - Metabolic Diseases Affecting the Retina - Miscellaneous Disorders - Electromagnetic Radiation Effects on the Retina - Retinal Physiology and Psychophysics - Hereditary Macular Disorders (Including Albinism) - Peripheral Retinal Degenerations - Retinal Holes and Detachments - Intraocular Foreign Bodies – Photocoagulation.

Module 3: NEURO-OPHTHALMOLOGY

Neuro-Ophthalmic Examination – History - Visual Function Testing - Technique of Papillary Examination - Ocular Motility - Checklist for Testing - Visual Sensory System - The Retina - The Optic Disc - The Optic Nerve - The Optic Chiasm -The Optic Tracts -The Lateral Geniculate Body - The Optic Radiations -The Visual Cortex -The Visual Field - The Blood Supply of the Anterior and Posterior Visual Systems - Disorders of Visual Integration - Ocular Motor System - Supranuclear Control of Eye Movements: Saccadic System, Clinical Disorders of the Saccadic System, Gaze Palsies, Progressive Supranuclear Palsy, Parkinson's Disease, Ocular Motor Apraxia, Ocular Oscillation - Smooth Pursuit System and Disorders - Vergence System - Cerebella System - Non-Visual Reflex System - Position Maintenance System – Nystagmus - Ocular Motor Nerves and Medial Longitudinal Fasciculus - The Facial Nerve - Pain and Sensation from the Eye - Autonomic Nervous System - Selected Systemic Disorders with Neuro-Ophthalmologic Signs.

Module 4: LENS

Anatomy and Pathophysiology - Normal Anatomy and Aging Process - Developmental Defects - Acquired Lenticular Defects.

Module 5: TRAUMA AND BLINDNESS

Anterior Segment Trauma - Posterior Segment Trauma – Blindness: Definitions – Causes - Social Implications - Rationale in Therapy - Drug Induced Ocular Diseases.

Text Books:

1. J. Kanski: Clinical Ophthalmology Elsevier; Ninth edition 2019.

Reference Books:

1. K. Dadapeer, Essentials of Ophthalmology Jaypee Brothers Medical Publishers; first edition 2015.
2. Deepak Mishra, Prashant Bhushan, M.K. Singh, Essentials in Ophthalmology, Elsevier, First edition 2018.

20OP2020 VISUAL OPTICS II

Credits 3:0:0

Course Objectives:

1. To provide knowledge on the basics of refractive conditions and visual defects
2. To get familiarized on the principles and method involved in retinoscopy
3. To acquire knowledge on the procedures related to spectacle correction

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the different types of defects associated with vision
2. Recognize various refractive conditions and relate both accommodation and convergence
3. Review on the methods and optimum conditions such as static and dynamic of retinoscopy
4. Compare the objective and subjective refractive methods along with other methods for astigmatism
5. Interpret on the astigmatic test and difficulties in objective tests
6. Analyze and correct the defects that are connected to the spectacles

Module 1: VISUAL DEFECTS

Emmetropia – Myopia – Hyperopia – Astigmatism - Anisometropia and Anisekonion – Presbyopia - Aphakia and Pseudo Aphakia - Correction and Management of Amblyopia.

Module 2: REFRACTIVE CONDITIONS

Far and Near Points of Accommodation - Correction of Spherical Ametropia - Axial Versus Refractive Ametropia - Relationship between Accommodation and Convergence - A/C Ratio.

Module 3: RETINOSCOPY

Retinoscopy – Principles and Methods - Retinoscopy – Speed of Reflex and Optimum Condition – Retinoscopy: Dynamic/Static.

Module 4: REFRACTIVE METHODS AND TESTS

Review of Objective Refractive Methods - Review of Subjective Refractive Methods - Cross Cylinder Method for Astigmatism - Astigmatic Fan Test - Difficulties in Objective Tests and their Avoidance - Transposition of Lenses - Spherical Equivalent - Prescribing Prisms - Binocular Refraction.

Module 5: SPECTACLE CORRECTION

Effective Power of Spectacles; Vertex Distance Effects - Ocular Refraction Versus Spectacle Refraction - Ocular Accommodation Versus Spectacle Accommodation - Spectacle Magnification and Relative Spectacle Magnification - Retinal Image Blur - Depth of Focus and Depth of Field.

Text Books:

1. D. Abrams: Duke elders Practice of Refraction, Edition 9, 1998

Reference Books:

1. K. Khurana, Theory and Practice of Optics & Refraction, Elsevier India; 4 edition (2016)
2. L. P. Agarwal: Principles of Optics and Refraction, CBS; 5 edition (2019)

200P2021 OPTOMETRIC INSTRUMENTATION

Credits 3:0:0

Course Objectives:

1. To illustrate the basic principles, features, merits and demerits of different refractive instruments
2. To impart knowledge on the design and usage of ophthalmoscopes and other related devices.
3. To demonstrate various orthoptic and ophthalmic instruments and screening devices.

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the various topics related to refractive instruments
2. Discuss about the design, features and advantages of ophthalmoscope and related devices
3. Illustrate on the principles, types and uses of tonometers
4. Interpret the techniques involved in fundus camera
5. Utilize the orthoptic and ophthalmic instruments for ultrasonography and electrodiagnostics
6. Appraise on the results of various vision testing and screening devices

Module 1: REFRACTIVE INSTRUMENTS

Test Chart Standards - Choice of Test Charts - Trial Case Lenses – Best Forms - Refractor (Phoropter) Head Units –Auto Refractors - Optical Considerations of Refractor Units - Trial Frame Design - Near Vision Difficulties with Units and Trial Frame - Retinoscope – Types Available - Adjustment of Retinoscopes – Special Features - Cylinder Retinoscopy - The Interpretation of Objective Findings - Special

Subjective Test – Polarizing and Displacement – Simultan Test - Projection Charts - Illumination of the Consulting Room - Special Instruments: Brightness Acuity Test, Vision Analyzer, Pupilometer, Video Acuity Test, Nerve Fiber Analyzer - Binocular Vision - Simple and Compound Microscope – Oil Immersion Eyepiece.

Module 2: OPHTHALMOSCOPES AND RELATED DEVICES

Design of Ophthalmoscopes – Illumination/Viewing - Ophthalmoscope Disc - Filters for Ophthalmoscopy - Indirect Ophthalmoscopes - The Use of the Ophthalmoscope in Special Cases - Lensometer: Lens Gauge or Clock - Slit Lamp - Slit Lamp Systems - Viewing Microscope Systems - Scanning Laser Devices - Slit Lamp Accessories - Mechanical Design in Instruments.

Module 3: TONOMETER AND FUNDUS CAMERA

Tonometer Principles - Types of Tonometers and Standardization - Use and Interpretation of Tonometers - The Fundus Camera: Principles, Techniques - External Eye Photography – Apparatus - Keratometer and Corneal Topography – Refractionometer.

Module 4: ORTHOPTIC AND OPHTHALMIC INSTRUMENTS

Orthoptic Instruments: Haploscopes, Home Devices, Pleoptics – Historical Instruments- Ophthalmic Ultrasonography: Biometry/Ultrasound/'A'Scan/'B'Scan/UBM – Electrodiagnostics: ERG/VEP//EOG – NFA.

Module 5: VISION TESTING AND SCREENING DEVICES

Colour Vision Testing Devices: Colour Confusion, Hue Discrimination, Colour Matching - FM-100 Hue Test - Fields of Vision and Screening Devices: Perimeter and the Visual Field, Illumination of Field Testing Instruments, Projection Perimeters, Screening Devices for Field Defects, Results of Field Examination, Vision Screeners – Principles and Details, Analysis of Screener Results, Bowl Perimeters, Goldmann and Humphrey Vision Analyzer - Optical Devices and Electronic (Low Vision) Aids.

Text Books:

1. David B Henson: Optometric Instrumentation, Butterworth-Heinemann Ltd (1 December 1982).

200P2022 OPTOMETRIC INSTRUMENTATION LAB

Credits 0:0:3

Course Objectives:

1. To train the students on optometric experiments so as to understand the basic concepts.
2. To impart skills on handling refractive instruments
3. To provide knowledge on testing and screening devices

Course Outcomes:

Students will have the ability to

1. Demonstrate the practical skills on optometric instrumentation with the aid of physics experiments
2. Describe the concepts and principles of refraction of light through refractive instruments
3. Interpret the results of various testing and scanning devices.
4. Illustrate on the photography of fundus camera through practical experiment
5. Carry out the associated test based on the ophthalmoscopes and other related devices
6. Utilize the orthoptic and ophthalmic instruments for electrodiagnostics

List of Experiments

1. Simple and compound microscope – oil immersion eyepiece
2. Refractive instruments: Test chart standards Trial case lenses – best forms Refractor (phoropter) head units –Auto refractors Retinoscope – types available Nerve fiber analyzer
3. Ophthalmoscopes and related devices Design of ophthalmoscopes – illumination/viewing Ophthalmoscope disc Filters for ophthalmoscopy Indirect ophthalmoscopes The use of the ophthalmoscope in special cases
4. Lensometer, lens gauge or clock
5. Slit lamp Slit lamp systems Viewing microscope systems Scanning laser devices Slit lamp accessories

6. Tonometer: Tonometer principles
7. Fundus camera
8. Keratometer and corneal topography
9. Orthoptic Instruments
10. Colour vision testing devices
11. Fields of vision and screening devices
12. Ophthalmic Ultrasonography
13. Electrodiagnostics

20OP2023 VISUAL OPTICS LAB II

Credits 0:0:3

Course Objectives:

1. To impart practical knowledge on visual optics through experiments
2. To provide practical knowledge about the defects involved in vision
3. To provide basic skill in identifying the type of visual defect

Course Outcomes:

At the end of the course, the student will be able to

1. Identify the myopia defect and thereby do the myopic corrections
2. Resolve hypermetropic correction and perform subjective verification
3. Use slit and Kertometry instrument to demonstrate astigmatism.
4. Review through experiments on the far and near points of accommodation
5. Classify the axial and refractive ametropia by doing the experiments
6. Analyze different measurements for effective understanding of the methods involved.

List of Experiments

1. Photometry
2. Visual acuity, stereo acuity in emmetropis
3. Myopia and pseudomyopia, myopia and visual acuity
4. Myopic correction – subjective verification – monocular and binocular
5. Hypermetropia – determination of manifest error subjectively
6. Hypermetropic correction: subjective verification
7. Demonstration of astigmatism. Use of slit and Kertometry to find the principal meridians
8. Astigmatism: fan – subjective verification tests
9. Astigmatism: Cross-Cyl. – Subjective verification test
10. Measurement of accommodation: near and far points and range
11. Presbyopic correction and methods: accommodative reserve, balancing the relative accommodation and cross grid test
12. Methods of differentiating axial and refractive ametropia
13. Practice of Retinoscopy – Emmetropia
14. Practice of Retinoscopy – Spherical ametropia
15. Practice of Retinoscopy – Simple astigmatism
16. Practice of Retinoscopy – Compound hyperopia
17. Practice of Retinoscopy – Compound myopia
18. Practice of Retinoscopy – Oblique astigmatism
19. Practice of Retinoscopy – in media apacities
20. Practice of Retinoscopy – in irregular astigmatism
21. Practice of Retinoscopy – in strabismus and eccentric fixation
22. Interpretation of cycloplegic retinoscopic findings
23. Prescription writing
24. Binocular refraction
25. Photo refraction

26. Vision therapy
27. Exercises for vergence

20OP2024 CLINICS LAB II

Credits: 0:0:3

Course Objectives:

To enable students to acquire the clinical skills necessary for entry into the pre-registration year following graduation

Course Outcomes:s

At the end of the course, the student will be able to

1. To demonstrate clinical understanding in all of the clinics covered in the unit
2. To demonstrate practical clinical competence in each of the areas covered by the unit
3. To develop effective clinical communication skills.
4. To demonstrate the instrumentation used in lens fitting
5. To demonstrate the refraction and refractive errors in eye.
6. To demonstrate the contact lens fitting

List of Experiments

1. Case Sheet
2. History Taking
3. Lensometry
4. Visual Acuity
5. Tests for Phorias and Tropias
6. External Examination
7. Slit Lamp Examination
8. Drugs And Method of Application
9. Do's and Don'ts – Papillary Dilatation
10. Direct Ophthalmoscopy
11. Indirect Ophthalmoscopy
12. Instrumentation
13. Patients Selection
14. Keratometry Reading
15. Refraction
16. Fluorescent Pattern
17. Over Refraction
18. Fitting of Hard Lenses
19. Rigid gas permeable lenses and soft lenses in refractive errors and in specialized condition. The students are made to observe the interneers initially, then gradually they are encouraged to work up a patient, and perform various examination techniques.

20OP2025 CLINICAL EXAMINATION OF VISUAL SYSTEM

Credits: 3:0:0

Course Objectives:

1. To impart knowledge on ocular symptoms, testing and ophthalmic examination
2. To illustrate the concept of ophthalmoscopy and fundus
3. To provide knowledge on lacrimal and macular examinations

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the basics of ophthalmic subject, symptoms and testing in visual system.
2. Examine various steps involved in ophthalmic treatment
3. Illustrate the different types of lens examination and diagnosis
4. Describe ophthalmoscopy and its different types of treatment methods.

5. Appraise the concepts of fundus and lacrimal examinations
6. Demonstrate the macular functioning and testing in ophthalmological examination

Module 1: Introduction

History of the ophthalmic subject - ocular symptoms, The past prescription, its influence, visual acuity testing – distance and near and colour vision -

Module 2: Ophthalmic Examinations

Examination of muscle balance - Slit lamp examination - Examination of eye lids, conjunctiva and sclera - Examination of cornea - Examination of iris - ciliary body and pupil

Module 3: Lens and Ophthalmoscopy

Examination of lens - Examination of intraocular pressure and examination of angle of anterior chamber - Ophthalmoscopy – Direct and Indirect

Module 4: Fundus and Lacrimal Examinations

Examination of fundus - vitreous and disc - choroids and retina - Examination of lacrimal system - Examination of the orbit.

Module 5: Macular Examination

Macular function test - Visual field charting – central and peripheral - Neuro – ophthalmological examination

Textbooks: -

1. Jack J. Kanski: Clinical Ophthalmology, Butter-worths, 2nd Ed, 1989

Reference Books: -

1. Clinical Examination in Ophthalmology, Dr. Mukherjee P. K, ISBN: 9788131244630, 9788131244630
2. Clinical Methods in Ophthalmology: A Practical Manual for Medical Students, Dadapeer K, Jaypee Brothers Medical Publishers, January 2015, ISBN 9789351529071

20OP2026 CLINICAL PSYCHOLOGY

Credits: 3:0:0

Course Objectives:

1. To impart knowledge on clinical psychology and the ideas of sensation and determinants
2. To illustrate the human psychology factors and methodologies involved in counselling therapy
3. To provide knowledge on the psychological reaction of patients and rehabilitation.

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the basics of clinical psychology and its various methods.
2. Analyze the various steps involved in the sensation process and determinants.
3. Illustrate the factors involved in human psychology and personality integration
4. Appraise various steps in counselling therapy in clinical psychology.
5. Describe the types of psychological reaction in patients with disability
6. Identify the disability and to allow the patients through rehabilitation process.

Module 1: Psychology

Introduction to Psychology - Definition, History, Branches, Scope and Current Status - Methods, Concepts of Normality and abnormality

Module 2: Sensation and Determinants

Sensation, Attention and Perception - Primary senses - Types of attention and determinants
Principles of perception and determinants

Module 3: Human Psychology Factors

A – Intelligence, B - Learning, C - Memory, D - Personality, E – Motivation and F – Body image and personality integration

Module 4: Counseling therapy

Helper – Helpee relationship and Ophthalmic counseling - Characteristics of therapist - Relationship between the therapist and client - Counseling patient with partial sight, colour blindness and hereditary vision defects

Module 5: Reaction and Rehabilitation

Psychological Reaction- A – Illness, loss and Grief - B - Adapting changes in Vision (age, diseases, etc....)
- Tests for people with disability- WAIS – R, WISC –R (for visually handicapped)- Blind learning aptitude tests - 7. Disability and Rehabilitation

Textbooks:

1. Introduction to Psychology, Morgon C.T., King R.A., Robinson N.M., Tata Mc Graw Hill Publishing Co.

Reference Books:

1. Introduction to Psychology, Hilgard and Atkinson, Tata Mc Graw Hill Publishing Co. Psychology 5th Ed. Dworesky J.P.
2. Child Development Hurlock, EB, VIED, Mc Graw Hill International Book Co. (1981)

20OP2027 LOW VISION AIDS

Credits: 3:0:0

Course Objectives:

1. To provide knowledge on the concepts of low vision diagnosis and its evaluation in demonstrating aids.
2. To impart knowledge on the need for teaching and guiding the patients with low vision
3. To illustrate the testing the methods of low vision, lens and devices for rehabilitation.

Course Outcomes:

At the end of the course, the student will be able to

1. Identify the diagnostic procedures in low vision patients and case management
2. Analyze the evaluation techniques and demonstrating aids in low vision diagnosis
3. Illustrate the need for taking care of the patients with teaching and guidance
4. Demonstrate the use of telescopes and microscopes in low vision tests.
5. Describe the pathological conditions and to administer the patients with low vision care.
6. Identify the right optical devices for the rehabilitation of the visually handicapped.

Module 1: Low Vision Introduction

Identifying the low vision patient - History - Diagnostic procedures in low vision case management - Optics of low vision aids

Module 2: Evaluation and Demonstrating aids

Refraction, special charts - Radical retinoscopy - Evaluating near vision: Amsler grid and field defects, prismatic scanning - Demonstrating aids – optical, Non-optical, Electronic

Module 3: Teaching and Guidance

Teaching the patient to use aids including eccentric viewing training when necessary - Guidelines to determining magnification and selecting low vision aids for distance, intermediate and near

Module 4: Low Vision Tests

Spectacle mounted telescopes and microscopes - Children with low vision - Choice of tests, aids in different pathological conditions - Light, glare and contrast in low vision care and rehabilitation

Module 5: Lens and Devices

Bioptic telescopes - Optical devices to help people with field defects - Contact lens combined system - Rehabilitation of the Visually handicapped

Textbooks: -

1. C.Dickinson : Principles and Practice of Low Vision, Butterworth- Heinemann Publication, 1998

Reference Books: -

1. Low Vision Aids Practice, 2nd Edition 2007, Bhootra Ajay, ISBN: 9788184480436, 9788184480436

20OP2028 DISPENSING OPTICS**Credits: 3:0:0****Course Objectives:**

1. To demonstrate the verification and dispensing of ophthalmic materials and special practices in clinics
2. To impart the knowledge on the lens standards for the usage in the dispensing instruments
3. To illustrate the design and selection of frames for the optics and safety wear

Course Outcomes:

At the end of the course, the student will be able to

1. Describe the ophthalmic materials in dispensing optics and its verification
2. Explain the special practices in handling the lenses and frames
3. Illustrate the procedures and process involved in the manufacturing of lenses.
4. Demonstrate the use of dispensing instruments in lens measurements and frame fittings.
5. Analyze various factors involved in the instrumentation for the selection of lenses.
6. Identify and select the right frame designs and fittings for the patients.

Module 1: Verification and Dispensing

Clinical experiences in verification and dispensing of ophthalmic materials outlined in Ophthalmic Optics (Optometric Optics Course) and Dispensing Optics

Module 2: Special Practices

Special practical instructions in centering, marking and mounting the lenses of all designs, types, shapes and sizes in accordance with frame and facial measurements

Module 3: Lens and Standards

Visit to lens manufacturing workshops - Video session on fitting of progressive lenses - ANSI standards

Module 4: Instruments and Analysis

Dispensing Instrumentation – Pupillometer - Pliers – PCD - Air blower – Distometer - Abbe's value, specific gravity, optical density, Pantoscopic flit

Module 5: Frames and Fittings

Patients selection, fitting Ms of PALs - Selection of designs - case study : problems, orientated dispensing optics - Recent developments - Special purpose frames - Safety wear

Textbooks: -

1. Clifford W Brooks & Irvin M Borish: System of Ophthalmic Dispensing, Professional press, 1979

Reference Books: -

1. Dispensing Optics, Ajay Kumar Bhootra, JP Medical Ltd, 2015, ISBN 935250013X, 9789352500130

20OP2029 BINOCULAR VISION**Credits: 3:0:0****Course Objectives:**

1. To impart knowledge on the aspects and evolution of binocular vision.
2. To demonstrate the qualitative and quantitative diagnosis of binocular vision and its treatment.
3. To illustrate the types and procedures of strabismus and orthoptic procedures

Course Outcomes:

At the end of the course student will be able to

1. Describe the evolution of binocular vision and its different parameters
2. Explain the development of binocular vision and its neural aspects

3. Illustrate the visually guided behavior in the diagnosis of binocular vision and its AV phenomena.
4. Demonstrate the various treatments and analysis of amblyopia in binocular vision
5. Analyze various types of strabismus and non-surgical management in binocular vision
6. Identify the orthoptic procedures involved in the treatment of binocular vision.

Module 1: Introduction to Binocular Vision

Spatial sense - Evolution of Binocular vision - Binocular fusion, suppression, rivalry and summation - Visual direction, local sign and corresponding points.

Module 2: Aspects of Binocular vision

Visual distance, empirical cues - Panum's space – Stereopsis - Development of Binocular vision - The longitudinal horopter - Neural aspects of Binocular vision

Module 3: Diagnosis

Visually guided behaviour and anisokonia – ARC - Qualitative and quantitative diagnosis of strabismus – Esodeviations – Exodeviations - A-V phenomena

Module 4: Treatment and Analysis

Cyclovertical squint - Pseudo strabismus - Amblyopia and eccentric fixation - Treatment of amblyopia

Module 5: Types and Procedures

Special forms of strabismus – Nystagmus - Non-surgical management of strabismus - Review of orthoptic procedures

Textbooks

1. R W Reading: Binocular Vision- Foundations and Applications

Reference Books

1. Basic Science, A.A.O (section-6) Pediatric Ophthalmology and Strabismus 1992-1993

20OP2030 LOW VISION AIDS LAB

Credits: 0:0:2

Course Objectives:

1. To train the students to understand the low vision aids through the experiments
2. To demonstrate the experiments involving corrective measurements in low vision patients
3. To impart hands on skills in the different tests and lenses for the visually handicapped.

Course Outcomes:

At the end of the course, the students will be able to

1. Demonstrate the practical skills on measurements and instrumentation techniques through refraction and radical retinoscopy
2. Describe the concepts and principles of evaluating near vision by prismatic scanning
3. Analyze optical and non-optical measurements for effective understanding of demonstrating aids
4. Describe the concepts and principles determining magnification and low vision aids through practical experiments
5. Workout calculations, property analysis of optic measurements for spectacle mounts and aids in different pathological conditions
6. Apply the concepts involved in selecting the contact lenses to administer the patients.

List of Experiments

1. Refraction, special charts.
2. Evaluating near vision: Amsler grid and field defects, prismatic scanning
3. Demonstrating aids – optical, Non-optical, Electronic
2. Guidelines to determining magnification and selecting low vision aids for distance, intermediate and near.
4. Spectacle mounted telescopes and microscopes
5. Choice of tests, aids in different pathological conditions
6. Contact lens combined system

20OP2031 DISPENSING OPTICS LAB

Credits: 0:0:2

Course Objectives:

1. To train the students to understand the dispensing optics through the experiments
2. To demonstrate the experiments involving corrective measurements in vision correction in patients
3. To train them in different measurements and tests for the visually handicapped.

Course Outcomes:

At the end of the course student will be able to

1. Demonstrate the practical skills on measurements and instrumentation techniques through optics center marking
2. Describe the concepts and principles of evaluating far and near PD measurements
3. Analyze effective understanding of pupillometer measurements in dispensing optics
4. Describe the concepts and principles determining tints and filters through practical experiments
5. Workout calculations, property analysis of different types of bifocal lenses in different pathological conditions
6. Apply the concepts involved in PAL's fitting to administer the patients.

List of Experiments

1. Optic center marking
2. PD Measurement – for far and near
3. Pupillometer
4. Tints and filters to be shown – indications
5. Different types of Bifocals to be shown
6. PALs fitting

20OP2032 GLAUCOMA

Credits: 3:0:0

Course Objectives:

1. To provide knowledge on the most common systemic diseases, and their relationship to the abnormal ocular conditions.
2. To provide knowledge on the different types of glaucoma and advances in the management of glaucoma
3. To prepare students for clinical challenges that may appear in this rapidly advancing profession

Course Outcomes:

At the end of the course the student will be able to

1. Understand the basics of glaucoma
2. Attain clear knowledge on the clinical examination of glaucoma.
3. Interpret and diagnosis the different types of glaucoma.
4. Articulate the medical characterisation of angle closure glaucoma.
5. Detect developmental abnormality of angle of anterior chamber leading to high intraocular pressure.
6. Adapt the proper medical treatment to normalize and control the intraocular pressure and to prevent loss of visual acuity.

Module 1 : Introduction to Glaucoma

Epidemiology – Heridity - Intra Ocular Pressure and Aqueous Humor Dynamics – Clinical Evaluation: Gonioscopy, Optic Nerve Head Analysis, Visual Fields.

Module 2 : Classification of Glaucoma

Open Angle Glaucoma: The Glaucoma Suspect, Open Angle Glaucoma without Elevated IOP, Primary Open Angle Glaucoma: Etiology, Clinical Features, Diagnosis and Management - Secondary Open Angle Glaucoma.

Module 3 : Angle Closure Glaucoma

Angle Closure Glaucoma - Primary Angle Closure Glaucoma: Etiology, Clinical Classification, Clinical Features, Diagnosis and Management - Secondary Angle Closure Glaucoma.

Module 4 : Developmental Glaucoma

Developmental Glaucoma - Congenital Glaucoma - Infantile Glaucoma - Juvenile Glaucoma Syndromes with Glaucoma.

Module 5 : Medical Management of Glaucoma

Medical Management of Glaucoma - Surgery Therapy for Glaucoma - Newer Advances in the Management of Glaucoma.

Text Books:-

1. M Bruce Shields (MBS): Text Book of Glaucoma, Williams & Wilkins, London, 2010.
2. A K Khurana: Comprehensive Ophthalmology, 4th edition, New age international (p) Ltd. Publishers, New Delhi, 2007.

Reference Books:-

1. Stephen J. Miller : Parsons Diseases of the Eye, 18th edition, Churchill Livingstone, 1990
2. Jack J. Kanski Clinical Ophthalmology: A Systematic Approach, 6th edition, Butterworth-Heinemann, 2007.

200P2033 PAEDIATRIC OPTOMETRY AND GERIATRIC OPTOMETRY

Credits: 3:0:0

Course Objectives:

1. To provide knowledge about ocular physiological changes of ageing
2. To impart knowledge on the common geriatric systematic and ocular diseases.
3. To demonstrate practical aspects of diagnosis and management of eye conditions related to pediatric inhabitants.

Course Outcomes:

At the end of the course the student will be able to

1. Understand the principal theories of childhood and visual development.
2. Analyse a thorough paediatric history which encompasses the relevant developmental, visual, medical and educational issues.
3. Attain clear knowledge on the accommodative-vergence system to assess the paediatric eye disorders.
4. Analyse the techniques for examining visual function of children of all ages and an understanding varied management concepts of paediatric vision disorders
5. Identify and investigate the age related changes in the eyes.
6. Demonstrate dispensing contact lens, low vision aids and referral to the surgeon.

Module 1 : Genetic Factors

Genetic factors - Prenatal systems - Prenatal factors - Postnatal factors - Normal prenatal development and Embryology - Tissue Origin of the Various Structure of the Eye.

Module 2 : Paediatric Optometry

Anomalies of Prenatal And Postnatal Development: Orbit Eyelids Lacrimal System Conjunctiva Cornea Sclera Anterior Chamber, Uveal Tract, Pupils Lens, Vitreous, Fundus Oculomotor System - Measurement of Refractive Status - Determining Binocular Status.

Module 3 : Compensatory Treatment and Remedial Therapy

Myopia, Pseudo myopia, Hyperopia, Astigmatism, Anisotropies, Amblyopia - Remedial & compensatory treatment for strabismus & nystagmus - Visual aids for children C/ L & LVA

Module 4 : Geriatric Optometry

Structural Changes in Eye - Physiological Changes in Eye - Optical and Refractive Changes in Eye - Aphakia, Pseudo Aphakia and its Correction - Ocular Diseases Common in Old Eye - With Special Reference to Cataract, Glaucoma, Macular Disorders, Vascular Diseases of the Eye.

Module 5 : Medical Management of Geriatric Optometry

Special Considerations in Ophthalmic Dispensing to the Elderly - Management of Visual Problems of Aging - How to Carry on One's Visual Task Overcoming the Problems of Aging? - Contact Lens in Elderly - Optometric Examination of Older Adults.

Text Books:-

1. A.J. Rossenbloom Jr & M.W.Morgan: Vision and Aging, Butterworth, Heinemann, Missouri, 2007.
2. Jerome Rosner: Pediatric Optometry, Butterworths, London, 1990.
3. William Harvey/ Bernard Gilmartin, Paediatric Optometry Butterworth –Heinemann, 2004.

Reference Books:-

1. OP Sharma: Geriatric Care – A textbook of geriatrics and Gerontology, viva books, New Delhi, 2005.
2. VS Natarajan: An update on Geriatrics, Sakthi Pathipagam, Chennai, 1998.
3. DE Rosenblatt, VS Natarajan: Primer on geriatric Care: A clinical approach to the older patient, Printers Castle, Cochin, 2002.

20OP2034 CONTACT LENS

Credits 3:0:0

Course Objectives:

1. To provide the suitable knowledge to the student both in theoretical and practical aspects of Contact Lenses.
2. To impart knowledge on designing skills of various types of contact lens
3. To illustrate knowledge on fitting philosophies and recent development of contact lenses.

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the history and basics of contact lenses.
2. List the important properties of contact lenses.
3. Predict the contact lens design for various kinds of patients
4. Recognize various type of contact lens fitting
5. Hypothesize the contact lens care procedures for the awareness of the patients
6. Demonstrate the instrumentation in contact lens practices.

Module 1 : History of Contact Lens

Corneal Anatomy and Physiology - Corneal Physiology and Contact Lens - Preliminary Measurements and Investigations - Slit lamp Biomicroscopy - Contact lens materials - Optics of Contact lenses.

Module 2 : Contact Lens Design

Glossary of Terms: Contact Lenses - Indications and Contra Indications of Contact Lens - Rigid gas permeable contact lens design - Soft contact lens design – Keratometry - Placido's disc –Topography.

Module 3 : Fitting Philosophies

Introduction to Contact lens fitting - Handling of contact lenses - Fitting of spherical Soft Contact Lens and effects of parameter changes - Astigmatism; Correction options - Fitting spherical RGP CL - Low DK High DK - Effects of RGP CL parameter changes on lens fitting - Fitting in Astigmatism - Fitting in Keratoconus - Fitting in Aphakia, Pseudophakia.

Module 4 : Contact Lens Care

Lens care & Hygiene Instructions Compliance - Follow up post fitting examination - Follow up slit lamp examinations - Cosmetic Contact lenses - Fitting contact lens in children - Toric Contact lenses - Bifocal contact lenses - Continuous wear and extended wear lenses - Therapeutic lenses / bandage lenses - Contact lens following ocular surgeries - Disposable contact lenses - Frequent replacement and lenses.

Module 5 : Contact Lens Practice

Use of Specular Microscopy and Tachymetry in Contact Lens - Care of contact lenses - Contact lens solutions - Complications of Contact lenses - Contact lens modification of finished lenses -Instrumentation in contact lens practice - Checking finished lens parameters - Contact Lens for Special purposes –

Swimming, Sports, Occupational etc., - Recent developments in Contact lenses - Review of lenses available in India.

Text Books:-

1. Anthony J. Phillips: Contact Lenses, 5th edition, Butterworth-Heinemann, 2006
2. Elisabeth A. W. Millis: Medical Contact Lens Practice, Butterworth-Heinemann, 2004
3. E S. Bennett, V A Henry :Clinical manual of Contact Lenses, 3rd edition, Lippincott Williams and Wilkins, 2008.

Reference Books:-

1. Robber B Mandell: Contact lens Practice, hard and flexible lenses, Charles C. Thomas, 4th Edition, 1988.
2. Ruben M Guillon: Contact lens practice, 1st Edition, 1994.

20OP2035 OCCUPATIONAL OPTOMETRY

Credits 3:0:0

Course Objectives:

1. To provide knowledge to the student on the general aspects of occupational health
2. To illustrate the ocular and visual problems of occupation
3. To impart knowledge on occupational hazards and remedial aspects through classroom teaching and field visits

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the occupational health
2. Identify the visual requirements in various jobs.
3. Illustrate the effects of physical, chemical and biological hazards on eye and vision
4. Analyze occupational causes of visual and eye problems.
5. Prescribe suitable corrective lenses and eye protective wear to the patients.
6. Formulate visual requirements and standards for different jobs.

Module 1 : Introduction

Introduction to Occupational Health, Hygiene and Safety - International Bodies: ILO, WHO -National Bodies: Labour Institutes, National Institutes of Occupational Health, National Safety Council.

Module 2 : Acts and Rules

Factories Act and Rules- Workmen's Compensation Act – ESI Act - Occupational Diseases/ Occupation Related Diseases Caused by Physical Agents, Chemical Agents and Biological Agents.

Module 3 : Occupational Hygiene and Safety

Environmental Monitoring Recognition - Evaluation and Control of Hazards Illumination – Definition, Measurements and Standards - Occupational Safety Causes of Accidents Vision, Lighting, Colour and Their Role - Accident Analysis - Accident Prevention.

Module 4 : Ocular and Visual Problems of Occupation

Electromagnetic Radiation - Ionizing Non-Ionizing: Infra-Red, Ultra Violet, Microwave, Laser – Injuries: Mechanical, Chemical -Toxicology – Metals, Chemicals - Prevention Of Occupational Diseases - Medical Examination / Medical Monitoring - Pre-Employment / Pre-Placement Periodic.

Module 5 : Personal Protective Equipment and Standards

General - Goggles, Face Shields - Selection And Use- Testing for Standards- Standards: Visual Standards for Jobs - Problems Of Special Occupational Groups: Drivers, Pilots and Others.

Text Books:-

1. R V North: Work and the eye, Second edition, Butterworth Heinemann, 2001 Seymour L Coblens: ptometry and the Law, American Optometric Association, St.Louis,1976
2. R.A.F. Cox (ed.) fitness for work – the medical aspects. Oxford University Press 2000, reprinted 2003

3. Indian Association of Occupation Health, Guidelines on Pre-Employment Medical Examination, Pune 1998
4. Barbara A.Plog, Patrica J. Quinlan. Fundamentals of Industrial Hygiene. 5th Edition, 2002
5. N.A. Smith: Lighting for Occupational Optometry, HHSC Handbook Series, Safchem Services, 1999 .
6. G Carson, S Doshi, W Harvey: Eye Essentials: Environmental & Occupational Optometry, Butterworth-Heinemann, 2008.

200P2036 SYSTEMIC DISEASES

Credits 3:0:0

Course Objectives:

1. To provide knowledge on the definition and classification of systematic diseases.
2. To impart knowledge on clinical diagnosis, complications and management of various systematic diseases.
3. To illustrate the immunology and components of the immunity system

Course Outcomes:

At the end of the course the student will be able to

1. Describe the common systematic conditions.
2. Classify the various systematic diseases and the respective clinical examinations.
3. Perform the clinical diagnosis of diverse systematic diseases.
4. Acquaint with the first aid knowledge and management options
5. Analyse the Ocular findings of the systematic conditions.
6. Design the report on malnutrition and immunology.

Module 1 : Arterial Hypertension and Diabetes Mellitus

Pathophysiology, Classification, Clinical Examination, Diagnosis, Complications, Management Hypertension and the Eye. Diabetes Mellitus: Pathology, Classification, Clinical Features, Diagnosis, Complications And Management Diabetes Mellitus and the Eye.

Module 2 : Embolism and Cancer

Acquired Heart Disease – Embolism: Rheumatic Fever- Pathophysiology, Classifications, Diagnosis, Complications, Management Embolism, Subacute Bacterial Endocarditis. Cancer: Definitions, Nomenclature, Characteristics of Benign and Malignant Neoplasms Grading of Staging of Cancer, Diagnosis, Principles of Treatment Neoplasia and the Eye.

Module 3 : Connective Tissue and Thyroid Disease

Anatomy and Pathophysiology Arthritis - Eye and connective tissue disease. Thyroid Disease: Anatomy and physiology of the thyroid gland, Classification of thyroid disease Diagnosis, complications, clinical features, management, thyroid disease and the eye.

Module 4 : Tuberculosis, Helminthiasis and Common Tropical Medical Ailments

Tuberculosis: Aetiology, Pathology, Clinical Features, Pulmonary Tuberculosis, Diagnosis, Complications, Treatment, Tuberculosis and the Eye. Helminthiasis: Classification, Schistosomiasis, Principles of Diagnosis and Management. Common Tropical Medical Ailments: Malaria - Tropical Diseases and the Eye: Leprosy, Toxoplasmosis, Syphilis Trachoma.

Module 5 : Malnutrition and Immunology

Malnutrition: Aetiology, Protein Energy Malnutrition, Water Electrolytes, Minerals, Vitamins, Nutritional Disorders and the Eye. Immunology: Components of the Immune System, Principle of Immunity in Health, Immunology in Disease, Immunology and the Eye. Neurological Disorders - Stroke/CVA: Disseminated Sclerosis and Subacute Combined Degeneration.

Text Book

1. Stuart H Raiston, Ian D Ponman, Mark W J Strachan, Richard P Hopson: Davidson's Principles and Practice of Medicine by Walker, International Edition, 23rd Edition, 2018.

Reference Book

1. Basic and clinical Science course: Update on General Medicine, American Academy of Ophthalmology, Section 1, 1999.

20OP2037 CLINICS AND SPECIAL CLINICAL LAB I**Credits 0:0:3****Course Objective:**

1. To enable students to acquire the clinical skills necessary for entry into the pre-registration year following graduation

Course Outcomes:

At the end of the course, the students will be able

1. Demonstrate clinical understanding in all of the clinics covered in the unit
2. Demonstrate practical clinical competence in each of the areas covered by the unit
3. Develop effective clinical communication skills.
4. Demonstrate the instrumentation used in lens fitting.
5. Demonstrate the refraction and refractive errors in eye.
6. Demonstrate the contact lens fitting

List of Experiments

1. Case Sheet
2. History Taking
3. Lensometry
4. Visual Acuity
5. Tests for Phorias and Tropias
6. External Examination
7. Slit Lamp Examination
8. Drugs And Method of Application
9. Do's and Don'ts – Papillary Dilatation
10. Direct Ophthalmoscopy
11. Indirect Ophthalmoscopy
12. Instrumentation
13. Patients Selection
14. Keratometry Reading
15. Refraction
16. Fluorescent Pattern
17. Over Refraction
18. Fitting of Hard Lenses
19. Rigid gas permeable lenses and soft lenses in refractive errors and in specialized condition. The students are made to observe the interneers initially, then gradually they are encouraged to work up a patient, and perform various examination techniques.

20OP2038 CLINICS AND SPECIAL CLINICAL LAB II**Credits 0:0:3****Course Objective:**

1. To enable students to acquire the clinical skills necessary for entry into the pre-registration year following graduation

Course Outcomes

The students will be able

1. To demonstrate clinical understanding in all of the clinics covered in the unit
2. To demonstrate practical clinical competence in each of the areas covered by the unit
3. To develop effective clinical communication skills.

4. To demonstrate the instrumentation used in lens fitting.
5. To demonstrate the refraction and refractive errors in eye.
6. To demonstrate the contact lens fitting

List of Experiments

1. Case Sheet
2. History Taking
3. Lensometry
4. Visual Acuity
5. Tests for Phorias and Tropias
6. External Examination
7. Slit Lamp Examination
8. Drugs And Method of Application
9. Do's and Don'ts – Papillary Dilatation
10. Direct Ophthalmoscopy
11. Indirect Ophthalmoscopy
12. Instrumentation
13. Patients Selection
14. Keratometry Reading
15. Refraction
16. Fluorescent Pattern
17. Over Refraction
18. Fitting of Hard Lenses
19. Rigid gas permeable lenses and soft lenses in refractive errors and in specialized condition. The students are made to observe the interneers initially, then gradually they are encouraged to work up a patient, and perform various examination techniques.

20PH3001 CLASSICAL MECHANICS

Credits: 3:1:0

Course Objectives:

1. To impart knowledge on the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulations.
2. To demonstrate the theoretical methods like variation principle and Hamilton Jacobi theory for elementary mechanical systems.
3. To illustrate the fundamental conservation principles for the mechanical systems with an emphasis on central force problem and rigid body motion.

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the properties of Lagrangian to interpret the physical significance of linear momentum, angular momentum and energy.
2. Interpret mathematical results in physical terms using central force problem.
3. Demonstrate the kinematics of rigid body and oscillating system.
4. Apply the techniques and results of classical mechanics to real time problems
5. Appraise the motion of physical systems with Hamilton formulation and Hamilton Jacobi equation.
6. Correlate classical mechanics with the special theory of relativity.

Unit I – Lagrangian Formulation

Mechanics of a System of Particles - Constraints – Generalized co-ordinates – Lagrange's equations of motion from D'Alembert's principle - Deduction of Lagrange's equations from Hamilton's Principle - Applications of the Lagrangian formulation.

Unit II - Central Force Problem

Reduction to an equivalent one body problem – The equation of motion and first integral – Kepler Problem: Inverse square law of force and classification of orbits – The motion in time in the Kepler's problem – Scattering in a central force field.

Unit III - The Kinematics of Rigid Body Motion

The independent coordinates of a rigid body – Orthogonal transformations – The Euler Angles – Symmetric top and its applications - Small Oscillations – Normal mode analysis – Normal modes of a linear triatomic molecule - Forced oscillations – Effect of dissipative forces on free and forced oscillations.

Unit IV - The Hamilton Formulation

Canonical Transformations and the Hamilton equation of motion – Cyclic coordinates – Hamiltonian-Jacobi Theory - Hamilton-Jacobi equations for principle function-Harmonic Oscillator problem as an example of the Hamilton-Jacobi method - Actions angle variables in the Systems with one degree of freedom.

Unit V - Special Theory of Relativity

Internal frames – Principle and postulate of relativity – Lorentz transformations – Length contraction, time dilation and the Doppler effect – Velocity addition formula – Relativistic invariance of physical laws.

Reference Books

1. Classical Mechanics, H. Goldstein, Narosa publishing house, Second Edition 2001
2. Classical Mechanics, S.L.Gupta, V. Kumar & H.V.Sharma, Pragati Prakashan, Meerut., 2003
3. Classical Mechanics, T. W. B. Kibble, Frank H. Berkshire, Imperial College Press, 2004
4. Classical Mechanics, J C Upadhyaya, Himalaya Publishing House, 2012
5. Introduction to Classical Mechanics, R. G. Takwale, P. S. Puranik, Tata McGraw-Hill, 2006
6. Classical Mechanics, John Robert Taylor, University Science Books, 2005
7. Classical Mechanics, Tai L.Chow, Taylor and Francis group, 2013

20PH3002 STATISTICAL MECHANICS AND THERMODYNAMICS

Credits 3:1:0

Course Objectives:

1. To impart knowledge on the laws of thermodynamics from the fundamental principles of equilibrium statistical mechanics.
2. To demonstrate the principles of thermodynamics using statistical mechanics
3. To create a bridge between the microscopic and macroscopic phenomena

Course Outcomes:

At the end of the course, the student will be able to

1. Describe the different thermodynamic systems based on the laws and their consequences
2. Illustrate the statistical description of systems of particles
3. Examine the applications of partition function in thermodynamics
4. Understand the need for quantum statistics in thermodynamic systems
5. Understand the specific heat of solids and analyze the phase transitions using statistical mechanics
6. Apply the statistical mechanics in solving the thermodynamic problems

Unit I :Thermodynamic systems based on laws of thermodynamics

Thermodynamic system-Intensive and extensive variables-Thermodynamic variables and equation of state-limitations-three classes of system-Zeroth law of thermodynamics-concept of heat-Thermodynamic equilibrium-Work-A path dependent function -Internal energy-First law - Thermodynamic systems and its significance-consequences-concept of entropy and second law of thermodynamics-Third law of thermodynamics-Nernst heat theorem-zero point energy- Thermodynamic potentials and Maxwell relations –chemical potentials-Phase equilibria.

Unit II: Statistical basis of thermodynamics

Statistical formulation of the state system – Introduction-statistical basis-three types of statistics-Probability –Principle of Equal A Priori Probability-Probability and frequency-Some basic rules of probability theory-joint probability-permutations and combinations-Microstate and Macrostate-Thermodynamic Probability-

Static and dynamic system-Most Probable State-Concept of cell in a compartment-Phase Space-types-fundamental postulates of statistical mechanics -Density of quantum states –Statistical Ensembles-types-Entropy and probability-Boltzmann entropy relation-Density operator -Liouville theorem.

Unit III :Partition function and its application in thermodynamics

Boltzmann canonical distribution law-Partition function -The Equipartition of energy-statistical interpretation of II law of thermodynamics -Partition function and its relation with thermodynamic quantities: entropy-Helmholtz free energy-total energy-enthalpy-Gibbs potential- Pressure and specific heat-Gibbs paradox.

Unit IV :Classical and Quantum statistics

Three kinds of particles-Statistical equilibrium-Maxwell Boltzmann distribution law-Failure of Maxwell Boltzmann statistics-Development of Quantum statistics-bosons-fermions-‘h’ as a natural constant-Essential difference in three statistics-Bose Einstein distribution law-Planck’s radiation law for black body radiation-Bose Einstein condensation-Fermi Dirac distribution law-Electron gas-Application to liquid helium

Unit V: Statistical Mechanics approach of specific heat and phase transitions

Dulong and Petit law-drawbacks of Debye model of specific heat-Einstein Solid-A qualitative description of phase transitions-first order-Clausius-Clapeyron equation – Gibbs phase rule-second order-phase diagrams-critical points-Diamagnetism-Paramagnetism-Ferromagnetism-Ising model-Phase transitions of the second kind – Ferromagnetism.

Reference Books

1. Robert J. Hardy, Christian Binek, Thermodynamics And Statistical Mechanics, John Wiley & Sons Inc, 2014
2. Terrell L. Hill, An Introduction to Statistical Thermodynamics, 2007
3. Brijlal, Dr.N.Subrahmanyam, P.S.Hemne, Heat, Thermodynamics, and Statistical Physics, S. Chand Limited, 2008
4. John M. Seddon, Thermodynamics and Statistical mechanics, 2001
5. S.K.Sinha, Introduction to Statistical Mechanics, 2005

20PH3003 MATHEMATICAL PHYSICS I

Credits: 3:1:0

Course Objectives:

1. To impart knowledge on basic and advanced level of Vectors and matrices
2. To demonstrate the use of differential equations and special functions in solving problems in physics.
3. To solve the problems in physics using mathematical principles.

Course Outcomes:

At the end of the course, the student will be able to

1. Master the complex mathematical analysis, integral theorems, complex function and residue theorem to evaluate definite integrals
2. Solve linear systems, matrix inverses, eigen values and eigen vectors
3. Solve ordinary differential equations of second order
4. Express any physical law in terms of tensors and coordinate transforms
5. Learn the theory of probability, various distribution functions, errors and residuals
6. Apply the mathematical concepts to solve the problems in physics.

Unit I VECTOR ANALYSIS: Addition, Subtraction, multiplication of vectors –Simple Problems – Magnitude of Vectors – Linear Combination of vectors –Simple problems – Product of two vectors – Triple product of vectors - Simple applications of vectors to Mechanics – Work done by force - Torque of a force-Force on a particle in magnetic field-Force on a charged particle- Angular velocity - Differentiation of vectors – Scalar and vector fields - Gradient, Divergence and Curl operators –

Integration of vectors – Line, surface and volume integrals – Gauss's Divergence theorem – Green's theorem – Stoke's theorem

Unit II MATRICES: Equality of matrices – Matrix Addition, multiplication and their properties – Special matrices – Definitions: Square matrix, Row matrix, Null matrix, Unit matrix, Transpose of a matrix, Symmetric and skew symmetric matrices, Conjugate of matrix Adjoint of matrix (Simple problems)- Unitary matrix, Orthogonal matrix (simple problems) – Inverse of matrix – Problems- Rank of matrix – Problems - Solutions of linear equations – Cramer's rule – Cayley-Hamilton Theorem – Eigen Values and Eigen vectors of matrices and their properties – Quadratic forms and their reduction - Diagonalisation of matrices

Unit III TENSOR ANALYSIS: Definition of tensors – Transformation of coordinates – The summation convention and Kronecker Delta symbol – Covariant Tensors – Contravariant tensors – Mixed Tensors - Rank of a tensor – Symmetric and anti-symmetric tensors – Quotient law of tensor - Invariant Tensors - Algebraic operations of tensors - Addition, subtraction and multiplication(inner and outer product) of tensors Derivative of tensors

Unit IV LINEAR DIFFERENTIAL EQUATIONS:

Linear differential equations of second order with constant and variable coefficients – Homogeneous equations of Euler type – Equations reducible to homogeneous form – method of variation of parameter – Problems.

Unit V PROBABILITY AND THEORY OF ERRORS: Definition of probability – Compound Probability – Total Probability – The multinomial law – Distribution functions - Binomial, Poisson and Gaussian distribution– Mean (Arithmetic - Individual observations ,Discrete series, Continuous series) – Median (Individual observations, Discrete series, Continuous series) – Mode (Individual observations, Discrete series, Continuous series) - Mean Deviation and Standard Deviation(Individual observations, Discrete series, Continuous series) – Different types of errors – Errors and residuals —The principle of Least squares fitting a straight line.

Reference Books

1. Mathematical Physics – B.D.Gupta – Vikas Publishing House, 3rd edition, 2006
2. Mathematical Physics – B.S.Rajput – PragatiPrakashan – Meerut, 17th edition, 2004
3. Mathematical Methods for Engineers and Scientists – K.T.Tang – Springer Berlin Heidelberg New York ISBN,10 3,540,30273,5 (2007)
4. Mathematical Methods for Physics and Engineering – K.F.Riley, M.P.Hobson and S.J.Bence, Cambridge University Press – ISBN 0 521 81372 7 (2004)
5. Essential Mathematical Methods for Physicists – Hans J.Weber and George B.Arffen – Academic Press, U.S.A. – ISBN 0,12,059877,9 (2003)
6. Mathematical Physics Including Classical Mechanics, SatyaPrakash, Sultan Chand & Sons, New Delhi, ISBN,13: 9788180544668 (2007)

20PH3004 SEMICONDUCTOR PHYSICS

Credits: 3:1:0

Course Objectives:

1. To impart knowledge on the different semiconductor devices and linear integrated circuits
2. To demonstrate the fabrication process of integrated circuits
3. To illustrate the working of logic gates, the architecture and functioning microprocessors and microcontrollers

Course Outcomes:

At the end of the course, the students will be able to

1. Understand the construction, working and applications of semiconductor devices
2. Interpret the principle and characteristics of linear integrated circuits
3. Explain the different types of transducers and its applications.
4. Appraise different types optoelectronic devices and its applications.

5. Illustrate the fabrication and manufacturing process involved in integrated circuits.
6. Develop and design special purpose devices using digital electronics.

Unit I : Semiconductor Devices

PN Diode – Zener Diode - Bipolar Junction Transistor – Biasing and Operation– CB Configuration – input/output characteristics -Breakdown in transistors Uni-Junction Transistor- – FET – Construction of N Channel JFET - MOSFET and types – FET as a voltage variable resistor – SCR – TRIAC – DIAC – Tunnel Diode Characteristics.

Unit II : Fabrication of Integrated Circuits

Integrated circuits fabrication – Photolithographic process– epitaxial growth, diffusion, masking, metallization and etching,– Diffusion of impurities – Monolithic diodes, integrated resistors, –Construction of a bipolar transistor integrated capacitors and inductors - Monolithic layout, large scale integration (LSI), medium scale integration (MSI) and small scale integration (SSI)

Unit III : Operation Amplifiers and Transducers

Ideal Operational amplifiers -OPAMP stages – Parameters – Equivalent circuit – Open loop OPAMP configurations - Closed loop OPAMP configurations - OPAMP applications – summing – integrator- Differentiator - comparator – Transducers: Active and Passive transducers – Different types – Thermistor – Thermocouple – Hall effect – Piezoelectric and photoelectric transducers.

Unit IV : Optoelectronic devices

Optoelectronic Sensors - Photodetector – Junction type Photoconductive cell – Construction and characteristics – Photovoltaic sensors –Solar Cell – Construction, working, Characteristics and applications – Photo emissive sensors – Vacuum phototube – gas filled phototube – photomultiplier – Light emitting diodes – Construction, working and applications – Infrared emitters – Fiber optic communication system

Unit V: Digital Electronics

Boolean Algebra – De Morgan's Theorem – Logic gates - Karnaugh map simplifications - Counters – synchronous, asynchronous and decade- Registers – Multiplexers – Demultiplexer – Flip flops – Digital to Analog converters – Analog to Digital converters - Introduction to Microprocessor – 8085A - Basics of Microcontroller.

Reference Books

1. Integrated Electronics – Millmaan. J. and Halkias C.C
2. Electronic Devices and Circuits – Allen Mottershead
3. Microwaves – Gupta K.C
4. Digital Principles and Applications – Malvino and Leach.

20PH3005 QUANTUM MECHANICS I

Credits 3:1:0

Course Objectives:

1. To disseminate the knowledge on the general formulation of quantum mechanics
2. To impart knowledge in solving the wavefunction that represent different physical systems
3. To provide information on the theoretical aspects of various time independent perturbed systems

Course Outcomes:

At the end of the course, the students will be able to

1. Gain an in depth understanding on the central concepts and principles of quantum mechanics
2. Improve the mathematical skills necessary to solve the differential equations and eigenvalue problems using the operator formalism
3. Apply the Schrodinger wave equation and obtain the solution for various quantum mechanical systems such as particle in a box, harmonic oscillator, rigid rotator and hydrogen atom.
4. Develop the concepts of angular momentum, such as the addition and commutation relation with components.
5. Analyze different time independent perturbed systems and solve them with the aid of approximation methods

6. Appraise quantum mechanical systems involving many electron atoms and use the available models to solve them.

Unit I - GENERAL FORMALISM OF QUANTUM MECHANICS: Linear vector space- Linear operator- Eigenfunctions and Eigenvalues - Normalisation of wave function- orthonormality- Probability current density - Expectation values - operator formalism in quantum mechanics - Hermitian operator- properties of Hermitian operator - General uncertainty relation - Dirac's notation- Equations of motion – Ehrenfest's theorem - Schrodinger, Heisenberg and Dirac representation.

Unit II - ENERGY EIGEN VALUE PROBLEMS: Particle in a box – Linear Harmonic oscillator- Tunnelling through a barrier- particle moving in a spherically symmetric potential- System of two interacting particles- Rigid rotator- Hydrogen atom.

Unit III - ANGULAR MOMENTUM: Angular momentum operator in position representation - Orbital angular momentum- Spin angular momentum -Total angular momentum operators- Commutation relations of total angular momentum with components- Ladder operators - Eigen values of J_+ and J_- - Eigen values of J_x and J_y – Explicit form of the angular momentum matrices - Addition of angular momenta: Clebsch Gordon coefficients (no derivation) – properties.

Unit IV - APPROXIMATE METHODS: Stationary perturbation theory (non-degenerate case) – Application of non-degenerate perturbation theory: Normal Helium atom, First order Zeeman effect – Stationary degenerate perturbation theory – Application: First order Stark effect in hydrogen atom – Spin-orbit interaction- Variation method – Application: Ground state of Helium - WKB approximation

Unit V - MANY ELECTRON ATOMS: Identical particles – Pauli's principle- Inclusion of spin – spin functions for two electrons - The Helium Atom – Central Field Approximation – The Born-Oppenheimer approximation - Thomas-Fermi model of the Atom – Hartree's self-consistent field method.

Reference Books

1. Quantum Mechanics – G. Aruldas - Prentice Hall of India, 2006
2. Advanced Quantum mechanics - Satya Prakash – Kedar Nath Ram Nath & Co, Meerut, 2014
3. A Text Book of Quantum Mechanics - P.M. Mathews & K. Venkatesan – Tata McGraw Hill 2007
4. Introduction to Quantum Mechanics – David J. Griffiths Pearson Prentice Hall 2005
5. Quantum Mechanics – L.I Schiff - McGraw Hill 1968
6. Principles of Quantum Mechanics - R. Shankar, Springer 2005

20PH3006 MATHEMATICAL PHYSICS II

Credits 3:1:0

Course Objectives:

1. To provide knowledge about elements of complex analysis and transforms
2. To demonstrate group theory and its implications for applications in physics
3. To enumerate numerical methods, Fourier series and integral transforms.

Course Outcomes:

Students will be able to

1. Expand a function in terms of a Fourier series, with knowledge of the conditions for the validity of the series expansion
2. Apply Fourier and Laplace transforms to solve mathematical problems and analyzing experimental data
3. Solve partial differential equations of second order by use of standard methods like separation of variables, series expansion (Fourier series) and integral transforms
4. Understand the fundamental concepts of group theory.
5. Appraise numerical interpolation and approximation of functions, numerical integration and differentiation
6. apply the mathematical concepts to solve the problems in physics.

Unit I COMPLEX VARIABLES:

Functions of a complex variable– Analytic functions – Cauchy – Riemann conditions and equation – Conjugate functions – Complex Integration – Cauchy's integral theorem, integral formula – Taylor's series and Laurent Series – Poles, Residues and contour integration - Cauchy's residue theorem – Computation of residues - Evaluation of integrals.

Unit II FOURIER SERIES AND FOURIER TRANSFORMS:

Fourier series – Dirichlet conditions – Complex representations – Sine and Cosine series – Half range series – Properties of Fourier Series – Physics applications of Fourier series – The Fourier Transforms – Applications to boundary value problems

Unit III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS & GREENS FUNCTION:

Solutions of one dimensional wave equation- one dimensional equation of heat conduction-Two dimensional heat equations – Steady state heat flow in two dimensions – Green's Function – Symmetry properties - Solutions of Inhomogeneous differential equation - Green's functions for simple second order differential operators.

Unit IV GROUP THEORY:

Basic definition of a group – Subgroups – Classes – Isomorphism Homomorphism – Cayley's theorem – Endomorphism and automorphism – Important Theorems of Group representations – Unitary theorem – Schur's Lemma – Equivalent Theorem – Orthogonality Theorem – Some special groups – Unitary Group – Point Group – Translation Group – Homogenous and Inhomogenous Lorentz groups – Direct product group

Unit V NUMERICAL METHODS:

Finite Differences – Shifting Operator – Numerical Interpolations – Newton's forward and backward formula – Central Difference interpolation – Lagrange's Interpolation – Numerical Differentiation – Newton's and Stirling's Formula – Numerical Integration – Trapezoidal Rule – Simpson's 1/3 and 3/8 rule – Numerical Solution of ordinary differential equations – Runge-Kutta methods – Piccard's Methods

Reference Books

1. B.D.Gupta – Mathematical Physics –Vikas Publishing House, 3rd edition, 2006
2. B.S.Rajput – Mathematical Physics –Pragati Prakashan – Meerut, 17th edition, 2004
3. K.T.Tang – Mathematical Methods for Engineers and Scientists –Springer Berlin Heidelberg New York ISBN,10 3,540,30273,5 (2007)
4. K.F.Riley, M.P.Hobson and S.J.Bence, Mathematical Methods for Physics and Engineering – Cambridge University Press – ISBN 0 521 81372 7 (2004)
5. Hans J.Weber and George B.Arffken – Essential Mathematical Methods for Physicists – Academic Press, U.S.A. – ISBN 0,12,059877,9 (2003)
6. Satya Prakash, Mathematical Physics Including Classical Mechanics, Sultan Chand & Sons, New Delhi, ISBN,13: 9788180544668 (2007).

20PH3007 SPECTROSCOPY-I

Credits 3:1:0

Course Objectives:

1. To impart knowledge on the physical and chemical properties of matter through spectroscopy
2. To illustrate the principles and the theoretical framework of different spectroscopic techniques.
3. To demonstrate the spectroscopic techniques in solving the structure of molecules

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the fundamentals of spectroscopy and the atomic spectra of hydrogen atom
2. Appreciate the role of microwaves in rotational spectroscopy and its working principle
3. Experiment the use of infrared rays in finding the structure of molecules
4. Find the use of Raman spectroscopy in studying the matter
5. Analyze the structure of atoms through the electronic spectroscopy

6. Identify the best method to solve the spectroscopic problems

Unit I: Electronic Spectroscopy of atoms

Electromagnetic radiation-quantization of energy-absorption and emission process-continuous and line spectra- representation of spectra-instrument-signal to noise ratio-resolving power-width and intensity of spectral lines-concept of fourier transform-Electronic wave functions-atomic quantum numbers-electronic angular momentum-orbital-spin-total angular momentum;spin- orbit interaction and Fine structure of hydrogen atom spectrum-XPS-Zeeman effect-influence of spin.

Unit II: Microwave Spectroscopy

Rotation of molecules- Diatomic Molecules-the rigid diatomic molecule- Intensities of Spectral Lines- Effect of Isotope Substitution- Non-rigid Rotator- Polyatomic Molecules- Techniques and Instrumentation- Microwaves in space communication-chemical analysis in industries by microwave spectroscopy

Unit III: Infra-red Spectroscopy

Vibration of Diatomic Molecules- Simple harmonic Oscillator-Anharmonic Oscillator- the diatomic vibrating rotator- Vibration- Breakdown of Born-Oppenheimer Approximation- Vibration of Polyatomic Molecules- H₂O and CO₂-Vibration-Rotation Spectra of Polyatomic Molecules-Techniques and Instrumentation-applications: automobile components analysis for automobile industries, forensic department, environmental applications: food and water industries

Unit IV: Raman Spectroscopy

Quantum Theory of Raman Effect- Classical Theory- Molecular Polarizability-Rotational Raman Spectra-linear molecules-Vibrational Raman Spectra-Rule of mutual exclusion- Techniques and Instrumentation-application in pharmaceutical and cosmetic industries

Unit V: Electronic Spectroscopy of molecules

Electronic Spectra of Diatomic Molecules- Born-Oppenheimer Approximation- vibrational coarse structure-progressions-intensity of vibrational-electronic spectra-Franck-Condon Principle- Dissociation Energy and dissociation products-Re-emission energy from Excited Molecules.

Reference Books:

1. C. N. Banwell, Fundamentals of Molecular Spectroscopy, Tata McGraw-Hill Publ.Comp. Ltd, 2010
2. G. Herzberg, Molecular Spectra and Molecular Structure, Van Nostrand, 1997
3. M.Hollas, Modern Spectroscopy, John Wiley, 2004
4. Mark F. Vitha, Spectroscopy Principles and Instrumentation, Wiley, 2018

20PH3008 ELECTROMAGNETIC THEORY

Credits 3:1:0

Course Objectives:

1. To impart knowledge on the basics of electrostatics and magnetostatics through the equations governing them.
2. To demonstrate electromagnetic field theory using Maxwells equations.
3. To provide formulations for electromagnetic wave propagation systems and solve the associated problems.

Course Outcomes:

At the end of the course, the student will able to

1. Explain the concept of different laws of electro-magnetic fields
2. Solve static electric and magnetic field problems using coordinate systems
3. Relate the applications of EM Waves in different domains and to find the time average power density
4. Explain Maxwell's equation for time varying electric and magnetic fields
5. Illustrate the wave equation and its parameters for a conductor, dielectric and magnetic medium
6. Analyse moving charges and radiation from an oscillating dipole antennae

Unit I ELECTRO STATICS:

Gauss Law and Coulomb's law-surface, line and volume charge distributions-Scalar potential-Multipole expansion of electric fields-Poisson's equation-Laplace's equation-Uniqueness theorem-electrostatic potential energy and energy density-Electrostatics in matter-Polarization and electric displacement vector-Electric field at the boundary of an interface.

Unit II MAGNETO STATICS:

Biot and Savart law-Lorentz force law-Differential equations of magnetostatics and Ampere's law-The magnetic vector potential-The magnetic field of distant circuit-Magnetic moment-The magnetic scalar potential-Macroscopic magnetization-Magnetic fields in matter-Magnetization-The field of a magnetized object.

Unit III PLANE ELECTROMAGNETIC WAVES:

Plane wave in a non conducting medium – Boundary conditions – Reflection and refraction of E.M. waves at a plane interface between dielectrics – Polarization by reflection and total internal reflection - Waves in a conducting, non conducting or dissipative medium-Electromagnetic waves in vacuum – Energy and momentum of EMW – Propagation in linear media

Unit IV ELECTRODYNAMICS:

Radiation from an oscillating dipole – Radiation from a half wave antenna – Radiation damping – Thomson cross section – Lienard – Wiechert Potentials – The field of a uniformly moving point charge.

Unit V TIME VARYING FIELDS:

Electromagnetic induction – Faraday's law – Maxwell's equations – Displacement current – Vector and Scalar potentials – Gauge transformation – Lorentz gauge – Columb's gauge – Gauge invariance – Poynting's theorem-Dynamics of charged particles in static and uniform electromagnetic fields-Plasma confinement-Applications

Reference Books

1. Classical Electrodynamics, J. D. Jackson, John Wiley & Sons, 1998
2. Foundations of Electro Magnetic Theory – John R. Reits, Fredrick J. Milford & Robert W. Christy. Narosa Publishing House (1998)
3. Electromagnetics: B. B. Laud, New Age International 2nd Edition (2005)
4. Electromagnetic Waves and Radiating Systems, E. C. Jordan, K. G Balmain, PHI Learning Pvt. Ltd., 2008
5. Engineering Electromagnetics, W. H. Hayt, J. A., Buck, Tata McGraw-Hill, 2011.

20PH3009 QUANTUM MECHANICS II

Credits 3:1:0

Course Objectives:

1. To impart knowledge on how to apply quantum mechanics to solve problems in atomic physics
2. To illustrate time dependent perturbation theory using quantum mechanics
3. To provide knowledge on the formulation of quantum field theory

Course Outcomes::

At the end of the course, the student will be able to

1. Recognize the systems that are subjected to different time dependent perturbations such as harmonic, sudden and adiabatic.
2. Classify the quantum problems involving scattering and interpret them using approximations such as Born, Partial wave analysis etc.
3. Solve the quantum mechanical systems related to radiation by using the semiclassical theory.
4. Apply relativistic wave equation to study hydrogen like atom, free particle and other relativistic problems.
5. Appraise on the quantization of wave field, non-relativistic equation, electromagnetic field energy and momentum.
6. Develop appropriate skill in analytical, theoretical and/or practical techniques to further their understanding in the chosen topic.

Unit I - TIME DEPENDENT PERTURBATION THEORY:

Time Dependent Perturbation Theory-Perturbation constant in time-Transition probability: Fermi Golden Rule- Harmonic Perturbation-Selection Rules – Forbidden transitions - Adiabatic Approximation – Sudden approximation.

Unit II - SCATTERING THEORY:

Scattering cross-sections – Differential and total Scattering cross-sections - Scattering Amplitude – General formulation of the scattering theory - Green's Function - Born approximation and its validity- Partial wave analysis - Phase Shifts - Scattering by coulomb and Yukawa Potential.

Unit III - THEORY OF RADIATION (SEMI CLASSICAL TREATMENT):

Einstein's Coefficients- Spontaneous and Induced Emission of Radiation from Semi Classical Theory- Radiation Field as an Assembly of Oscillators-Interaction with Atoms-Emission and Absorption Rates- Density Matrix and its Applications.

Unit IV - RELATIVISTIC WAVE EQUATION:

Klein Gordon Equation - Charge and Current Density- Klein Gordon Equation in electromagnetic field - Dirac Relativistic Equation - Dirac Relativistic Equation for a Free Particle- Electromagnetic potentials: Magnetic moment of the electron –Theory of positron.

Unit V - QUANTUM FIELD THEORY:

Quantization of Wave Fields- Lagrangian and Hamiltonian formulations- Field Quantization of the Non-Relativistic Schrodinger Equation-Creation, annihilation and Number Operators-Anti Commutation Relations- Quantization of Electromagnetic Field Energy and Momentum.

Reference Books

1. Advanced Quantum Mechanics -Satya Prakash – Kedar Nath Ram Nath & Co, Meerut, 2014
2. A Text Book of Quantum Mechanics -P.M. Mathews & K. Venkatesan-Tata McGraw Hill2007
3. Quantum Mechanics – G Aruldas - Prentice Hall of India2006
4. Introduction to Quantum Mechanics – David J.Griffiths Pearson Prentice Hall2005
5. Quantum Mechanics – L.I Schiff - McGraw Hill1968
6. Quantum Mechanics - A.K. Ghatak and S. Loganathan-McMillanIndia,2004

20PH3010 SPECTROSCOPY-II

Credits 3:1:0

Course Objectives:

1. To impart knowledge on the physics of electron and nuclei spin in establishing the advanced spectroscopic techniques like NMR, ESR and NQR using low energy electromagnetic waves.
2. To demonstrate the role of high energy electromagnetic waves in the advanced spectroscopic techniques like Mossbauer spectroscopy.
3. To illustrate properties of matter by analysis and interpretation of spectral data from mass spectrometer.

Course Outcomes:

At the end of the course, the student will able to

1. Understand the role of nuclei spin in determining the structure of matter through NMR technique.
2. Appreciate the physics of electron spin used in ESR technique.
3. Determine the structure of molecules using NQR spectroscopic technique
4. Appreciate the principles and working of Mossbauer spectroscopy.
5. Analyze the structure of matter using mass spectroscopy.
6. Identify the best method to solve the spectroscopic problems

Unit I - NMR Spectroscopy:

Nature of spinning particles-Interaction between spin and a magnetic field-nuclei spin-population of energy levels-the larmor precession-NMR – Basic principles – Classical and Quantum mechanical description – Bloch equation –Spin – Spin and spin lattice relaxation times – Experimental methods –

Single Coil and double coil methods – Pulse method

Unit II - ESR Spectroscopy:

ESR basic principles – High Resolution ESR Spectroscopy – Double Resonance in ESR-ESR spectrometer.

Unit III – Nuclear Quadrupole Resonance Spectroscopy:

NQR Spectroscopy – Basic Principles – Quadrupole Hamiltonian Nuclear Quadrupole energy levels for axial and nonaxial symmetry – NQR spectrometer – chemical bonding – molecular structural and molecular symmetry studies.

Unit IV - Mossbauer Spectroscopy:

Basic principles, spectral parameters and spectrum display, applications to the study of bonding and structure of Fe^{2+} compounds. Isomer shift, quadrupole splitting, hyperfine interaction, instrumentations and applications.

Unit V - Mass Spectroscopy:

Introduction- ion production- fragmentation- ion analysis- ion abundance- common functional groups- high resolution mass spectroscopy- instrumentation and application.

Reference Books:

1. C. N. Banwell, Fundamentals of Molecular Spectroscopy, Tata McGraw-Hill Publ.Comp. Ltd, 2010
2. J.M. Hollas, Modern Spectroscopy, John Wiley, 2004
3. T.P. Das and Hahn, Nuclear Quadrupole Resonance Spectroscopy, Supplement, 1998
4. Mark F. Vitha, Spectroscopy Principles and Instrumentation, Wiley, 2018

20PH3011 NUCLEAR AND PARTICLE PHYSICS

Credits: 3:1:0

Course Objectives::

1. To describe the basic properties, structure of the nucleus and nuclear stability.
2. To impart knowledge about the concepts of nuclear forces and radioactive decay modes.
3. To demonstrate the working principles of various nuclear reactions and nuclear reactors and about basics of particle physics.

Course Outcomes::

At the end of the course, the student will be able to

1. Understand the basic structure of the nucleus and apply Weizsacker semi-empirical mass formula for determining the nuclear stability.
2. Comprehend the nature of nuclear forces and its applications to real physical systems of nuclei.
3. Apply the radioactive properties of certain nuclides for water, food, health, and energy sectors.
4. Analyse different types of nuclear reactions with special reference to nuclear fission and fusion reactions and their applications to nuclear power reactors.
5. Evaluate the classification scheme of fundamental forces and particles and their relevance to various applications in physics.
6. Create new concepts in physics by comprehending the latest research in nuclear and particle physics.

Unit I : Nuclear Structure

Basic Nuclear Properties – Size, Shape and Charge Distribution – Spin and Parity – Magnetic Moments – Quadrupole Moments – Binding Energy – Bethe–Weizsäcker formula Semi-Empirical Mass Formula – Nuclear Stability – Mass Parabolas – Liquid Drop Model – Shell Model – Application of Semi-Empirical Mass Formula to Neutron Stars.

Unit II : Nuclear Forces

Nature of the Nuclear Force – Form of Nucleon-Nucleon Potential – Deuteron Problem – Ground State of Deuteron – Charge Independence and Charge-Symmetry of Nuclear Forces – Spin Dependence of Nuclear

Forces – Meson Theory – Spin, Orbit and Tensor Forces – Exchange Forces. Applications: Nuclear Weapons.

Unit III : Radio Activity

Alpha Decay – Gamow's Theory – Geiger-Nuttall Law – Fine Structure of Alpha Decay – Neutrino Hypothesis – Beta Decay – Fermi's Theory – Energies of Beta Spectrum – Fermi and Gamow-Teller Selection Rules – Non-Conservation of Parity – Gamma Ray Emission – Selection Rules – Nuclear Isomerism – Applications: Radioisotopes in Health, Food Industry, Agriculture, Water Hydrology and Industry.

Unit IV : Nuclear Reactions

Level Widths in Nuclear Reaction – Nuclear Reaction Cross Sections – Partial Wave Analysis – Compound Nucleus Model – Resonance Scattering – Breit-Wigner one level formula – Optical Model – Reaction Mechanisms – Direct Reactions – Stripping and Pick-up Reactions – Elementary Theory of Fission and Fusion – Applications: India's Three Stage Nuclear Power Programme – Fusion power.

Unit V : Particle Physics

Classification of Fundamental Forces and Elementary Particles – Quantum Numbers – Charge – Spin – Parity – Isospin – Strangeness – Gell-Mann Nishijima's formula – Quark Model – Baryons and Mesons – C, P, and T Invariance – SU (3) Symmetry – Parity Non-Conservation in Weak Interaction – K meson – Relativistic Kinematics – Application of Symmetry Arguments to Particle Reactions.

Reference Books

1. Concepts of Nuclear Physics – B.L. Cohen – McGraw-Hill – 2001.
2. Introduction to Nuclear Physics – H.A. Enge – Addison-Wesley, 1983.
3. Introduction to Particle Physics : M. P. Khanna Prentice Hall of India (1990)
4. Nuclear and particle Physics : W. Burcham and M. Jobes, Addison-wesley (1998)
5. S N Ghoshal, Nuclear Physics 1st Edition, S.Chand Publishing, 1994.
6. Irving Kaplan, Nuclear Physics 2nd Edition, Narosa Publishing House, 2002.
7. Kenneth S.Krane, Introductory Nuclear Physics 1st Edition, Wiley India Pvt Ltd, 2008.
8. S L Kakani, Nuclear and Particle Physics, Viva Books Pvt Ltd.-New Delhi, 2008.
9. Gupta, Verma, Mittal, Introduction to nuclear and particle physics, 3/E 3rd Edition, PHI Learning Pvt. Ltd-New Delhi, 2013.
10. Samuel S. M. Wong, Introductory Nuclear Physics 1st Edition, PHI Learning, 2010.

20PH3012 SOLID STATE PHYSICS

Credit: 3:1:0

Course Objectives:

1. To impart knowledge on the properties of crystals and its dielectric, ferroelectric properties
2. To demonstrate concepts of solid-state physics and its concepts in magnetic and optical properties of materials.
3. To illustrate the properties of superconducting materials and its applications

Course Outcomes:

At the end of the course students will be able to

1. Describe the crystal properties and elementary models for bonding of atoms and molecules.
2. Explain the concepts leading to dielectric and ferroelectric properties in detail.
3. Interpret the fundamental ideas of magnetic properties in solid state phenomena
4. Describe the theories involved in the magnetic and superconducting materials phenomena
5. Illustrate optical properties of materials and its importance in luminescence applications
6. Apply the solid-state physical phenomena in the areas of superconductors and its applications

Unit I : Crystal Properties and Lattice Vibrations

Bravais lattices and crystal systems - Reciprocal lattice - Diffraction and the structure factor.- Bonding of solids- Elastic properties, lattice specific heat. - Brillouin zones – Density of states - Phonons - acoustic

and optical branches- -scattering of phonons. Electron motion in a periodic potential - Band Theory of Solids - Kronig-Penney model - Effective mass of electron-Nearly free electron model

Unit II : Dielectric And Ferroelectric Properties

Dipole Moment and Polarization – Types of Polarization – Ionic, Electronic and Orientation - Langevin function- Dielectric constant and polarizability – Local field – Clausius – Mosotti relation – Lorentz-Lorenz formula – Elemental dielectrics- Polarization of Ionic crystals- Polar Solids- Measurement of dielectric constant - Ferroelectricity – General properties – Dipole theory – Classification of ferroelectric materials - Antiferroelectricity

Unit III : Magnetic Properties

Magnetic Permeability- Magnetization – Bohr Magneton – Electron Spin and Magnetic Moment – Diamagnetism – Langevin's theory of diamagnetism- Para magnetism – Classical theory of Para magnetism - Weiss theory of Para magnetism – Determination of Susceptibilities – Quincke's method – Hund rules - Ferromagnetism – Weiss Molecular Field – Curie-Weiss law - Ferromagnetic domains – Magnetization Curve – Bloch Wall – Antiferromagnetism – Neel temperature – Ferrimagnetism.

Unit IV : Crystal defects and Optical Properties

Crystal defects - Point imperfections – Concentrations of Vacancy, Frenkel and Schottky imperfections - Line Imperfections – Burgers Vector – Presence of dislocation – surface imperfections- Polarons – Excitons- Colour centers – Optical absorption in Metals, Insulators and Semiconductors - Luminescence – Excitation and emission – Decay mechanism – Thermo luminescence and glow curves – Electroluminescence – Phosphors in Fluorescent Lights.

Unit V: Superconductivity

Properties of Superconductors – Effects of magnetic field – The Meissner effect – Thermal properties of Superconductors - Type I and II superconductors - London equations : Electrodynamics — B.C.S. theory – Quantum Tunneling - A.C. and D.C. Josephson effect – Macroscopic Quantum interference — High temperature super conductors – Squids – Magnetic levitation and Power applications

Reference Books

1. Solid State Physics – S.O. Pillai, New Age International Publishers, 5th Edition 2002
2. Introduction to Solid State Physics- Kittel, John Wiley, 8th edition, 2004
3. Elementary Solid State Physics, M. Ali Omar, Pearson Education, 2004
4. Introductory solid state Physics, H.P. Myers, Second edition, Taylor and Francis, 2009
5. Advanced Solid State Physics, P. Philips, Cambridge University Press, 2012
6. Solid State Physics, Neil W. Ashcroft, N. David Mermin, Cengage Learning, 2011
7. Solid State Physics, R.J. Sing, Pearson, 2012.

20PH3013 PHYSICS OF NANOMATERIALS

Credits 3:0:0

Course Objectives:

1. To illustrate the Quantum mechanical concepts for nanoscale systems
2. To impart knowledge on the different nanofabrication methods
3. To Demonstrate the electrical, magnetic, mechanical and optical properties of nano devices

Course Outcomes:

Students will be able to

1. Define quantum confinement effects in nano materials
2. Describe the different fabrication techniques of nanomaterials
3. Examine the characteristics of nanomaterials
4. Analyse the nanodevices with different characterization tools
5. Evaluate the nano devices for different applications
6. Design and create advanced nano devices

Unit I INTRODUCTION TO NANOMATERIALS:

Basic concepts of nano materials – Density of states of 1,2 and 3D quantum well, wire, dot-Shrodinger wave equation for quantum wire, Quantum well, Quantum dot-Formulation of super lattice- Quantum confinement- Quantum cryptography

Unit II FABRICATION OF NANOSCALE MATERIALS:

Top-down versus Bottom-up –ball milling, Lithography- photo, e-beam - Etching -Synthesis -Colloidal dispersions -Atomic and molecular -manipulations –Self assembly -Growth modes, Stransky-Krastinovec –Ostwald ripening

Unit III ELECTRICAL AND MAGNETIC PROPERTIES:

Electronic and electrical properties-One dimensional systems-Metallic nanowires and quantum conductance -Carbon nanotubes and dependence on chirality -Quantum dots –Two dimensional systems - Quantum wells and modulation doping -Resonant tunnelling –Magnetic properties Transport in a magnetic field - Quantum Hall effect. -Spin valves -Spin-tunnelling junctions -Domain pinning at constricted geometries -Magnetic vortices.

Unit IV MECHANICAL AND OPTICAL PROPERTIES

Mechanical properties hardness – Nano indentation -Individual nanostructures -Bulk nanostructured materials-Ways of measuring- Optical properties-Two dimensional systems (quantum wells)-Absorption spectra -Excitons - Coupled wells and superlattices -Quantum confined Stark effect

Unit V ADVANCED NANODEVICES:

Background -Quantization of resistance -Single-electron transistors -quantum dot LEDs- Magnetic Nanodevices -Magnetoresistance –Spintronics- MEMS and NEMS, haptic devices, nanomaterial based drug delivery system, nanobots.

Reference Books

1. Introduction to Nanotechnology, Charles P.Poole, Jr. and Frank J.Owens, Wiley, 200
2. Silicon VLSI Technologies, J.D.Plummer, M.D.Deal and P.B. Griffin, Prentice Hall, 2000
3. Introduction to Solid State Physics, C.Kittel, a chapter about Nanotechnology, Wiley,2004

20PH3014 FABRICATION AND TESTING OF THIN FILM DEVICES

Credits 3:0:0

Course Objectives:

1. To impart knowledge on functioning of vacuum pumps, measuring gauges and thin film coating techniques.
2. To describe the influence of different substrate materials and growth process.
3. To demonstrate the properties of thin films and apply it for device fabrication.

Course Outcomes:

At the end of the course, the students will be able to

1. Identify the vacuum pumps and measure the vacuum level
2. Illustrate the mechanism of thin film deposition
3. Apply the knowledge on the influence of substrates on the growth of thin films
4. Analyse the thin film characteristics through different tools
5. Appraise the latest thin film device fabrication and testing
6. Create fabrication methods for thin film based devices like solar cells and gas sensors

Unit I: Vacuum system

Categories of deposition process, basic vacuum concepts, pumping systems- rotary, diffusion and turbo molecular, monitoring equipment –McLeod gauge, pirani, Penning, Capacitance diaphragm gauge.

Unit 2: Thin film coating techniques

Physical vapour deposition, sputtering - dc, rf, magnetron, Molecular beam epitaxy, Pulsed laser deposition, chemical vapour deposition, electroplating, sol gel coating, spray Pyrolysis

Unit 3: Substrate materials and Growth process

Substrate materials, material properties – surface smoothness, flatness, porosity, mechanical strength, thermal expansion, thermal conductivity, resistance to thermal shock, thermal stability, chemical stability, electrical conductivity -Substrate cleaning, substrate requirements, buffer layer, metallization control, lattice mismatch, surface morphology, Growth process- Adsorption, surface diffusion, nucleation, surface energy, texturing, structure development, interfaces, stress, adhesion, temperature control -growth monitoring, composition.

Unit 4: Structural, Optical and electrical studies on thin films

X-Ray Diffraction studies –Bragg's law – particle size – Scherrer's equation – crystal structure – UV Vis NIR Spectroscopy , Photoluminescence (PL) studies –Fourier Transform Infrared Spectroscopy(FTIR) - Electrical properties: dc electrical conductivity as a function of temperature - Hall effect – types of charge carriers – charge carrier density, C-V/I-V characteristics.

Unit 5: Device fabrication-testing and validation

Design fabrication and testing of Flexible transistor, CNT based transistor, Multilayer solar cell, flexible gas sensors, Project presentation and report submission.

Reference Books

1. Handbook of Thin Film Technology, Edited by Hartmut Frey and Hamid R.Khan, Springer, 2015.
2. Thin Films Phenomena by K L Chopra, McGraw Hill, 2018.
3. Thin Film Technology Handbook by AichaElshabini, AichaElshabini-Riad, Fred D. Barlow, McGraw-Hill Professional, 1998
4. Handbook of Thin-film Deposition Processes and Techniques: Principles, Method, equipment and Applications By Krishna SeshanWilliam Andrew Inc., 2002
5. Thin-film deposition: principles and practice by Donald L. Smith, McGraw-Hill Professional, 1995

20PH3015 SOLID STATE BATTERIES

Credit: 3:0:0

Course Objectives:

1. To impart knowledge on the cutting edge technology in lithium ion batteries
2. To illustrate energy storage devices and their applications in smart devices/vehicles
3. To demonstrate Thin film lithium ion batteries and advancement in lithium ion battery technology

Course Outcomes:

At the end of the course, the student will be able to

1. Identify the terminologies (thin and bulk) used in lithium ion batteries
2. Illustrate the working of lithium ion batteries
3. Apply the knowledge on lithium ion batteries to construct lithium ion Coin –Power Micro-batteries
4. Analyze the output of the fabricated coin cell
5. Appraise the power of lithium ion battery
6. Design lithium ion battery with smart materials

Unit I: Battery Fundamentals

Invention, Early innovators, Global Battery Markets, Voltage, Capacity, C-rates, Watts and Volt-Amps, State of Health, Octagon Battery: Specific Energy, Specific Power, Price, Cycle Life, Safety, Operating range, Toxicity, Fast Charging, Battery building blocks: Anode, Cathode, Electrolyte, Current Collectors, Separators for different battery systems; Primary and secondary batteries: Comparison, its Advantages and disadvantages; Comparison of Secondary Batteries based on Octagon terms;

Unit II: Introduction to Lithium Batteries

Types of lithium battery: primary and secondary; Fabrication and working of lithium metal battery using liquid electrolyte; Fabrication and working of lithium ion battery using liquid electrolyte; Working of lithium metal and lithium ion polymer battery: role of polymer membranes.

Unit III: Microbatteries fabrication

Fundamentals on thin and thick films- flexible and non-flexible substrates; Methods of constructing microbatteries- Rf-sputtering and Pulsed Laser Deposition Techniques. Design and working of Glove Box- Fabrication of coin-power microbatteries. Crimping Machine-working; Types of cells in fabrication of lithium ion batteries- Coin cell types, prismatic, cylindrical and other types.

Unit IV: Testing of Coin-Power Micro-batteries

Characterization of material components: X-ray Diffraction, Scanning Electron Microscope, Fourier Transform Spectroscopy; X-ray Photoelectron Spectroscopy; Battery Characteristics: Open Circuit Voltage; Cyclic Voltammetry; Galvanostatic Charge-Discharge Studies; Electrochemical Impedance Spectroscopy studies.

Unit V: Recent Progress

Recent materials for lithium ion battery; advantages and disadvantages of lithium ion battery; alternative technologies: Sodium, Potassium, Magnesium, Iron ion, Aluminium ion, Silver ion batteries and other alternative batteries, Supercapacitor, Fuel Cells. Design of lithium ion batteries for specific applications: Space craft, Land and marine applications – pros and cons.

Reference Books:

1. Beta Writer, Heidelberg Germany, Lithium-Ion Batteries, Springer Nature Switzerland AG, Springer, Cham, ISBN 978-3-030-16800, 2019
2. Julien C., Stoyanov Z. Lithium Microbatteries. Materials for Lithium-Ion Batteries. NATO Science Series (Series 3. High Technology), vol 85. Springer, Dordrecht, ISBN 978-0-7923-6651-5, 2000.
3. David Linden and Thomas. B. Reddy, Hand Book of Batteries and Fuel cells, 3rd Edition, Edited by McGraw Hill Book Company, N.Y. 2002.
4. John O'M Bockris, Amulya K. N. Reddy and Maria Gamboa-Aldeco, Modern Electrochemistry 2A, Fundamentals of Electrode, Kluwer Academic Publishers, Newyork, 2000.

20PH3016 QUANTUM COMPUTING IN AI

Credits 3:0:0

Course Objectives:

1. To impart knowledge on the basics and scientific background of quantum computing.
2. To provide knowledge on various quantum circuits and quantum algorithms.
3. To demonstrate the interplay between quantum theory and artificial intelligence.

Course Outcomes:

At the end of the course, students will be able to

1. Identify the origin of quantum computing and gain information about qubits, quantum superposition and entanglement.
2. Understand the scientific background such as Hilbert space, tensors and operators behind quantum computing.
3. Distinguish between various quantum circuits that are involved in the field of quantum computing.
4. Classify different quantum algorithms and discuss the relation between quantum and classical complexity.
5. Appraise on the theory of quantum information, quantum error and correction.
6. Validate on the inter relation between quantum theory and artificial intelligence through applications.

Module I: FOUNDATION OF QUANTUM COMPUTING

From classical to quantum information-origin of quantum computing- postulates of quantum mechanics - qubits and multi-qubits states, bra-ket notation- Bloch sphere representation- quantum superposition- quantum entanglement – Bell's theorem

Module II: SCIENTIFIC BACKGROUND

Basis vectors and orthogonality - Hilbert spaces – density matrices - tensors – probability and measurements - unitary operators and projectors - quantum Fourier transform - Dirac notation - eigen values and eigen vectors

Module III: QUANTUM CIRCUITS AND ALGORITHMS

Quantum circuits: Single qubit gates - multiple qubit gates - quantum superposition - design of quantum circuits – quantum algorithms: classical computation on quantum computers – relationship between quantum and classical complexity classes- Deutsch’s algorithm - Jozsa and Grover algorithms – Shor factorization

Module IV: QUANTUM INFORMATION AND ERROR CORRECTION

Comparison between classical and quantum information theory - quantum noise and quantum operations - applications of quantum operations and limitations – error correction: theory of quantum error and correction - tolerant quantum computation - entropy and information – basic properties of entropy - Von Neumann - strong sub additivity - data compression - entanglement as a physical resource

Module V: QUANTUM THEORY AND AI - INTERPLAY AND APPLICATIONS

Semantic analysis – recognition and discrimination of quantum states and operators - quantum neural and Bayesian networks – quantum genetic algorithm – quantum algorithms for machine learning - quantum algorithms for decision problems – quantum search – quantum game theory

References Books:

1. Micheal A. Nielsen. & Issac L. Chiang, “Quantum Computation and Quantum Information”, Cambridge University Press, Fint South Asian edition, 2002.
2. David McMahon, “Quantum Computing Explained”, Wiley, 2007.
3. Eleanor G. Rieffel and Wolfgang H. Polak, “Quantum Computing: A Gentle Introduction” (Scientific and Engineering Computation), The MIT Press.
4. C. T. Bhunia, “Introduction To Quantum Computing”, Publisher New Age International Pvt Ltd Publishers, ISBN 9788122430752.
5. Susan Shannon, “Trends in Quantum Computing Research”, Nova Publishers, 2006.
6. Sahni, “Quantum Computing”, Tata McGraw-Hill Education, 2007.
7. Phillip Kaye, Raymond Laflamme, Michele Mosca, “An Introduction to Quantum Computing”, Oxford, 2006.

20PH3017 ASTRONOMY AND ASTROPHYSICS

Credits: 3:0:1

Course Objectives:

1. To impart the knowledge about ancient astronomy, solar system models, various types of stars and their evolution.
2. To disseminate information about the various tools available to study the cosmos.
3. To provide with a fundamental understanding of galaxies, big bang theory and life in the universe.

Course Outcomes:

At the end of the course, the student will be able to

1. Remember the various solar system models, our own solar system and earth’s immediate cosmic neighborhood.
2. Understand intricate details about the life cycle of a star and different types of stars.
3. Apply the modern day telescopes to explore the cosmos.
4. Analyze the various types of galaxies, their formation and cosmic distant scales.
5. Evaluate the formation of the universe through the big bang theory and understand about how the universe is likely to end.
6. Formulate novel techniques and theorems to explore the space to solve problems yet to be solved.

Module I - THE SOLAR SYSTEM:

Various Solar System Models – The Solar System in Perspective: Planets, Moons, Rings and Debris – Other Constituents of Solar System – Kepler's laws of planetary motion. -Coronal mass ejection. Lab experiment: Identification of spectral types of stars.

Module II - THE STARS:

The Sun – Important Properties of stars, HR diagram – Measuring the distances of a star –The Parallax Method – The Formation of Stars and Planets – Types of Stars – White dwarfs, Neutron Stars and Black Holes – Star Clusters – Supernovae and their types. . Lab experiment: Finding out 12 constellations.

Module III - TELESCOPES AND DETECTORS:

Optical Telescopes – The Hubble Space Telescope, Modern telescopes-Ground based and space based, – Detectors and Image Processing: Photography, Phototubes, Charge Couple Devices, Signal to Noise – The New Generation of Optical Telescopes. – Other Windows to Heaven. . Lab experiment: Sky watching using 8 inch reflector.

Module IV - THE MILKY WAY GALAXY:

Interstellar Matter – The milky way galaxy, The Shape and Size of the Galaxy –The Rotation and Spiral Structure of Galaxy – The Center of Galaxy – Stellar Populations –Different types of Galaxies – The Cosmological Distance Scale – The Local Group. Lab experiment: Construction of a small Telescope.

Module V - THE UNIVERSE:

Clusters of Galaxies – Super Clusters of Galaxies - Hubble's Law –Cosmological Models – The Standard Big Bang Model – The Big Bounce Theory – The Fate of the Universe – The Big Crunch Theory – The Big Rip Theory – Life in the Universe-Hunt for exo planets-methods for finding exo planets. . Lab experiment: Skywatching using refractometer Telescope;

Reference Books

1. Michael Zeilik, Stephen .A.Gregory, Introductory Astronomy and Astrophysics, Fourth Edition, Saunders College Pub., Michigan, U.S.A, 1998 ISBN 9780030062285
2. B. Bhattacharya, S. Joardar, R. Bhattacharya, Astronomy and Astrophysics, Jones and Barlett Publishers, U.S.A., (2010) ISBN 978-1-934015-05-6
3. Martin V. Zombeck, Book of astronomy and Astrophysics, Cambridge University Press, U.K. (2007) ISBN 978-0-521-78242-5
4. ThanuPadmanabhan, Theoretical Astrophysics (Vol. I, II, II): Cambridge University Press, U.S.A., (2002) ISBN 0 521 56242 2
5. Wolfgang Kundt, Astrophysics: A new approach, Second edition, Springer, 2006
6. Introduction to Astrophysics: The Stars, Jean Dufay, Dover publications,2012
7. Arnab Rai Chaudhuri, AstroPhysics for Physicists, Cambridge University Press,2010. ISBN-10 : 052117693X,
8. Frank shu The Physical Universe

20PH3018 RADIATION PHYSICS

Credits: 4:0:0

Course Objectives:

1. To review the basic physics principles of atomic and nuclear physics
2. To demonstrate the basic radiation detection mechanisms and various types of detectors.
3. To illustrate the importance of counting statistics and other statistical tools in radiation measurements.

Course Outcomes:

At the end of the course, the student will be able to

1. Know the basic physics principles of atomic and nuclear physics
2. Understand the basics of radiation physics and interaction of radiation with matter
3. Apply the various absorption mechanisms of radiation and particles in detection of environmental radiation

4. Analyze the instrumentation principles of radiation detection mechanisms and various types of detectors.
5. Evaluate the importance of counting statistics and other statistical tools in radiation measurements will be learnt by the students.
6. Create peaceful applications of radiation in the field of food, water, health and energy

Unit I - REVIEW OF PHYSICAL PRINCIPLES

Mechanics – Units and Dimensions – Work and Energy – Relativity Effects – Electricity – Electrical Charge: The Stat Coulomb – Electric Potential: The Stat Volt – Electric Field – Energy Transfer – Elastic and Inelastic Collision – Electromagnetic Waves – Excitation and Ionization – Periodic Table of the Elements – The Wave Mechanics Atomic Model – The Nucleus – The Neutron and the Nuclear Force – Isotopes – The Atomic Mass Unit – Binding Energy – Nuclear Models – Nuclear Stability

Unit II - RADIOACTIVITY AND INTERACTION OF RADIATION WITH MATTER

Radioactivity and Decay Mechanism – Kinetics of Decay – The Units of Radioactivity – Series Decay – Alpha Rays – Range-Energy Relationship – Energy Transfer – Beta Rays – Range Energy Relationship – Mechanism of Energy Loss – Ionization and Excitation – Gamma Rays – Exponential Absorption – Absorption Mechanisms – Pair Production – Compton Scattering – Photoelectric Effects – Neutrons – Production – Classification – Interaction

Unit III - METHODS OF MEASURING RADIATION

Gas Filled Detectors – Ionization Chamber – Proportional Counters – Geiger Muller Counter – Scintillation Detection Systems – Photomultipliers – Scintillators – Semiconductor Detectors – Principles of Operation – Charged Particle Detectors – Thermo Luminescent Detectors – Film Badge – OSLD – High Purity Germanium Detectors – Track Devices – Photographic Emulsion – Track Etch Dosimeters – Spark Counters and Spark Chambers – Miscellaneous Detectors

Unit IV - COUNTING STATISTICS AND CALIBRATION OF INSTRUMENTS

Uncertainty in the Measuring Process – Various Types of Distribution – Error Propagation – Accuracy of Counting Measurements – Significance of Data from Statistical Viewpoint – Calibration and Standards – Source Calibration – Neutron Sources – X-ray Machines – Calibration of Detection Equipment

Unit V - RADIATION IN THE ENVIRONMENT AND THEIR APPLICATIONS

Types of Radiation Sources – Natural Radiation Sources – Artificial Sources of Radiation – Applications of Radiations – Medical Applications – Industrial Applications – Radiation in Food Processing Industry – Agricultural Applications – Isotope Hydrology – Miscellaneous Applications

Reference Books

1. Basic Radiological Physics, Kuppasamy Thayalan, Jaypee Brothers Medical Publishers (2017)
2. Radiation and Detectors: Introduction to the Physics of Radiation and Detection Devices (1st Edition), Lucio Cerrito, Springer Publications (2017)
3. Radiation Physics for Medical Physicists, Ervin B. Podgorsak, Springer, New York (2016)
4. Measurement and Detection of Radiation (4th Edition), Nicholas Tsoulfanidis and Sheldon Landsberger, CRC Press; 4th Edition (2015)
5. Principles of Radiation Interaction in Matter and Detection (4th Edition), Pier-Giorgio Rancoita and Claude Leroy, World Scientific; (2015)
6. Physics and Engineering of Radiation Detection (2nd Edition), Syed Naeem Ahmed, Academic Press, Elsevier (2014)
7. Radiation Detection and Measurement, Glenn F. Knoll, John Wiley & Sons, 2010
8. Review of Radiological Physics, Walter Huda, Lippincot, 2010
9. Environmental Radioactivity From Natural, Industrial & Military Sources (4th Edition), Merrill Eisenbud and Thomas F. Gesell, Academic Press, (1997)
10. Principles of nuclear radiation detection, Geoffrey G. Eicholz and John W. Poston, ANN Arbor Science Publishers, (1980)

20PH3019 GENERAL PHYSICS LAB I

Credits: 0:0:2

Course Objectives:

1. To get practical skill on basic optical experiments.
2. To get practical skill on non-ideal elements, such as lasers and optics in experiments..
3. To get practical skill on basic sound and ultrasonic experiments.

Course Outcomes:

At the end of the course, the student will be able to

1. apply knowledge on basic Physics experiments to solve practical problems.
2. apply experimental principles and error calculations to electromagnetism.
3. analyze basic quantities in electromagnetism.
4. present concepts and describe scientific phenomena.
5. design experiments, and analyze and interpret data.
6. get practical skill on analyzing the Magnetic properties of the material

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

20PH3020 GENERAL PHYSICS LAB II

Credits: 0:0:2

Course Objectives::

1. To get practical skill on digital electronics.
2. To get practical skill in studying the characteristics of low power semiconductor devices.
3. To get practical skill on analyzing the characteristics of Diode and transistor.

Course Outcomes::

At the end of the course, the student will be able to

1. understand the practical difficulties in measuring the standard parameters.
2. architecture of microprocessors and methodology of programming
3. design basic electric circuits using software tools.
4. identify, formulate and solve engineering problems with simulation.
5. experience in building and troubleshooting electronic circuits.
6. write simple program using microprocessor for practical applications.

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

20PH3021 ADVANCED PHYSICS LAB I

Credits: 0:0:2

Course Objectives:

To learn practical skills on

1. Thin film coating devices
2. Operation of physical method of thin film preparation
3. Synthesis of thin films through chemical route

Course Outcomes:

At the end of the course, the student will be able to

- apply the knowledge preparation of thin films
- demonstrate physical method of thin film preparation
- demonstrate the chemical method of thin film preparation
- evaluate the electrical properties of thin films
- estimate the hall measurements
- characterize the optical properties and to find the band gap.

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

20PH3022 ADVANCED PHYSICS LAB II

Credits 0:0:2

Course Objectives:

1. To get practical skill on various deposition techniques
2. to prepare thin films and
3. Crystals having nanostructures

Course Outcomes:

At the end of the course, the student will be able to

1. Fabricate novel nano structures
2. Fabricate nano thin films
3. Fabricate nano devices
4. Fabricate electronics devices
5. solve the out put properties of the devices
6. evaluate the efficiency of the devices

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

20PH3023 COMPUTATIONAL PHYSICS LAB

Credits: 0:0:2

Course Objectives:

1. To provide students with an opportunity to develop knowledge and understanding of the key principles of computational physics.
2. Synchronising computational skills acquired with requirements of theoretical physics courses.
3. Developing numerical, computational and logical skills relevant for solution of theoretical and experimental physics problems.

Course Outcomes:

At the end of the course, the student will be able to

1. Demonstrate knowledge in essential methods and techniques for numerical computation in physics
2. Apply the programming skills to solve practical problems.
3. Apply numerical and statistical problem solving skills and computer programming skills to solve research problems.
4. Use appropriate numerical method to solve the differential equations governing the dynamics of physical systems
5. Apply different methods to solve deterministic as well as probabilistic physical problems
6. Employ appropriate numerical method to interpolate and extrapolate data collected from physics experiments

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

20PH3024 MATERIALS CHARACTERIZATION LAB

Credit: 0:0:2

Course Objectives:

To train the students to operate

1. Spectro photometer
2. X-Ray diffractometer
3. Scanning electron microscope

Course Outcomes::

At the end of the course, the student will be able to

1. demonstrate optical propertis through Spectrophotometer
2. evaluate the structure through XRD

3. identify the morphology through SEM
4. appraise the surface roughness through AFM
5. calculate the dielectric constant through Impedance analyser
6. plot the IV characteristics through NI work station.

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

20PH3025 RADIATION TREATMENT AND PLANNING

Credits: 4:0:0

Course Objectives:

1. To disseminate knowledge on radiotherapy machines
2. To illustrate the interaction of photon beam on matter
3. To enlighten the students about various calibration methods

Course Outcomes:

At the end of the course, the student will be able to

1. Recall the basic information about radiotherapy machines
2. Understand the interaction of photon beam on matter
3. Apply various calibration methods to ensure better quality treatment using machines.
4. Analyze the various clinical treatment planning
5. Evaluate the various radiation treatment modalities
6. Create better treatment modalities using electron beam therapy and advanced radiotherapy treatment methods like Cyberknife.

Module I - RADIOTHERAPY MACHINES

X-rays and Gamma rays – Linear Accelerator – Components of Modern LINAC – Injection System - RF Power Generation System – Accelerating Wave Guide – Microwave Power Transmission – Auxiliary System – Electronic Beam Transport – LINAC Treatment Head – Production of Photon and Electron Beams from LINAC – Beam Collimation – Cobalt-60 versus LINAC – Radiation Therapy Simulators.

Module II - PHYSICAL ASPECTS OF EXTERNAL PHOTON BEAMS

Photon Beam Sources – Inverse Square Law – Penetration of Photon Beams into Phantom or Patient – Surface Dose – Build-up – Skin Sparing Effect – Percentage Depth Dose – Tissue air Ratio – Back Scattering Factor – Tissue Phantom Ratio – Tissue Maximum Ratio – Scatter Air Ratio – Total Scatter Factor – Isodose Distribution in Water Phantom – Isodose Charts and Factors Effecting – Correction of Irregular Counters – Missing Tissue Compensation – Correction of Tissue Inhomogeneity – Clarkson's Method – Dose Calculation.

Module III - CLINICAL TREATMENT PLANNING IN PHOTON BEAMS

Treatment Planning – Volume Definition - ICRU 50, ICRU 62, ICRU 83 Concepts – GTV – CTV – ITV – PTV – OAR – Dose Specification – Patient Data Acquisition – Simulation – Conventional Simulation – Isodose Curves – Wedge Filters – Bolus – Compensating Filters – Field Separation – Quality Assurance of Treatment Planning System – IAEA TRS 430 Protocol – AAPM TG 53 and 106 Protocols

Module IV - PHYSICAL ASPECTS OF ELECTRON BEAM THERAPY

Production of Electron Beams – Interaction of Electron with Matter – Range Concept – Percentage Depth Dose – Electron Energy Specification – Scattering Power – Rapid Dose Fall-off – Electron Shielding – Dose Prescription and Thumb Rule – Field Inhomogeneity – Dose Build-up – Photon Contamination – Back Scatter – Collimation – Virtual SSD – Oblique Incidence.

Module V - ADVANCED RADIOTHERAPY TREATMENT METHODS

Treatment Planning System – Imaging in Radiotherapy – Image Fusion – CT Simulation – Basics of 3-Dimensional Conformal Therapy – Beams Eye View – Digitally Reconstructed Radiograph – 3-D Conformal Radiotherapy – Plan Evaluation Methods – Dose Volume Histograms – Treatment Evaluation – Introduction to Intensity Modulated Radiotherapy and Image Guided Radiotherapy – Concept – Imaging Modality – 2D image – kV Cone Beam CT – Image Registration – Plan Adaptation – QA Protocol and

Procedures – Stereotactic Radiosurgery and Stereotactic Radiotherapy – Tomotherapy – Cyber Knife – Particle Beam Therapy.

Reference Books

1. Washington & Leaver's Principles and Practice of Radiation Therapy (5th Edition), Charles M. Washington, Dennis T. Leaver and Megan Trad, Mosby Publications (2020)
2. Khan's Treatment Planning in Radiation Oncology (4th Edition), Faiz M. Khan, John P. Gibbons and Paul W. Sperduto (Eds.), LWW Publishers (2016)
3. Principles and Practice of Radiation Therapy (4th Edition), Charles M. Washington and Dennis T. Leaver, Mosby Publications, (2015)
4. Khan's The Physics of Radiation Therapy (5th Edition), Faiz M. Khan and John P. Gibbons, Lippincott Williams & Wilkins; (2014)
5. Radiation Oncology Physics: A Handbook for Teachers and Students, E.B. Podgorsak Technical Editor, International Atomic Energy Agency Vienna, 2005
6. Radiation Therapy Physics (3rd Edition), William R. Hendee, Geoffrey S. Ibbot and Eric G. Hendee, Wiley-Liss Publications, (2004)

20PH3026 MEDICAL RADIATION DOSIMETRY

Credit 4:0:0

Course Objectives:

1. To explain the basic concepts of atoms and nucleus
2. To illustrate the different types of radiation emitted from nuclear sources
3. To disseminate knowledge on the interaction of radiation with matter

Course Outcomes:

At the end of the course, the student will be able to

1. Remember the basic concepts of atoms and nucleus
2. Understand the different types of radiation emitted from nuclear sources
3. Apply the interaction of radiation with matter in novel peaceful applications
4. Analyze and understand the various units of radiation measurements.
5. Evaluate the different types of radiation detection and measurement.
6. Create novel dosimetry systems for measuring different types of nuclear radiation

Module I - BASIC RADIATION PHYSICS

Atoms and Nuclei – Fundamental Particles – Atomic and Nuclear Structure – Mass Defect and Binding Energy – Radiation – Classification of Radiation – Electromagnetic Spectrum – Radioactivity – Alpha, Beta and Gamma Rays – Methods of Decay – Isotopes – Radiation Sources.

Module II - INTERACTION OF RADIATION WITH MATTER

Types of Indirectly Ionizing Radiation – Photon Beam Attenuation – Types of Photon Interactions – Types of Electron Interactions – Types on Neutron Interactions – Photo Electric Effect – Coherent Scattering – Compton Effect – Pair Production – Photo Nuclear Disintegration – Effect following Radiation Interaction.

Module III - RADIATION QUANTITIES AND UNITS

Radiometric, Interaction, Protection and Dosimetric Quantities – Particle and Energy Fluence – Linear and Mass Attenuation Coefficient – Stopping Power – Linear Energy Transfer – Absorbed Dose – Kerma – Exposure – Activity – Equivalent Dose – Effective Dose – Electronic or Charged Particle Equilibrium – Bragg Gray Cavity Theory – Spencer-Attix Cavity – Burlin Cavity Theory – Bremsstrahlung Radiation – Bragg's Curve.

Module IV - RADIATION DETECTION

Properties of Dosimeters – Methods of Radiation Detection – Ionization Chamber Dosimetry System – Proportional Counters – Geiger-Muller Counters – Semiconductor Detector – Solid and Liquid Scintillation Counters – Film Dosimetry – Thermo Luminescent Dosimetry – Calorimetry – Chemical Dosimetry

Module V - CALIBRATION OF PHOTON AND ELECTRON BEAMS

Calibration Chain – Ionization Chambers – Electro Meter and Power Supply – Phantoms – Chamber Signal Corrections for Influence Quantities – Calibration of Mega Voltage Photon Beams and Mega Voltage Electron Beams based on Standard National and International Protocols.

Reference Books

1. Clinical 3D Dosimetry in Modern Radiation Therapy, Ben Mijnheer, CRC Press (2019)
2. Medical Radiation Dosimetry: Theory of Charged Particle Collision Energy Loss, Brian J. McParland, Springer (2016)
3. Nuclear Medicine Radiation Dosimetry: Advanced Theoretical Principles, Brian J. McParland, Springer Publications (2010)
4. Fundamentals of Nuclear Medicine Dosimetry, Michael G. Stabin, Springer (2008)
5. Advanced Medical Radiation Dosimetry, Govinda K N Rajan, Prentice-Hall of India Pvt.Ltd (2004)
6. Introduction to Radiological Physics and Radiation Dosimetry, Fran Herbert Attix, Wiley VCH Publications (1986)
7. Fundamentals of Radiation Dosimetry, J.R. Greening, Institute of Physics Publishing (1981)

20PH3027 SOLID STATE IONICS

Credit:4:0:0

Course Objectives:

1. To impart knowledge on the crystal structures
2. To provide knowledge on the advanced level science in the development of solid electrolytes
3. To demonstrate the working of solid-state devices

Course Outcomes:

At the end of the course, the students will be able to,

1. Understand the crystal structure and its types
2. Appreciate the theoretical aspects of solid electrolytes
3. Analyze the diffusion process in ionic crystals
4. Evaluate the transport properties of ionic conductors
5. Create new types of energy devices utilizing the knowledge on solid state Ionics

UNIT I: CRYSTAL STRUCTURE

Crystalline Solids- Space Lattice – the basis and crystal structure; crystal translational vectors, symmetry operation, Primitive lattice cell and unit cell, symmetry elements. Fundamental types of lattices- atomic packing, atomic radius, lattice constant and density, crystal structures; other cubic structure- type of bonding – ionic bonding – energy of formation of NaCl Molecule; Madelung constant- potential energy of diagram of ionic molecule- calculation of repulsive exponent – Born-Haber cycle – characteristics of ionic bond

UNIT II: THEORETICAL ASPECTS OF SOLID ELECTROLYTES

Distinguish between Normal and Superionic Conductor - Sublattice Disorder – Ionic motion in Fast ionic conductor- Co-operative motion of ions – Ionic Diffusion and conduction in disordered systems ; The Path Probability method – The State Variable – The Path Variables – The Path Probability – Stationary State Condition Phenomenological Models : Hubermann's Theory – Rice-Strassler and Toomb's theory – Welch and Dienes Theory

UNIT III: DIFFUSION PROCESS IN IONIC CRYSTALS

Microscopic Aspects of Diffusion:- Markov Process – Mechanism of Diffusion – Microscopic Interpretation of Diffusion Coefficient – Self and Isotope Diffusion Coefficient – Defects Diffusion Coefficient – Chemical Diffusion Coefficient – Measurement of Diffusion Coefficient

:- Tracer Method- NMR method:- Motional Narrowing of Resonance Band – Diffusion Coefficient from NMR Relaxation time

UNIT IV : TRANSPORT PROPERTIES OF IONIC CONDUCTORS

Definition of Conductivity and Transference number – Equation of flow of charged particles measurement of Conductivity- Determination of Transference Number – Interrelation among diffusion coefficient, mobility and ionic conductivity-Experimental methods to separate ionic and electronic conductivity parameter: wagner polarization method, emf method of transport number determination- Determination of small electronic transport numbers-The permeation technique (static)- The polarized cell technique (static), The polarized cell technique (dynamic)- The permeation technique (dynamic)

UNIT V: SUPERIONIC SOLIDS AND APPLICATIONS

Superionic solid, types of batteries, lithium ion battery, disadvantages of liquid electrolyte, Role of mixed conductors as electrodes in batteries, lithium polymer battery, supercapacitors, types of supercapacitors, EDLC, Pseudocapacitors, hybrid capacitors, lithium ion capacitors, microbatteries- thin film based-construction methods, Proton Exchange Membrane Fuel Cell.

References:

1. C. S. Sunandana, Introduction to Solid State Ionics: Phenomenology and Applications, CRC Press, 2015
2. H.L. Tuller, Minko Balkanski, T. Takahashi, Solid State Ionics, 2012
3. Suresh Chandra, Superionic Solids-Principles and Applications, North Holland Publishing Company, Amsterdam, New York, Oxford ISBN: 0444860398, 1981
4. S.Geller, Solid Electrolytes, Springer Verlag Berlin Heidelberg, New York, ISBN 3-540-08338-3, 1977
5. T.Kudo and K.Fueki, Solid State Ionics, Kodansha Ltd, Tokyo, (Japan), VCH Publisher, New York, USA (1990) ISBN: 3-527-28166-5, 1990

20PH1001 ELEMENTS OF PHYSICS IN AVIATION

Credit:3:0:0

Course Objectives:

Impart knowledge on

1. Optics and its behaviour in different medium.
2. Celestial Mechanics and Solar System
3. Oscillations and waves, analytical instruments and nanomaterial.

Course Outcomes:

At the end of the course, the student will able to

1. Compare the laws of optics with regards to reflection, refraction, interference, diffraction and polarization.
2. Explain various laws governing oscillations and waves.
3. Appraise the characterisation ability of analytical instruments.
4. Describe the interplanetary travel in solar system.
5. Describe the characteristics of acoustic waves.
6. Demonstrate the process of obtaining nanomaterial and its applications.

MODULE 1: OPTICS

7 HOURS

Nature of light, ray approximation in geometrical optics, Reflection, Refraction, Fermat's principle, Mirrors and lenses, Interference, Diffraction, Lasers : absorption, Spontaneous Emission, He:Ne laser, Welding and cutting.

MODULE 2: ELECTROMAGNETISM**6 HOURS**

Electric Charge and Electric Field, Gauss's Law, Electric Potential, Capacitance and Dielectrics, Current, Resistance and Electromotive Force, Direct-Current Circuits, Magnetic Field and Magnetic Forces, Sources of Magnetic Field.

MODULE 3: ELECTROMAGNETIC INDUCTION**7 HOURS**

Induced Emf and Magnetic Flux, Faraday's Law of Induction: Lenz's Law, Motional Emf, Eddy Currents and Magnetic Damping, Electric Generators, Back Emf, Transformers, Electrical Safety: Systems and Devices, Inductance, RL Circuits, Reactance, Inductive and Capacitive, RLC Series AC Circuits.

MODULE 4: FUNDAMENTALS OF ACOUSTICS**11 HOURS**

Types of Mechanical Waves, Periodic Waves Mathematical Description of a Wave, Speed of a Transverse Wave, Energy in Wave Motion, Wave Interference, Boundary Conditions and Superposition, Standing Waves on a String, Normal Modes of a String. Introduction, History of high frequency Acoustics, Basic elements, Mechanisms of transmission, Acoustic motion and driving motion, Notion of frequency, Acoustic amplitude and intensity, Viscous and thermal phenomena.

MODULE 5: INTRODUCTION TO ANALYTICAL INSTRUMENTS**7 HOURS**

Dual nature of matter, de-Broglie wave. Basic principles of Atomic Force Microscope, Scanning Electron Microscope, X-ray diffraction, Absorption and Fluorescence spectrometers, Differential Thermal Analysis, Applications.

MODULE 6: FLUID STATICS**7 HOURS**

Density, Pressure, Variation of Pressure with Depth in a Fluid, Pascal's Principle Gauge Pressure, Absolute Pressure and Pressure Measurement, Archimedes' Principle, Cohesion and Adhesion in Liquids: Surface Tension and Capillary Action Pressures in the Body, Flow Rate and Its Relation to Velocity, Bernoulli's Equation, The Most General Applications of Bernoulli's Equation.

CONTENT BEYOND SYLLABUS

Videos on production of nanomaterial on a larger scale or application of orbital Mechanics in space flight etc.

Text Books:

1. Hugh D. Young and Roger A. Freedman, "Sears and Zemansky's University Physics with Modern Physics", Pearson Education, New Delhi (2018), Fourteenth Edition.
2. Mathur D.S., Shyam Lal, "Elements of Properties of Matter" Charitable Trust, New Delhi, 2008

References:

1. Michael Zeilik, Stephen A. Gregory, "Introductory to Astronomy and Astrophysics", 4th edition, Thomson Learning, Inc., 1998.
2. Michel Bruneau, "Fundamentals of Acoustics", British Library, 2006.
3. Warren P. Mason, "Physical Acoustics Principles and Methods", Academic Press, 1981.
4. C.P. Poole and F.J. Owens, "Introduction to Nanotechnology", Wiley, New Delhi 2007.

20PH1002 APPLIED PHYSICS LAB FOR AEROSPACE ENGINEERING**Credits 0:0:2:1****Course Objectives:**

1. Impart knowledge on the basics of the vector and scalar representation of forces and moments
2. Give emphasis on momentum, friction and rotation of particles applicable in Aerospace engineering.
3. Provide an insight on the concept of optics and lasers.

Course Outcomes:

At the end of the course, the student will be able to

1. Demonstrate the ability to solve the problems based on modulus of elasticity.
2. Apply the concepts of rotational kinetic energy & angular momentum to the problems involved in rigid body rotation.
3. Estimate the frequency of a vibrating body at different modes.

4. Standardize the methods to calibrate low range voltmeter.
5. Calculate the magnetic field along the axis of current carrying coil.
6. Apply the concepts of laser diffraction to determine particle size.

List of experiments

1. Determination of Young's modulus of the given beam using non-uniform bending method.
2. Determination of Young's modulus of the given beam using uniform bending method.
3. Determination of rigidity modulus of the given wire by torsional pendulum method.
4. Determination of frequency of tuning fork using Melde's string.
5. Calibration of a low range voltmeter using potentiometer.
6. Determination of magnetic field along the axis of a circular coil.
7. Determination of magnetic field along the axis of a circular coil and pole strength of the given magnet using Tan C method.
8. Determination of the particle size using laser diffraction method.
9. Determination of the thickness of given samples using single optic lever.
10. Determination of the radius of curvature of the given lens using Newton's ring method.

20PH1003 APPLIED PHYSICS FOR BIOMEDICAL ENGINEERING

Credits 3:0:0:3

Course Objectives:

1. Impart knowledge on Physics of optics and Lasers
2. Identify the significance of fiber optics and LiFi
3. Provide understanding on the modern practices related to Flexible sensors and Electromagnetic Theory

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the basic optical laws applied in biomedical Instrumentation.
2. Explain and interpret the basics of Lasers and its applications in biomedical field.
3. Apply the concepts of Optical Fiber Cables in medical instrumentation
4. Perceive the significance of LiFi in medical field.
5. Appraise the various types of flexible sensors and its application in health care.
6. Discuss the basic principles of Electromagnetic radiation, its health hazards and opportunities in health sector.

Module 1: Optics in Biomedical instrumentation (9 Hours)

Dual nature of light- Simple harmonic waves, superposition of waves, Interference: Coherence; path and phase difference, Diffraction by multiple slit- grating. Diffraction- HUYGENS' principle, Difference between interference and diffraction fringes, circular aperture – amplitude & intensity distribution. Polarization and its types, Applications and opportunities- Optical microscopy, Interferometric imaging.

Module 2: Lasers (7 Hours)

Components of Laser – Principle of Laser Action – Properties of Laser – Spontaneous Emission and Stimulated Emission – Einstein's coefficients – Population inversion – Types of lasers – He-Ne laser -CO₂ laser – Excimer laser – Biomedical applications and opportunities – Lasik surgery, Photodynamic therapy (PDT) for cancer, transmyocardial laser revascularization for treatment of angina.

Module 3: Fiber optics (7 Hours)

Propagation of Light in Optical Fibers – Numerical Aperture and Acceptance Angle – Types of Optical Fibers based on materials, mode and refractive index, Double crucible technique of fiber drawing, fiber splicing, Power Losses in Optical Fibers – Biomedical applications and opportunities- Fiber Optic pressure sensors – Fibre endoscope -Temperature measurement during Magnetic Resonance Imaging (MRI).

Module 4: LiFi (Light Fidelity) (7 Hours)

Electromagnetic spectrum, Introduction, architecture and construction of Li-Fi system, Working of Li-Fi, significance, comparison between Li-Fi, Wi-Fi and other radio communication technologies – Advantages

and limitations, Applications and opportunities – Photoplethysmography (PPG) , Medical field, Education and disaster management.

Module 5: Flexible Sensors (8 Hours)

Role of electrical conductors, semiconductors, dielectrics and substrate materials, Design, fabrication and testing methods of flexible sensors, Types of sensors – strain sensors-resistive, capacitive and piezoelectric, Pressure sensors – resistive, capacitive, Field effect transistors, piezoelectric and piezocapacitive pressure sensors. Applications and Opportunities - health monitoring devices – wearable device.

Module 6: Electromagnetics in biomedical application (8 Hours)

Gradient, Divergence, Gauss divergence theorem, Curl, Stoke's theorem, Maxwell's Electromagnetic wave Equations – Ampere's Circuital Law – Displacement Current Electromagnetic Energy Density – Intensity of Electromagnetic Waves –health hazards of wireless communication systems - interaction of electromagnetic waves with biological systems, Applications and Opportunities - Cancer detection, wireless bioimplants.

Text Books

1. Engineering Physics, D.K. Bhattacharya and Poonam Tandon, New Delhi: Oxford University Press (2017)
2. A Text Book of Optics, Brij Lal, M.N. Avadhanulu and N. Subrahmanyam, S. Chand Publishing, (2012)
3. Engineering Physics, Shatendra Sharma and Jyotsna Sharma, New Delhi: Pearson India Education Services Pvt. Ltd., (2019)
4. Wearable Sensors- Applications, design and implementation, Edited by Subhas Chandra Mukhopadhyay and Tarikul Islam, IOP Publishing Ltd 2017
Online ISBN: 978-0-7503-1505-0 • Print ISBN: 978-0-7503-1503-6

Reference Books

1. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition
2. Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman, Pearson Education, New Delhi (2018), Fourteenth Edition.
3. Engineering Physics, R.K. Gaur and S.L.Gupta, New Delhi: Dhanpat Rai Publications (P) Ltd. (2008).
4. Li-Fi Technology for Indoor Access: Li-Fi, Mohamed Gado and Doa Abd El-Moghith, LAP LAMBERT Academic Publishing (March 13, 2015)

20PH1004 APPLIED PHYSICS LAB FOR BIOMEDICAL ENGINEERING

Credits 0:0:2:1

Course Objectives:

1. Impart knowledge on Lasers, fiber optics and electromagnetism
2. Acquire knowledge on the Fundamentals of optics
3. Impart knowledge on Piezoelectric sensors

Course Outcomes:

At the end of the course, the student will be able to

1. Demonstrate the lens laws using different optical systems.
2. Evaluate the refractive index of various materials.
3. Apply the concept of laser diffraction in determination of particle size.
4. Determine the different wavelengths of the electromagnetic spectra.
5. Evaluate the macro bending losses in fiber optic cables.
6. Design innovative products based on piezoelectric sensors applicable in biomedical instrumentation.

List of experiments

1. Determination of the focal length & the power of a convex lens by displacement method.

2. Determination of refractive index of the material of a prism by minimum deviation method.
3. Determination of Particle size using LASER diffraction method.
4. Determination of radius of curvature of a plano-convex lens Newtons rings.
5. Determination of thickness of a glass plate using single optic lever.
6. Determination of wavelength of mercury spectrum by diffraction grating using spectrometer
7. Evaluation of the attenuation and numerical aperture in fiber optics
8. Demonstration of Piezoelectric Sensor
9. Determination of Planck's constant
10. Determination of thickness of a film by Air wedge experiment.

20PH1005 APPLIED PHYSICS FOR CIVIL ENGINEERING

Credits 3:0:0:3

Course Objectives:

1. Principles of acoustics and lighting designs for civil engineering applications.
2. Knowledge on new engineering materials and thermal physics for buildings.
3. Glimpse of temperature management in building and disaster mitigation

Course Outcomes:

At the end of the course, the student will be able to

1. Tune their knowledge on the acoustical effects of buildings.
2. Analyse the properties of light and its optical effect for buildings.
3. Understand the concept of engineering new building materials
4. Apply the concept of thermal physics in the performance of buildings
5. Solve problems of thermal performance and prevention care of buildings.
6. Illustrate the physics concepts of the disaster mitigation in structure of buildings.

Module: 1: ACOUSTICS (7 Hours)

Classification of Sound – Decibel-Weber-Fechner law-Sabine's formula-Reverberation Time-Derivation using growth and decay time-Absorption Coefficient and its determination-factors affecting acoustics of buildings and their remedies-Methods of sound absorptions-absorbing materials-noise and its measurements, sound insulation and impact of noise in multi-storey buildings.

Module: 2: LIGHTING DESIGNS(8 Hours)

Radiation quantities-relationship between luminescence and radiant quantities-hemispherical reflectance and transmittance-photometry: cosines law, inverse square law-Vision-photopic and mesopic luminance conditions-Colour-luminous efficiency function-Visual field glare, day light design of windows,principles of artificial lighting, supplementary artificial lighting-Lighting applications for mobile devices.

Module: 3: NEW ENGINEERING MATERIALS(8 Hours)

Composites-Definition and classification-Fibre reinforced plastics (FRP) and fiber reinforced metals (FRM)-Metallic glasses-Ceramics-Classification-Crystalline-Non Crystalline. Bonded ceramics-Manufacturing methods-Slip casting-Gas pressure bonding-Properties – thermal and mechanical ceramic fibres-ferroelectric and ferromagnetic ceramics-multilayer capacitors and piezoelectric transducers.

Module 4: THERMAL PHYSICS (6 Hours)

Transfer of heat energy-thermal expansion of solids and liquids-expansion joints-bimetallic strips-thermal conduction, convection and radiation-heat conduction in solids-thermal conductivity-specific heat, thermal diffusivity-Forbe's and Lee's disc method: theory and experiment-applications:heat exchangers, solar water heaters.

Module 5: PHYSICS OF TEMPERATURE MANAGEMENT IN BUILDINGS(7 Hours)

Heat transfer through thermal insulation and its benefits-Heat gain and heat loss estimation-factors affecting the thermal performance of buildings-Thermal measurements, thermal comfort, indices of thermal comfort, climate and design of solar radiation-shading devices-Central heating-Principles of natural ventilation-ventilation measurements, design for natural ventilation-Air conditioning systems for different types of buildings-Temperature sensors.

Module 6: DISASTER MITIGATION IN BUILDINGS(8 Hours)

Seismology and Seismic waves-Earth quake ground motion-Basic concepts and estimation techniques-site effects-Cyclone and flood hazards-Fire hazards and fire protection-fire-proofing of materials, fire safety regulations and fire fighting equipment-Prevention and safety measures-Gas sensors and detectors-physics of Tsunami-physics based wild fire simulation

Text Books:

1. Ing. Marek Zozulák. Marek Zozulák, “Building Physics”, ISBN 978-80- 553-1261-3, 2012
2. Gaur R.K. and Gupta S.L., Engineering Physics. Dhanpat Rai publishers, 2012.
3. Budinski, K.G. & Budinski, M.K. “Engineering Materials Properties and Selection”, 9th Edition, Prentice Hall, 2010.
4. Stevens, W.R., “Building Physics: Lighting: Seeing in the Artificial Environment, Pergaman Press, 2013.

Reference Books:

1. Gaur R.K. and Gupta S.L., Engineering Physics. Dhanpat Rai publishers, 2012.
2. John Schroder “Earthquake hazard and Disasters Academic Press, 2016.
3. Shearer, P.M. “Introduction to Seismology”, Cambridge University Press, 2019.

20PH1006 PHYSICS FOR CIVIL ENGINEERS LAB

Credits 0:0:2:1

Course Objectives:

The course aims to provide

1. Knowledge on basics of the elasticity of materials
2. Insight into the physics of light and its optical effect in buildings
3. Knowledge on the concept of Doppler effect and Sound wave properties

Course Outcomes:

The student will be able to

1. Demonstrate Young’s Modulus of a beam by Non-Uniform bending
2. Illustrate the wavelength spectrum using Mercury light Source
3. Demonstrate the Torsional pendulum to measure Moment of Inertia of solid bodies
4. Understand the longitudinal and Transverse modes of vibration
5. Solve and evaluating the relationship between sound and Doppler effect
6. Apply Physics concepts in solving the problems pertaining to thermal conductivity of solids

List of experiments

1. Determination of Young’s Modulus by Non-Uniform bending
2. Determination of Young’s Modulus by Uniform bending
3. Radius of curvature of a Lens- Newton’s rings method
4. Determination of wavelength of colours-Mercury Grating spectrum
5. Determination of rigidity Modulus of a wire-Torsional Pendulum
6. Determination of frequency of tuning fork-Melde’s string
7. Estimation of Doppler effect by Ultrasonic Waves – Laser and Photo diode
8. Determination of Thermal conductivity of a bad conductor-Lees Disc
9. Specific heat capacity of solids and liquids – Joule’s Calorimeter
10. Determination of velocity of sound-Acoustic Grating method

20PH1007APPLIED PHYSICS FOR COMPUTER SCIENCE AND ENGINEERING

Credits 3:0:0:3

Course Objectives:

The course aims to

1. Impart knowledge on the fundamental concepts of physics in Quantum computing and semiconductor Quantum dots
2. Provide the basic physics underlying the field of display technology, superconducting quantum bit and magnetic storage
3. Throw light on new age Physics applications in computer networking for IoT applications

Course Outcomes:

The student will be able to

1. **Remember** the fundamentals of Quantum Reality in Space, Time and Quantum Entanglement in making of Qubits.
2. **Understand** the physics of nanomaterials with Quantum Confinement for making Quantum Chips.
3. **Apply** the advancements in latest technologies for computer quantum processing units and display devices.
4. **Design** superconducting quantum bits, and high end data storage using the physics of superconductors and magnetic materials.
5. **Develop** the high speed data transmission for computer networks using the physics of fiber optics and LASERS.
6. **Innovate** in the field of IoT by analyzing the problems associated with microbatteries and sensors;

Module: 1: Physics of Quantum Computing (7 Hours)

Physics of Computation: Quantum Computing-introduction and definition; Physics behind Qubit: Young's Double Slit experiment-Probability Wave-Schrodinger Equation- time dependent-Heisenberg's uncertainty principle-Quantum Entanglement; Qubit: difference between the Qubit and Classical bit-quantum particles-types of Qubits; Making of Qubit : electron spin Qubit-Electron spin-intrinsic angular momentum-quantum spin angular momentum-magnetic dipole moment-spin under magnetic field-Stern Gerlach Experiment;Nuclei spin Qubit: binding energy per nucleon curve-intrinsic angular momentum of nuclei-nuclei spin under magnetic field;applications of Quantum computing

Module: 2: Semiconductor Quantum dots to Quantum Chips (7 Hours)

Quantum Chips: Band Theory of Solids; p and n type semiconductors; direct and indirect bandgap- Silicon-III-V semiconductors-GaAs-application-lab on a chip; Quantum Confinement: 1 D, 2 D and 0 D materials with emphasis on Quantum dot; de Broglie wavelength and Bohr-Exciton radius; Band gap of nanomaterials: Density of states; -Schrodinger Square well potential; preparation of core-shell quantum dots;Heterostructures and Quantum arrays

Module: 3: Physics of Display Technology (7 Hours)

CMOS technology: Definition- pn junction device-construction - working-forward and reverse biasing-Junction Field Effect Transistor- Construction and working-key advantages and disadvantages-MOSFET in Construction and working-key advantages; Integrated Circuits-preparation - photolithography; Quantum Transistors: Tunnel Field Effect Transistor- construction and working; introduction to Quantum transistor in Quantum Computing (QPU); introduction to Graphics Processing Unit (GPU); Quantum Display Technology: Quantum dot LED display design and working;

Module 4: Superconducting Quantum Bit & computer memory(7 Hours)

Superconductors: Introduction to use of superconductors in Quantum Computing-definition-copper pairs-Type I and II-applications; The SQUID - superconducting quantum interference device -superconducting qubit-basic building block of a quantum computer-Josephson Junction; Magnetic Materials: introduction-classification-dia,para and ferro- Hysteresis-role of Coercivity in magnetic data storage-working of a hard diskhard drive – construction and working; magnetic tape: construction and working-key advancements using sputtered tape; introduction to Heat assisted magnetic recording using tiny LASERS

Module 5: Physics of High Speed Data Transmission (7 Hours)

Fastest mode of data communication-light as the medium of data transmission-refractive index-Snell's Law; Optical Fibers: Introduction-Principle of optical fiber – Structure of optical fibers - Propagation of light in optical fiber-acceptance angle and Acceptance cone; Numerical Aperture derivation; Types of optical fibers: material-mode of propagation-refractive index profile; Data communication system-block

diagram-types of attenuation and drawbacks due to attenuation; Light sources for optical fiber: Introduction to LASER –properties of LASER-components of LASER-semiconductor LASER-construction and working;

Module 6: Physics for Internet of Things (IoT) (7 Hours)

Microbatteries for IoT: Introduction-to battery technology-types-Design and working of microbattery-possibilities for flexible batteries-advantages and disadvantages; Thin film making for microbatteries: construction and working of spray deposition unit-construction and working of pulsed laser deposition unit-Self powered sensors for IoT: introduction to Sensor-Definition and need of self powered sensors for IoT-design and working principle-advantages and shortcomings.

Text Books:

1. V. Rajendran – Engineering Physics, Tata McGraw –Hill Publishing company Ltd, 2008 Publication
2. M.N. Avadhanulu, P.G. Kshirshagar & [TVS Arun Murthy](#), A Text Book of Engineering Physics-S.ChandPublishing, 2018
3. M. Arumugam- Materials Science – Anuradha Publications, 1998
4. Quantum Mechanics ,G. Aruldas, PHI Learning Pvt. Ltd, 2008

Reference Books:

1. Motion Mountain: The Adventure of Physics Volume IV, Christoph Schiller, 2019 Edition
2. Charles P.Poole. “Introduction to Nanotechnology”, Wiley publications, 2007
3. Handbook of Semiconductor Manufacturing Technology, Yoshio Nishi, Robert Doering, CRC Press, Taylor and Francis, 2nd edition, 2017

20PH1008 APPLIED PHYSICS LAB FOR COMPUTER SCIENCE ANDENGINEERING

Credits 0:0:2:1

Course Objectives:

The course aims to

1. Provide knowledge on the fundamentals of semiconductors
2. explain the characteristics of electronic devices for applications in integrated circuit technology
3. Impart hands on training on the Lasers and Optical fibers.

Course Outcomes:

Students will be able to

1. Demonstrate the fundamentals of semiconducting materials
2. Analyzethe principle and operation of semiconductor devices
3. Study the principles and characteristics of diodes and transistors
4. Apply the concept of laser diffraction in determination of particle size
5. Evaluate the macro bending losses in fiber optic cables and systems
6. Apply and design various logic circuits in field of electronics.

List of experiments

1. Determination of Planck’s constant using LED’s.
2. Determination of Particle size using LASER diffraction method.
3. Evaluation of the attenuation and numerical aperture in fiber optics
4. Characteristics of Zener Diode- Forward and Reverse bias
5. Characteristics of PN diode - Forward and Reverse bias
6. Study the response of Halfwave and Fullwave rectifier using PN diode in circuits
7. Characteristics analysis of Junction field effect transistor (JFET)
8. Characteristics analysis of bipolar junction transistors (BJT)
9. Construction and verification of truth tables of logic gates (AND, OR, NOT)
10. Construction and verification of truth tables of logic gates (NAND, NOR, EX-OR)

20PH1009 APPLIED PHYSICS FOR ELECTRICAL AND COMPUTER ENGINEERING

Credits 3:0:0:3

Course Objectives:

1. To provide an understanding on electrical and dielectric characteristics of the materials used in engineering applications
2. To Emphasis on the recent advances of fluid dynamics and aerodynamics
3. To Impart knowledge on the thermal devices and energy systems.

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the fundamentals of electrical properties of materials.
2. Describe the dielectric properties of materials and its significance.
3. Differentiate the applications of fluid dynamics.
4. Distinguish the aerodynamic properties of specific electrical devices.
5. Evaluate various applications of thermoelectric materials and their mechanism.
6. Apply the physics principle in the fabrication of energy conversion devices.

Module: 1: ELECTRICAL PROPERTIES OF MATERIALS (8 Hours)

Classical free electron theory - Expression for electrical conductivity - Thermal conductivity, Wiedemann-Franz law - Electrons in metals - Particle in a three dimensional box - Degenerate states - Fermi- Dirac statistics - Density of energy states - Energy bands in solids - Tight binding approximation

Module: 2: DIELECTRICS PROPERTIES OF MATERIALS (8 Hours)

Electric field strength in dielectrics - Electric flux - dipole moment in dielectrics - dielectric constant - Temperature dependence of dielectric constant - Polarization and types of polarization - Classification of dielectric materials - Internal field of a solid dielectric material - Dielectric breakdown - Dielectric losses – Applications of dielectric materials.

Module: 3: Fluid Dynamics (8 Hours)

Fundamental terms. Fluids and their properties. Forces inside fluid. Fluid Statistics: Pascal's law. Euler's equation of fluid statics. Fluid Kinematics: Euler and Lagrangian specification of fluid flow. Streamlines. Pathlines. Stream surface. Stream tube. Mass/volume flow. Control volume. Fluid Dynamics: Continuity equation. Basic laws of fluid dynamics – conservation of mass, conservation of linear momentum, conservation of energy. Ideal fluid flow. Application of Bernoulli's equation.

Module: 4: AERODYNAMICS (7 Hours)

Basic aerodynamics, Aerofoils, wings and their nomenclature; lift, drag and pitching moment coefficients, centre of pressure and aerodynamic centre, NACA airfoil nomenclature.

Module: 5: THERMAL PHYSICS (7 Hours)

Transfer of heat energy – thermal expansion of solids and liquids – expansion joints – bimetallic strips – thermal conduction, convection and radiation – heat conduction in solids – thermal conductivity – Fourier's and Lee's disc method: theory and experiment – conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.

Module: 6: PHYSICS OF ENERGY DEVICES (7 Hours)

Energy sources: conversion and storage - Principle and working of a solar cell, Li-ion rechargeable Battery, Super capacitor, Fuel cells, thermoelectric devices – Electricity from hydro power - Fabrication and working of piezoMEMS energy harvesters.

Text Books

1. R K Shukla and Archana Singh, —Electrical Engineering Materials. McGraw Hill, 2012, ISBN: 978-1-25-90062-0
2. Gaur, R.K. & Gupta, S.L. —Engineering Physics. Dhanpat Rai Publishers, 2012.
3. Pandey, B.K. & Chaturvedi, S. —Engineering Physics. Cengage Learning India, 2012.
4. Frank Kreith and Yogi Goswami D, “Handbook of Energy Efficiency and Renewable Energy”, CRC Press, 2007.

Reference Books

1. S.O. KASAP, —Electronic Materials and Devices 3rd edition, McGraw Hill, 2014, ISBN-978-0-07-064820-3.
2. C.S.Indulkar and S. Thiruvengadam, S., —An Introduction to Electrical Engineering Materials, ISBN-9788121906661.
3. Kothari P, Singal K C and RakeshRanjan, “Renewable Energy Sources and Emerging Technologies”, PHI Pvt. Ltd., New Delhi, 2008.

20PH1010 APPLIED PHYSICS LAB FOR ELECTRICAL AND COMPUTER ENGINEERING

Credits 0:0:2:1

Course Objectives:

The course aims to

1. Attain knowledge on electrical and dielectric characteristics of the materials
2. Acquire knowledge on the magnetic properties of materials.
3. Impart knowledge on the working principle of energy devices.

Course Outcomes:

The student will be able to

1. Determine the electrical properties of a material.
2. Evaluate the dielectric properties of a material.
3. Analyse the magnetic properties of a given material.
4. Understand the conducting characteristic of a material.
5. Demonstrate the piezoelectric effect of a crystal.
6. Design the energy devices for electricity generation.

List of Experiments (Any 10 experiments)

1. To determine the specific resistance of a given wire using Carey Foster’s bridge
2. To measure resistivity on a thin slice-conducting bottom surface by four-probe method.
3. To determine the dielectric constant of a given solid material.
4. To study the charge and discharge of a capacitor.
5. To draw hysteresis curve of a given sample of ferromagnetic material and from - this to determine magnetic susceptibility and permeability of the given specimen.
6. To determine the mass susceptibility of a para-magnetic material by Quincke’s method
7. To determine the variation of magnetic field along the axis of a current carrying coil and then to estimate the radius of the coil
8. To determine the electrical conductivity of the material using Hall effect
9. Demonstration of piezoelectric effect by the electric charge generated by the bending of piezoelectric ceramic membrane
10. To design a piezoelectric generator to power LED.
11. Demonstration of energy conversion by photovoltaic cell and plot the V-I characteristics of a solar cell.
12. Demonstration of fabrication of rechargeable Li-ion battery.

20PH1011 PHYSICAL ELECTRONICS

Credits 2:0:0:2

Course Objectives:

The course aims

1. To acquire knowledge on the fundamentals of semiconductors
2. To explain the characteristics of semiconductors junctions and MOS structures
3. To understand about the acoustics and ultrasonics.

Course Outcomes:

Students will be able to

1. Remember the fundamentals of semiconducting physics

2. Understand the principle and operation of semiconductor junctions
3. Demonstrate the MOS structures.
4. Analyse the application of acoustics in construction and acoustic design.
5. Ability to explore the application of ultrasonics in various fields.
6. Understand about the renewable energy sources and devices.

Module: 1: Introduction to semiconductor Physics

(5 Hours)

Review of quantum mechanics, Electrons in periodic lattices, E-k diagrams, Quasiparticles in semiconductors, electrons, holes and phonons. Boltzmann transport equation and solution in the presence of low electric and magnetic fields - mobility and diffusivity; Carrier statistics; Continuity equation, Poisson's equation and their solution; High field effects: velocity saturation, hot carriers and avalanche breakdown.

Module 2: Semiconductor junctions

(5 Hours)

Schottky, homo- and hetero-junction band diagrams and I-V characteristics, and small signal switching models; two terminal and surface states devices based on semiconductor junctions.

Module 3: MOS structures

(5 Hours)

Semiconductor surfaces; The ideal and non ideal MOS capacitor band diagrams and CVs; Effects of oxide charges, defects and interface states; Characterization of MOS capacitors: HF and LF CVs, avalanche injection; High field effects and breakdown-Characterization of semiconductors: Four probe and Hall measurement; CVs for dopant profile characterization; Capacitance transients and DLTS.

Module 4 : Acoustics

(5 Hours)

Classification of sound – Characteristics of musical sound – Absorption Coefficient – Reverberation Time Sabine's Formula – Factors affecting the acoustics of a buildings and their remedies.

Module 5: Ultrasonics (5 Hours)

Production of ultrasonic waves; Magnetostriction and Piezoelectric Methods - Applications of Non-Destructive Testing (NDT) of materials – Flaw detection – Measurement of velocity in liquids.

Module 6: Green Energy Physics

(5 Hours)

Solar energy; Energy conversion by photovoltaic principle – Solar cells – Wind Energy; Basic components and principle of wind energy conversion systems – Ocean energy; Wave energy; Wave energy conversion devices

Text books

1. Shatendra Sharma, Engineering Physics, Pearson (2018)
2. Allen Mottershead, Electronic Devices and Circuits, Prentice Hall of India (2008)

References

1. Jacob Milliman ,Milliman's Electronic Devices and Circuits, 3rd edition, Tata McGraw-Hill (2010)
2. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).
3. J. P. McKelvey, introduction to Solid State and Semiconductor Physics, Harper and Row and John Weathe Hill, 1966.
4. E. H. Nicollian and J. R. Brews, MOS Physics and Technology, John Wiley, 1982.
5. K. K. Ng, Complete Guide to Semiconductor Devices, McGraw Hill, 1995.
6. D.K. Schroder, Semiconductor Material and Device Characterization, John Wiley, 1990.
7. C. T. Sah, Fundamentals of Solid-State Electronic Devices, Allied Publishers and World Scientific, 1991.
8. E. F. Y. Waug, Introduction to Solid State Electronics North Holland, 1980.

20PH1012 PHYSICAL ELECTRONICS LAB

Credits 0:0:2:1

Course Objectives:

The course aims

1. To acquire knowledge on the fundamentals of semiconductors

2. To explain the characteristics of electronic devices for applications in integrated circuit technology
3. To understand about the Lasers, acoustics and optical devices.

Course Outcomes:

Students will be able to

1. Remember the fundamentals of semiconducting materials
2. Understand the principle and operation of semiconductor devices
3. Demonstrate the application of optical devices in communications.
4. Analyse the application of acoustics in construction and acoustic design.
5. Ability to explore the application of solar cells and diodes.
6. Understand about the renewable energy sources and devices.

List of experiments

1. LED and Laser
2. Solar Cell
3. Resistivity by four probe method (virtual lab)
4. Attenuation and Numerical aperture measurement – Fibre Optics
5. Characteristics of Zener Diode- Forward and Reverse bias
6. Characteristics of PN diode
7. Halfwave and fullwave rectifier using PN diode
8. Characteristics of JFET
9. Characteristics of bipolar junction transistor
10. Verification of logic gates AND, OR, NOT
11. NAND and EX-OR gates
12. Hall effect experiment

20PH1013 APPLIED PHYSICS FOR MECHANICAL ENGINEERING

CREDITS 3:0:0:3

Course Objectives:

The course aims to Impart knowledge on

1. Lasers and Fiber Optics
2. Ultrasonics and Acoustics
3. Magnetic and Superconducting Materials.

Course Outcomes:

The student will be able to

1. Understand the concept of lasers and apply laser action in industries.
2. Explain and interpret the principle of fiber optics for different types of industrial sensors.
3. Apply the fundamentals of ultrasonics in non-destructive testing.
4. Discern the laws governing acoustics and implement the same in acoustic quieting.
5. Evaluate and perceive various laws governing magnetism with special reference to magnetic confinement for future power generation.
6. Create a novel method of transport by applying the basic principles of superconducting materials.

Module 1: Lasers and their Industrial Applications (8 Hours)

Introduction – Principle and Properties of Laser Action – Population Inversion – Einstein's Coefficients – Types of Lasers – Helium-Neon Laser – CO₂ Laser - Applications: Holography – Industrial Applications – Drilling – Welding – Cutting – Heat Treatment of Materials.

Module 2: Optical Fiber Sensors (8 Hours)

Introduction – Propagation of Light in Optical Fibers – Numerical Aperture and Acceptance Angle – Types of Optical Fibers – Applications: Industrial Applications – Live Monitoring of Industrial Processes – Fiber Optic Sensors – Temperature Sensor – Pressure Sensor –Displacement Sensors – Liquid Level Sensors – Chemical Sensors.

Module 3: Ultrasonics in Non-Destructive Testing (8 Hours)

Introduction – Properties of Ultrasonics – Production of Ultrasonic Waves – Magnetostriction Effect – Piezoelectric Effect – Piezoelectric Transducers – Applications: Industrial applications – NDT — Pulse Echo Method – Different Types of Scans – Ultrasonic Flaw Detector.

Module 4: Acoustical Design of Materials (7 Hours)

Introduction – Characteristics of Musical Sound – Intensity of Sound – Reverberation – Reverberation Time – Factors Affecting the Acoustics of a Building – Applications: Industrial Applications – Acoustic Quieting – Methods of Quieting – Quieting for Specific Observers – Mufflers – Automobile Industries.

Module 5: Magnetic Materials and Magnetic Confinement (7 Hours)

Introduction – Dia, Para, and Ferro Magnetic Materials – Properties – Hysteresis Curve – Hard and Soft Magnetic Materials – Applications: Industrial Applications – Ferrite Materials – Magnetic Confinement of Plasma for Nuclear Fusion Reactors.

Module 6: Superconductors and Hyperloop Technology (7 Hours)

Introduction – Superconductors – Properties of Superconducting Materials – Type I and Type II Superconductors – Applications: Industrial Applications – Superconducting Magnets – Electrical Applications – Computer Applications – Maglev – Hyperloop Technology.

Textbooks:-

1. Engineering Physics, D.K. Bhattacharya and Poonam Tandon, New Delhi: Oxford University Press (2017)
2. Engineering Physics, S.Mani Naidu, New Delhi: Pearson India Education Services Pvt. Ltd., (2014)

Reference Books:-

1. Engineering Physics, R.K. Gaur and S.L.Gupta, New Delhi: Dhanpat Rai Publications (P) Ltd. (2008)
2. Engineering Physics, Shatendra Sharma and Jyotsna Sharma, New Delhi: Pearson India Education Services Pvt. Ltd., (2019)
3. Engineering Physics, Dattu R. Joshi, New Delhi: Tata McGraw Hill Education Private Ltd., (2010)
4. A Textbook of Engineering Physics, M. N. Avadhanulu and P. G. Kshirsagar, New Delhi: S.Chand and Company Ltd., (2009)
5. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition
6. Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman, Pearson Education, New Delhi (2018), Fourteenth Edition.

20PH1014 APPLIED PHYSICS LAB FOR MECHANICAL ENGINEERING

Credits 0:0:2:1

Course Objectives:

The course aims to

1. Impart knowledge on lasers and fiber optics.
2. Give practical demonstration of wave phenomenon in acoustics and ultrasonics.
3. Provide knowledge on magnetism and superconducting phenomenon.

Course Outcomes:

The students will be able to

1. Demonstrate phenomena such as reflection, refraction, interference and diffraction in optics.
2. Apply total internal reflection principle to determine attenuation coefficient, numerical aperture and acceptance angle of optical fiber cables.
3. Calculate the velocity of ultrasonic waves in different liquids.
4. Determine the frequency of electrically maintained tuning fork by wave phenomenon.
5. Evaluate the properties of different magnetic materials.
6. Design innovative transportation modes by practical demonstration of superconducting levitation principle.

List of Experiments

1. Particle Size Measurement	– Laser Diffraction
2. Refractive index of a prism	– Spectrometer
3. Measurement of Thickness of a Glass Plate	– Single Optic Lever
4. Radius of Curvature of a Lens	– Newton's Rings
5. Radius of Curvature	– Plane Mirror Method
6. Optical Fiber Cable	– Attenuation Coefficient Measurement
7. Frequency of a Tuning Fork	– Melde's String
8. Rigidity Modulus of a Wire	– Torsional Pendulum
9. Young's Modulus of a Wooden Beam	– Non-Uniform Bending
10. Planck's Constant Measurement	– Light Emitting Diode
11. Velocity of Ultrasonic Waves	– Acoustic Grating
12. Determination of Velocity of Sound	– Interference of Two Coherent Sources
13. Magnetic Properties of Manganese Sulphate	– Guoy Balance Method
14. Magnetic Susceptibility of a Solution	– Quincke's Method
15. B-H Curve of an Iron Specimen	
16. Superconductivity of Yttrium Barium Copper Oxide	

[A total of ten experiments will be carried out in a semester based on the decision of the Head, Department of Applied Physics]

Textbooks:-

1. Practical Physics, P.R.S. Kumar, New Delhi: Prentice Hall India Learning Private Ltd., (2011)
2. B.Sc. Practical Physics, C.L. Arora, New Delhi: S. Chand & Company (2010)
3. Practical Physics, G.L. Squires, London: Cambridge University Press (2001)
4. B.Sc. Practical Physics, Harnam Singh and P.S. Hemne, New Delhi: S. Chand & Company (2014)

20PH1015 PHYSICS FOR ROBOTICS ENGINEERS

Credits: 3:0:0:3

Course Objectives:

1. To acquire knowledge on linear momentum and rigid body mechanics
2. To impart knowledge on the concept of stress, strain and elasticity
3. To provide an insight into the theory and applications of lasers and fiber optics.

Course Outcomes:

The student will be able to

1. Apply Newtonian Mechanics to solve problems.
2. Demonstrate the ability to solve the problems based on modulus of elasticity
3. Analyze rigid body mechanics using transformations
4. Apply the fundamentals laws concerning Oscillations.
5. Discuss about the concepts of lasers and its applications.
6. Relate the application of fibre optics in optic devices

Module: 1 Newtonian Mechanics: (8 Hours)

Momentum, Force, Newton's laws, applications- conservation of momentum, impulse, center of mass. Work and Energy: integration of the equation of motion – work energy theorem, applications – gradient operator – potential energy and force, - energy diagrams – law of conservation of energy.

Module 2: Elasticity and Elastic Constants (8 Hours)

Introduction – Stress and strain – Hooke's law – Three types of Elasticity – Rigidity modulus – Young's modulus – Bulk modulus – Relation connecting elastic constants – Poisson's Ratio – Torsional pendulum

Module 3: Rigid Body Mechanics (8 Hours)

Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum about a point of a rigid body in planar

motion; Euler's laws of motion, their independence from Newton's laws, and their necessity in describing rigid body motion; Examples.

Module 4: Oscillations (7 Hours)

Oscillatory Systems – Potential Energy Function and Restoring Force – Linear Harmonic Oscillations – Equation of Motion – Simple Pendulum – Physical Pendulum – Damped Harmonic Oscillations – Forced Vibrations – Chaos – Coupled Oscillations.

Module 5: Lasers (7 Hours)

Components of Laser – Principle of Laser Action – Properties of Laser – Spontaneous Emission and Stimulated Emission – Einstein's coefficients – Population inversion – Types of lasers – concepts of LIDAR Industrial applications of laser – Holography.

Module 6: Fiber optics (7 Hours)

Propagation of Light in Optical Fibers – Numerical Aperture and Acceptance Angle – Types of Optical Fibers – Splicing – Power Losses in Optical Fibers – Fiber Optic Communication Systems – Fiber Optic Sensors – Fibre endoscope.

Text Books

1. Introduction to Mechanics, R. K. Verma, Universities Press, 2019
2. Engineering Physics, D.K. Bhattacharya and Poonam Tandon, New Delhi: Oxford University Press, 2017
3. Engineering Physics, Shatendra Sharma and Jyotsna Sharma, New Delhi: Pearson India Education Services Pvt. Ltd., (2019)

Reference Books

1. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition
2. Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman, Pearson Education, New Delhi (2018), Fourteenth Edition.
3. Engineering Physics, R.K. Gaur and S.L. Gupta, New Delhi: Dhanpat Rai Publications (P) Ltd. (2008)

20PH1016 PHYSICS LABORATORY FOR ROBOTICS ENGINEERS

Credits: 0:0:2:1

Course Objectives:

The course aims to

1. To acquire knowledge about properties of matter and fiber optics.
2. To acquire knowledge on thermal and crystal physics.
3. To impart knowledge on quantum physics and wave equation

Course Outcomes:

The student will be able to

1. Demonstrate the basics of properties of matter and its applications.
2. Understand the advanced physics concepts of quantum theory and its application in microscope
3. Acquire knowledge on the concepts of waves and oscillations and its applications
4. Understand the basics of crystals their structures and different crystal growth techniques
5. Acquire adequate knowledge on the concepts of thermal properties of materials and their applications in expansion joints and heat exchangers
6. Relate the application of fiber optics in optical devices

List of experiments

1. Young's Modulus – Non-Uniform bending
2. Rigidity Modulus – Torsional Pendulum
3. Melde's string – Oscillations
4. Particle size determination – LASER diffraction

5. Refractive index of a prism – Spectrometer
6. Wavelength of Mercury spectrum – Diffraction grating – Spectrometer
7. Attenuation and Numerical aperture measurement – Fibre Optics
8. Radius of Curvature – Newton's rings
9. Thickness measurement – Single Optic Lever
10. Thermal conductivity of a bad conductor – Lee's Disc
11. Demonstration of SEM, AFM, DSC, DTA, XRD, UV-VIS spectrometer

20PH1017 APPLIED PHYSICS FOR BIOTECHNOLOGY ENGINEERING

Credits 2:0:2:3

Course Objectives:

Impart knowledge on

1. Lasers and Fiber Optics
2. Ultrasonics and Acoustics
3. Magnetic and Superconducting Materials.

Course Outcomes:

The student will be able to

1. Understand the concept of lasers and apply laser action in biotechnology related industries.
2. Explain and interpret the principle of fiber optics for biochemical processes monitoring and drug design.
3. Apply non-destructive testing techniques in activation of enzymes and various other processes in biotechnology industry.
4. Discern the laws governing acoustics and implement the same in synthetic biology and understand bioacoustics and plant acoustics.
5. Evaluate and perceive various laws governing magnetism with special reference to magnetic separation of heavy minerals and magnetic drug delivery.
6. Create novel industrial and medical imaging applications by applying the principles of superconducting materials.

Module 1: Applications of Lasers (5 Hours)

Introduction – Principle and Properties of Laser – Population Inversion – Einstein's Coefficients – Types of Lasers – Helium-Neon Laser – Bio Industry Applications: Manipulation and Detection of Living Cells – Gene Imaging.

Lab Experiment: Wavelength determination of Laser Source

Module 2: Optical Fiber Sensors(5 Hours)

Introduction – Propagation of Light in Optical Fibers – Numerical Aperture and Acceptance Angle – Types of Optical Fibers – Bio Industry Applications: Characterization of Biomolecules in Solution – Fabrication of Drugs and Proteins.

Lab Experiment: Determination of Fibre attenuation

Module 3: Ultrasonics in Bio-Industry (5 Hours)

Introduction – Properties of Ultrasonics – Production of Ultrasonic Waves – Magnetostriction Effect – Piezoelectric Effect – Piezoelectric Transducers – Bio Industry Applications: Synthesis of Bio-Materials – Activation of Enzymes – Modifying Cellular.

Lab Experiment: Ultrasonic frequency determination

Module 4: Acoustics in Biotechnology(5 Hours)

Introduction – Classification of Sound – Characteristics of Musical Sound – Intensity of Sound – Reverberation – Reverberation Time – Factors Affecting the Acoustics of a Building – Bio Industry Applications: Bioacoustics – Acoustic Droplet Ejection – Plant Acoustics.

Lab Experiment: Design of A hall with acoustic effect-simulation

Module 5: Magnetism and Medicine(5Hours)

Introduction –Origin of Magnetic Moment – Bohr Magneton – Dia, Para, and Ferro Magnetism – Hysteresis Curve –Soft and Hard Magnetic Materials –Bio Industry Applications: Magnetic Beads coated with Anti-Bodies – Magnetic Drug Delivery –Inactivation of Vegetative Cells.

Lab experiments: Magnetic nano fluids experiment

Module 6: Superconducting Magnets (5Hours)

Introduction –Principle of Superconductivity – Concept of Perfect Diamagnetism – Properties of Superconductors– Types of Superconductors – Bio Industry Applications: Magnetic Resonance Imaging – Magnetoencephalography – Magnetic Source Imaging.

Lab experiment: Superconducting experiment demonstration virtual lab

Textbooks:-

1. Engineering Physics, D.K. Bhattacharya and Poonam Tandon, New Delhi: Oxford University Press (2017)
2. Engineering Physics, S.Mani Naidu, New Delhi: Pearson India Education Services Pvt. Ltd., (2014)

Reference Books:-

1. Engineering Physics, R.K. Gaur and S.L.Gupta, New Delhi: Dhanpat Rai Publications (P) Ltd. (2008)
2. Engineering Physics, Shatendra Sharma and Jyotsna Sharma, New Delhi: Pearson India Education Services Pvt. Ltd., (2019)
3. Engineering Physics, Dattu R. Joshi, New Delhi: Tata McGraw Hill Education Private Ltd., (2010)
4. A Textbook of Engineering Physics, M. N. Avadhanulu and P. G. Kshirsagar, New Delhi: S.Chand and Company Ltd., (2009)
5. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition
6. Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman, Pearson Education, New Delhi (2018), Fourteenth Edition.

20PH1018 APPLIED PHYSICS FOR FOOD PROCESS OPERATIONS

Credits 2:0:0:2

Course Objectives:

Impart knowledge on

1. Lasers and Fiber Optics
2. Ultrasonics and Acoustics
3. Magnetic and Superconducting Materials.

Course Outcomes:

The student will be able to

1. Understand the concept of lasers and apply laser action in food processing industries.
2. Explain and interpret the principle of fiber optics for food quality and safety assessment.
3. Apply non-destructive testing techniques in agro-food products.
4. Discern the laws governing acoustics and implement the same in creating better environment for workers in food industries.
5. Evaluate and perceive various laws governing magnetism with special reference to magnetic separation of contaminants in food industries.
6. Create efficient industrial applications by applying the principles of superconducting materials.

Module 1: Food Industry Applications of Lasers (5 Hours)

Introduction – Principle and Properties of Laser –Population Inversion – Einstein's Coefficients –Types of Lasers –CO₂ Laser– Food Industry Applications: Laser Marking – Laser Packaging – Laser Cutting.

Module 2: Optical Fiber Sensors in Food Industry (5 Hours) Introduction – Propagation of Light in Optical Fibers – Numerical Aperture and Acceptance Angle – Types of Optical Fibers – Food Industry Applications: Food Quality Monitoring – Food Safety Assessment– Fiber Optic Bio-sensors.

Module 3: Non-Destructive Testing in Food Industry (5 Hours)

Introduction – Properties of Ultrasonics – Production of Ultrasonic Waves – Magnetostriction Effect – Piezoelectric Effect – Piezoelectric Transducers – Food Industry Applications: Non-Destructive Quality Assessment of Agro-Food Products.

Module 4: Acoustical Analysis in Food Industry (5 Hours)

Introduction – Classification of Sound – Characteristics of Musical Sound – Intensity of Sound – Reverberation – Reverberation Time –Factors Affecting the Acoustics of a Building – Food Industry Applications: Measurement of Crispness, Water Activity, Ripening and Firmness.

Module 5: Magnetic Separation in Food Industry (5 Hours)

Introduction –Origin of Magnetic Moment – Bohr Magneton – Dia, Para, and Ferro Magnetism –Hysteresis Curve –Soft and Hard Magnetic Materials –Food Industry Applications: Magnetic Separators – Prevention of Metal and Rare Earth Minerals Contamination.

Module 6: Superconducting Magnets (5Hours)

Introduction –Principle of Superconductivity – Concept of Perfect Diamagnetism – Properties of Superconductors– Types of Superconductors –Food Industry Applications: Superconducting Magnetic Separation – Industrial Processing – HTS Induction Heaters.

Textbooks:-

1. Engineering Physics, D.K. Bhattacharya and Poonam Tandon, New Delhi: Oxford University Press (2017)
2. Engineering Physics, S.Mani Naidu, New Delhi: Pearson India Education Services Pvt. Ltd., (2014)

Reference Books:-

1. Engineering Physics, R.K. Gaur and S.L.Gupta, New Delhi: Dhanpat Rai Publications (P) Ltd. (2008)
2. Engineering Physics, Shatendra Sharma and Jyotsna Sharma, New Delhi: Pearson India Education Services Pvt. Ltd., (2019)
3. Engineering Physics, Dattu R. Joshi, New Delhi: Tata McGraw Hill Education Private Ltd., (2010)
4. A Textbook of Engineering Physics, M. N. Avadhanulu and P. G. Kshirsagar, New Delhi: S.Chand and Company Ltd., (2009)
5. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition
6. Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman, Pearson Education, New Delhi (2018), Fourteenth Edition.

20PH1019 APPLIED PHYSICS FOR FOOD PROCESS OPERATIONS LAB

Credits 0:0:3:1.5

Course Objectives:

The course aims to

1. Impart knowledge on lasers and fiber optics.
2. Give practical demonstration of wave phenomenon in acoustics and ultrasonics.
3. Provide knowledge on magnetism and superconducting phenomenon.

Course Outcomes:

The students will be able to

1. Demonstrate phenomena such as reflection, refraction, interference and diffraction in optics.
2. Apply total internal reflection principle to determine attenuation coefficient, numerical aperture and acceptance angle of optical fiber cables.
3. Calculate the velocity of ultrasonic waves in different liquids.
4. Determine the frequency of electrically maintained tuning fork by wave phenomenon.

- Evaluate the properties of different magnetic materials.
- Design innovative transportation modes by practical demonstration of superconducting levitation principle.

LIST OF EXPERIMENTS

1. Particle Size Measurement	– Laser Diffraction
2. Refractive index of a prism	– Spectrometer
3. Measurement of Thickness of a Glass Plate	– Single Optic Lever
4. Radius of Curvature of a Lens	– Newton's Rings
5. Radius of Curvature	– Plane Mirror Method
6. Optical Fiber Cable	– Attenuation Coefficient Measurement
7. Frequency of a Tuning Fork	– Melde's String
8. Rigidity Modulus of a Wire	– Torsional Pendulum
9. Young's Modulus of a Wooden Beam	– Non-Uniform Bending
10. Planck's Constant Measurement	– Light Emitting Diode
11. Velocity of Ultrasonic Waves	– Acoustic Grating
12. Determination of Velocity of Sound	– Interference of Two Coherent Sources
13. Magnetic Properties of Manganese Sulphate	– Guoy Balance Method
14. Magnetic Susceptibility of a Solution	– Quincke's Method
15. B-H Curve of an Iron Specimen	
16. Superconductivity of Yttrium Barium Copper Oxide	

[A total of six experiments will be carried out in a semester based on the decision of the Head, Department of Applied Physics]

Textbooks:-

- Practical Physics, P.R.S. Kumar, New Delhi: Prentice Hall India Learning Private Ltd., (2011)
- B.Sc. Practical Physics, C.L. Arora, New Delhi: S. Chand & Company (2010)
- Practical Physics, G.L. Squires, London: Cambridge University Press (2001)
- B.Sc. Practical Physics, Harnam Singh and P.S. Hemne, New Delhi: S. Chand & Company (2014)

20PH1020	Application of Engineering Materials	L	T	P	C
		3	0	0	3

Course Objectives:s:

Impart knowledge on

- Structure, composition and behavior of metals.
- Material selection for high and low temperature applications.
- The principles of design, selection and processing of materials for various engineering applications.

Course Outcomes:

The student will be able to

- Apply the concepts of materials science for material selections towards new product development.
- Evaluate behavior of metal/alloys for engineering applications.
- Suggest the modern ceramic materials for engineering applications.
- Synthesize and develop the unique customized composites for aerospace applications.
- Demonstrate use of bearing, cutting and refractory metals for special engineering applications
- Develop the corrosion resistance materials for marine applications.

Module 1 ENGINEERING MATERIALS

7 Hours

Classification and properties of Materials, selection and Processing of engineering materials, Structure of atoms and Molecules – concept of atom – crystal structure – Co-ordination number – Bonds in solids – Classification of solids.

Module 2 METALS AND ALLOYS

8 Hours

Metallurgical Considerations, Ferrous Metals and alloys, Non-ferrous metals and alloys, Mechanical Properties - testing and Identification of metals and alloys. Deformation of metals – Deformation, Slip, Twinning, Imperfection in crystals, Yield point phenomenon. Strengthening of metals – strengthening of grain refinement, dispersion hardening, and heat treatment: Iron-carbon equilibrium diagram. Failure Analysis.

Module 3 MATERIALS FOR HIGH AND LOW TEMPERATURE APPLICATIONS 7 Hours

High and low temperature materials, Types and applications of Ceramics - Structure of Crystalline Ceramics, Glass ceramics, Refractories, Advanced ceramics, Ceramic phase diagram. Mechanical properties – Brittle fracture of ceramics, stress-strain behaviour, plastic deformation, and other properties.

Module 4 COMPOSITE MATERIALS FOR AEROSPACE APPLICATIONS 8 Hours

Composite materials in Aerospace, Types – particle reinforced composites, fiber reinforced composites, structural composites. Composites Manufacturing, Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Hybrid composites, Sandwich panel.

Module 5 MATERIALS FOR SPECIAL ENGINEERING APPLICATIONS 8 Hours

Tool and die materials, Bearing materials, Spring materials, Precious metals, Metals for nuclear energy, Refractory metals, Sound insulating materials, Thermal insulators.

Module 6 MATERIAL PROPERTIES FOR MARINE APPLICATIONS 7 Hours

Marine materials, Factors influencing corrosion, Chemical or dry corrosion, Electrode potential, Wet or electrochemical corrosion, Corrosion mechanism, various types of corrosion, corrosion in marine concrete, control and prevention of corrosion, Monitoring and measurement, Oxidation resistant materials.

Total Lectures 45 Hours

Text Books

1. William D. Callister and David G. Rethwisch, Callister's Materials Science and Engineering, Wiley, 2015
2. Er. R. K. Rajput, A text book of Materials Science & Engineering, S. K. Kataria & Sons, New Delhi, 2014.

Reference Books

1. V. Raghavan, Materials Science and Engineering, Prentice Hall of India (P) Ltd., New Delhi. 2004.
2. Kenneth G. Budinski, Michael K. Budinski, Engineering Materials: Properties and Selection, Prentice Hall, 2010.
3. G. E. Dieter, Mechanical Metallurgy, Mc-Graw Hill, 1987
4. Joshua Pelleg, Mechanical Properties of Materials, Springer Netherlands, 2013
5. Chawla, Krishan K. Composite Materials Science and Engineering, Springer-Verlag New York, 2012
6. Alan A. Baker and Murray L. Scott, Composite Materials for Aircraft Structures, Third Edition (AIAA Education) 3rd Edition, AIAA American Institute of Aeronautics & Ast.; 3rd edition (September 30, 2016)

DEPT. OF PHYSICS

LIST OF NEW COURSES

S.No.	Course Code	Name of the Course	Credits			
			L	T	P	C
1	19PH1001	Engineering Physics – Mechanics, Electromagnetic Waves and Optics	3	0	0	3
2	19PH1002	Engineering Physics – Mechanics, Electromagnetic Waves and Optics Lab	0	0	2	1
3	19PH1003	Engineering Physics	2	0	0	2
4	19PH1004	Engineering Physics – Lab	0	0	2	1
5	19PH1005	Engineering Physics – Basic Mechanics	3	0	0	3
6	19PH1006	Engineering Physics – Basic Mechanics Lab	0	0	2	1
7	19PH1007	Engineering Physics – Properties of Matter, Optics and Quantum Mechanics	3	0	0	3
8	19PH1008	Engineering Physics – Properties of Matter, Optics and Quantum Mechanics Lab	0	0	2	1
9	19PH1009	Engineering Physics - Electromagnetics, Optics and Properties of Matter	3	0	0	3
10	19PH1010	Engineering Physics - Electromagnetics, Optics and Properties of Matter	0	0	2	1
11	19PH1011	Engineering Physics – Lasers, Fiber Optics, Waves and Electromagnetics	3	0	0	3
12	19PH1012	Engineering Physics – Properties of Matter, Mechanics, Lasers and Fiber Optics	3	0	0	3
13	19PH1013	Engineering Physics- Properties of Matter, Mechanics, Lasers and Fiber Optics Laboratory	0	0	2	1

19PH1001 ENGINEERING PHYSICS – MECHANICS, ELECTROMAGNETIC WAVES AND OPTICS

Credits: 3:0:0:3

Course Objectives

The course aims to provide

1. To impart knowledge on the basics of the vector and scalar representation of forces and moments
2. To acquire knowledge on electricity and magnetism
3. To impart knowledge on the concept of optics and lasers

Course outcome

The student will be able to

1. Ability to differentiate statics and kinematics
2. Demonstrate the ability to solve the problems in Newton's laws
3. Appreciate to understand rotational kinetic energy & angular momentum
4. Acquire adequate knowledge on electrostatics and dielectrics
5. Apply the relative concepts of magnetism in various fields
6. Apply the concepts of optics and lasers in aerospace engineering

Module: 1: Vector Statics, and kinematics; (7 Hours)

Introduction to vectors – principles of statics, system of forces in plane and space, conditions of equilibrium – displacement, derivatives of a vector, velocity, acceleration – kinematic equations – motion in plane polar coordinates.

Module: 2: Newtonian Mechanics: (7 Hours) Momentum, Force, Newton's laws, applications- conservation of momentum, impulse, center of mass. Work and Energy: integration of the equation of

motion – work energy theorem, applications – gradient operator – potential energy and force, - energy diagrams – law of conservation of energy.

Module: 3: Rotation and Harmonic oscillator (8 Hours)

Angular momentum – torque on a single particle – moment of inertia – angular momentum of a rotating rigid body. Central force motion of two bodies – planetary motion and Kepler’s laws. One dimensional harmonic oscillator – damped and forced harmonic oscillators.

Module: 4: Electrostatics (8 Hours)

Electric flux – conservative vector fields and their potential functions – Gauss’ theorem, Stokes’ theorem – physical applications in electrostatics – electrostatic potential and field due to discrete and continuous charge distributions – energy density in an electric field – dielectric polarization – conductors and capacitors – electric displacement vector – dielectric susceptibility.

Module: 5: Magnetism (8 Hours)

Biot-Savart’s law and Ampere’s law in magneto statics – magnetic induction due to current carrying conductors – magnetic permeability and susceptibility – force on a charged particle in magnetic fields – Maxwell’s equations, displacement current.

Module: 6: Optics (7 Hours)

Nature of light, ray approximation in geometrical optics – reflection – refraction, Fermat’s principle – mirrors and lenses – interference – diffraction- lasers : absorption, spontaneous emission, He:Ne laser, Welding and cutting.

Text Books:

1. Kleppner D and Kolenkow, R.J. An Introduction to Mechanics, 2nd ed., Cambridge Univ. Press (2013)
2. Griffith, D.J., Introduction to Electrodynamics, 4th ed., Prentice Hall (2012).
3. Hecht, E., Optics, 4th Edition, Pearson Education (2008)

References:

1. Serway, R. A. and Jewett, J.W., Principles of Physics: A Calculus Based Text, 5th ed., Thomson Brooks/Cole (2012).
2. Halliday, D., Resnick, R., and Walker, J., Fundamentals of Physics, 9th ed., Wiley (2010).
3. Young, H.D., Freedman, R. A., Sundin, T. R., and Ford, A. L., Sears and Zemansky’s University Physics, 13th ed., Pearson Education (2011).
4. Feynman, R. P., Leighton, R. B., and Snads, M., The Feynman Lectures on Physics, Narosa (2005).
5. Reits, J.R., Milford, F.J., and Christy, R. W., Foundations of “Electromagnetics Theory, 3rd ed., Narosa (1998).

19PH1002 ENGINEERING PHYSICS – MECHANICS, ELECTROMAGNETIC WAVES AND OPTICS LAB

Credits 0:0:2:1

Course Objectives

The course aims to provide

1. To impart knowledge on the basics of the vector and scalar representation of forces and moments
2. To acquire knowledge on electricity and magnetism
3. To impart knowledge on the concept of optics and lasers

Course outcome

The student will be able to

1. Demonstrate the ability to solve the problems based on modulus of elasticity
2. Appreciate to generate collisions in one and two dimensional bodies
3. Demonstrate the ability to solve the mechanics problems associated with friction forces.
4. Appreciate to understand rotational kinetic energy & angular momentum. Apply these concepts to problems involving rigid body rotation and equilibrium based applications

5. Solve practical problems through evaluating the relationship between stress and strain
6. Apply the concepts in solving the problems involving oscillation and resonance

List of experiments

1. Young's Modulus – Uniform bending
2. Young's Modulus –Non-Uniform bending
3. Young's Modulus - Cantilever
4. Moment of Inertia of different bodies - Torsional pendulum
5. Rigidity Modulus – Torsional Pendulum
6. Determination of frequency of tuning fork - Melde's string
7. Acceleration due to gravity – Compound pendulum
8. Coefficient of viscosity – Poiseuille's method
9. Thickness measurement - Single optic lever
10. Particle size measurement – Laser diffraction method
11. Charge of an electron – Millikan's oil drop method
12. Refractive index of a prism-Spectrometer
13. Radius of curvature – Newton's rings method

19PH1003 ENGINEERING PHYSICS

Credits 2:0:0:2

Course Objectives

The course aims

1. To acquire knowledge on the fundamentals of semiconductors
2. To explain the characteristics of electronic devices for applications in integrated circuit technology
3. To understand about the Lasers, acoustics and optical fibers

Course outcome

Students will be able to

1. Remember the fundamentals of semiconducting materials
2. Understand the principle and operation of semiconductor devices
3. Demonstrate the application of fibre optics in communication devices
4. Analyse the application of acoustics in construction and acoustic design
5. Ability to explore the application of ultrasonics in various fields
6. Understand about the renewable energy sources and devices

Module: 1: Fundamentals of Semiconductors (5 Hours)

Crystalline and amorphous solids – band theory of solids – classification of solids based on band theory – types of semiconductors - p-n junction diode LED - Zener diode, tunnel diode.

Module 2: Transistors (5 Hours)

Bipolar junction transistor (BJT), basic construction of JFET, characteristic curves of the JFET, principles of operation of the JFET, depletion MOSFET, enhancement MOSFET, difference between JFET and MOSFET.

Module 3: Fiber optics (5 Hours)

Principle of optical fiber – Structure of optical fibres - Propagation of light in optical fiber –acceptance angle and Acceptance cone- Numerical Aperture, Types of optical fibers –material-mode of propagation-refractive index profile

Module 4 : Acoustics (5 Hours)

Classification of sound – Characteristics of musical sound – Absorption Coefficient - Reverberation Time Sabine's Formula – Factors affecting the acoustics of a buildings and their remedies.

Module 5: Ultrasonics (5 Hours)

Production of ultrasonic waves; Magnetostriction and Piezoelectric Methods - Applications: Non-Destructive Testing (NDT) of materials – Flaw detection – Measurement of velocity in liquids.

Module 6: Green Energy Physics (5 Hours)

Solar energy; Energy conversion by photovoltaic principle – Solar cells – Wind Energy; Basic components and principle of wind energy conversion systems – Ocean energy; Wave energy; Wave energy conversion devices.

Text books

1. Shatendra Sharma, Engineering Physics, Pearson (2018)
2. Allen Mottershead, Electronic Devices and Circuits, Prentice Hall of India (2008)

References

1. Jacob Milliman, Milliman's Electronic Devices and Circuits, 3rd edition, Tata McGraw-Hill (2010)
2. S. Salivahanan, N.Suresh Kumar, Electronic Devices and Circuits, Tata McGraw-Hill (1998)
3. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).

19PH1004 ENGINEERING PHYSICS LAB

Credits 0:0:2:1

Course Objectives

The course aims

1. To acquire knowledge on the fundamentals of semiconductors
2. To explain the characteristics of electronic devices for applications in integrated circuit technology
3. To understand about the Lasers, acoustics and optical fibers

Course outcome

Students will be able to

1. Remember the fundamentals of semiconducting materials
2. Understand the principle and operation of semiconductor devices
3. Demonstrate the application of fibre optics in communications.
4. Analyse the application of acoustics in construction and acoustic design
5. Ability to explore the application of ultrasonics in various fields
6. Understand about the renewable energy sources and devices

List of experiments

1. Planck's constant – LED
2. Particle size determination – LASER diffraction method
3. Attenuation and Numerical aperture measurement – Fibre Optics
4. Characteristics of Zener Diode- Forward and Reverse bias characteristics
5. Characteristics of PN diode
6. Halfwave and fullwave rectifier using PN diode
7. Characteristics of JFET
8. Characteristics of bipolar junction transistor
9. Verification of truth tables of logic gates AND, OR, NOT
10. Verification of truth tables of logic gates NAND and EX-OR gates

19PH1005 ENGINEERING PHYSICS – BASIC MECHANICS

Credits 3:0:0:3

Course Objectives

The course aims to provide

1. To impart knowledge on the basics of the vector and scalar representation of forces and moments
2. To acquire knowledge on linear momentum and rotation of particles
3. To impart knowledge on the concept of stress strain and elasticity

Course outcome

The student will be able to

1. Demonstrate the ability to solve the problems in Newton's laws
2. Appreciate to understand rotational kinetic energy and angular momentum
3. Apply these concepts to problems involving rigid body rotation
4. Solve practical problems through evaluating the relationship between stress and strain
5. Evaluate the moment of inertia of various sections
6. Demonstrate the concepts of bending of beams

Module: 1: Vector mechanics (8 Hours)

Vectors and Scalars – Newton's First Law – Force – Inertial Reference Frame – Mass – Newton's Second Law – Forces in Equilibrium – External Forces – Some Particular Forces – Gravitational Force – Weight – Normal Force – Newton's Third Law – Friction – Types of Friction – Properties of Friction – The Drag Force and Terminal Speed – Uniform Circular Motion

Module: 2: Rotation and Linear Momentum (8 Hours)

Center of Mass – Newton's Second Law for a System of Particles – Linear Momentum – Collision and Impulse – Conservation of Linear Momentum – Momentum and Kinetic Energy in Collisions – Collisions in One and Two Dimensions – Rotational Variables – Rotation with Constant Angular Acceleration – Relating the Linear and Angular Variables – Kinetic Energy of Rotation

Module: 3: Angular Momentum (7 Hours)

Rolling as Translation and Rotation Combined – Forces and Kinetic Energy of Rolling – Angular Momentum – Newton's Second Law in Angular Form – Angular Momentum of a Rigid Body – Conservation of Angular Momentum - Equilibrium – Requirements of Equilibrium – The Center of Gravity – Some Examples of Static Equilibrium

Module 4: Elasticity and Elastic Constants (7 Hours)

Introduction – Stress and strain – Hooke's law – Three types of Elasticity – Rigidity modulus – Young's modulus – Bulk modulus – Relation connecting elastic constants – Poisson's Ratio – Torsional pendulum

Module: 5: Moment of Inertia (8 Hours)

Moment of Inertia :Moment of Inertia and its physical significance – Expression for moment of inertia – Radius of Gyration – Torque – General theorems on moment of inertia – Calculation of the moment of inertia of a body and its Modules.

Module 6: Bending of Beams (7 Hours)

Bending of beams – Expression for bending moment – Uniform bending – Determination of Young's modulus by Uniform and Non Uniform bending using pin and microscope – Cantilever – Expression for depression at loaded end of cantilever.

Text Books:

1. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition
2. D. S. Mathur, Elements of properties of matter, 2008, S.Chand and Co. New Delhi

Reference Books:

1. Physics for scientists and engineers, Randall D. Knight 3rdEdn, 2016, Pearson
2. An Introduction to the Mechanics of Solids, 2nd ed. with SI Module:s — SH Crandall, NCDahl & TJ Lardner

19PH1006 ENGINEERING PHYSICS – BASIC MECHANICS LAB

Credits 0:0:2:1

Course Objectives

The course aims to provide

1. To impart knowledge on the basics of the vector and scalar representation of forces and moments
2. To acquire knowledge on linear momentum, friction and rotation of particles
3. To impart knowledge on the concept of stress strain and elasticity

Course outcome

The student will be able to

1. Demonstrate the ability to solve the problems based on modulus of elasticity
2. Appreciate to generate collisions in one and two dimensional bodies
3. Demonstrate the ability to solve the mechanics problems associated with friction forces
4. Appreciate rotational kinetic energy & angular momentum
5. Solve practical problems through evaluating the relationship between stress and strain
6. Apply the concepts in solving the problems involving oscillation and resonance

List of experiments

1. Young's Modulus – Uniform bending
2. Young's Modulus –Non-Uniform bending
3. Young's Modulus - Cantilever
4. Moment of Inertia of different bodies - Torsional pendulum
5. Rigidity Modulus – Torsional Pendulum
6. Determination of frequency of tuning fork - Melde's string
7. Compound pendulum
8. Coefficient of viscosity – Poiseuille's method
9. Single optic lever – Thickness measurement
10. Particle size measurement – Laser diffraction method

19PH1007 - ENGINEERING PHYSICS - PROPERTIES OF MATTER, OPTICS AND QUANTUM MECHANICS

Credits 3:0:0:3

Course Objectives

The course aims to

1. To acquire knowledge about properties of matter and fiber optics
2. To acquire knowledge on thermal and crystal physics
3. To impart knowledge on quantum physics and wave equation

Course outcome

The student will be able to

1. Demonstrate the basics of properties of matter and its applications
2. Understand the advanced physics concepts of quantum theory and its application in microscope
3. Acquire knowledge on the concepts of waves and oscillations and its applications
4. Understand the basics of crystals their structures and different crystal growth techniques
5. Acquire adequate knowledge on the concepts of thermal properties of materials and their applications in expansion joints and heat exchangers
6. Relate the application of fiber optics in optical devices

Module 1: Properties of Matter (7 Hours)

Elasticity-Stress-strain diagram and its uses-factors affecting elastic modulus and tensile strength – torsional stress and deformations- torsion pendulum: theory and experiment- bending of beams- bending moment-cantilever: theory and experiment-uniform bending: theory and experiment- I form girders

Module 2: Quantum Physics (7 hours)

Black body radiation-Planck's theory – wave particle duality – experimental verification of matter waves: Davisson Germer experiment – wave function and its physical significance- Schrodinger's wave equation: time independent wave equation- Application: particle in one dimensional potential well-scanning electron microscope

Module 3: Waves and oscillations (7 hours)

Oscillatory Systems- Simple harmonic oscillators-Equation of motion of linear harmonic-Simple pendulum-damped harmonic oscillator – heavy, critical and light damping, Transverse wave, wave equation on a stretched string, Harmonic waves, reflection and transmission of waves at a boundary, standing waves, longitudinal waves and the wave equation, wave groups and group velocity

Module 4: Crystal Physics (8 hours)

Amorphous and crystalline materials: unit cell, crystal systems, Bravais lattices, Miller indices – interplanar distances – coordination number and packing factor for SC, BCC and FCC – crystal imperfection: point defects, line defects – growth of single crystals: Czochralski's technique

Module 5: Thermal Physics (8 hours)

Transfer of heat energy-thermal expansion of solids and liquids- expansion joints-bimetallic strips thermal conduction, convection and radiation- heat conduction in solids – thermal conductivity- Forbe's and Lee's disc method-conduction through compound media (series and parallel) – thermal insulation-applications: heat exchangers-solar water heaters

Module 6: Lasers and fiber optics (8 hours)

Lasers: Population of energy levels, Einstein's coefficient- resonant cavity, optical amplification (qualitative) – semiconductor lasers: homojunction and heterojunction-fiber optics: principle, numerical aperture and acceptance angle- types of optical fibers-fiber optic losses-fiber optic sensors: pressure and displacement.

Text Books

1. Engineering Physics, D.K. Bhattacharya and Poonam Tandon, New Delhi: Oxford University Press (2017)
2. Engineering Physics, R.K. Gaur and S.L.Gupta, New Delhi: Dhanpat Rai Publications (P) Ltd. (2008)

Reference Books

1. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition
2. Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman, Pearson Education, New Delhi (2018), Fourteenth Edition.

19PH1008 - ENGINEERING PHYSICS - PROPERTIES OF MATTER, OPTICS AND QUANTUM MECHANICS LAB

Credits 0:0:2:1

Course Objectives

The course aims to

1. To acquire knowledge about properties of matter and fiber optics
2. To acquire knowledge on thermal and crystal physics
3. To impart knowledge on quantum physics and wave equation

Course outcome

The student will be able to

1. Demonstrate the basics of properties of matter and its applications
2. Understand the advanced physics concepts of quantum theory and its application in microscope
3. Acquire knowledge on the concepts of waves and oscillations and its applications
4. Understand the basics of crystals their structures and different crystal growth techniques

5. Acquire adequate knowledge on the concepts of thermal properties of materials and their applications in expansion joints and heat exchangers
6. Relate the application of fiber optics in optical devices

List of experiments

1. Young's Modulus –Non-Uniform bending
2. Rigidity Modulus – Torsional Pendulum
3. Melde's string – Oscillations
4. Particle size determination – LASER diffraction
5. Refractive index of a prism – Spectrometer
6. Wavelength of Mercury spectrum – Diffraction grating – Spectrometer
7. Attenuation and Numerical aperture measurement – Fibre Optics
8. Radius of Curvature – Newton's rings
9. Thickness measurement – Single Optic Lever
10. Thermal conductivity of a bad conductor – Lee's Disc

19PH1009 ENGINEERING PHYSICS – ELECTROMAGNETICS, OPTICS AND PROPERTIES OF MATTER

Credits 3:0:0:3

Course Objectives

Impart knowledge on

1. Lasers and Fiber Optics
2. Oscillations and waves
3. Electromagnetic Theory and Dielectrics

Course Outcome

The student will be able to

1. Understand the basics of Lasers
2. Explain and interpret the concepts of Optical Fiber Cables
3. Apply the fundamentals laws concerning Oscillations
4. Discern the laws governing Wave Motion.
5. Evaluate and perceive the various laws governing Dielectric Materials
6. Understand the basic principles Electromagnetic Theory

Module 1: Lasers (7 Hours)

Components of laser – Principle of laser action – Properties of laser – Spontaneous emission and stimulated emission – Einstein's coefficients – Population inversion – Types of lasers – He-Ne laser –Nd-YAG laser – CO₂ laser – Semiconductor Laser – Industrial applications of laser – Holography.

Module 2: Fiber optics (7 Hours)

Propagation of light in optical fibers – Numerical aperture and acceptance angle – Types of optical fibers – Double crucible technique of fiber drawing – Splicing – Power losses in optical fibers – Fiber optic communication systems – Fiber Optic Sensors – Fibre endoscope.

Module 3: Oscillations (7 Hours)

Oscillatory systems – Potential energy Function and restoring force – Linear harmonic oscillations – Equation of motion – Simple pendulum – Physical pendulum – Damped harmonic oscillations – Forced vibrations – Chaos – Coupled oscillations.

Module 4: Waves (8 Hours)

Waves – Wave equation – Longitudinal and transverse waves – Standing waves – Formation of beats – String motion – Waves in pipes – Closed pipes and open pipes – Reflection and transmission at boundary – Both ends of strings fixed and one end of string fixed.

Module 5: Dielectric Properties of Materials (8 Hours)

Electric dipole – Dipole moment – Dielectric constant – Polarizability – Electric displacement vector – Different polarizations in dielectrics – Frequency and temperature dependence of polarization –

Polarizability and internal field – Clausius-Mossotti equation – Solid dielectrics – Dielectric losses – Dielectric breakdown.

Module 6: Electromagnetic Field Theory (8 Hours)

Vector calculus – Gradient, divergence and curl – Gauss divergence theorem – Stoke's theorem – Maxwell's electromagnetic wave equations – Ampere's circuital law – Displacement current – Electromagnetic energy Density – Intensity of electromagnetic waves – Poynting vector – Plane waves in dielectric medium and conducting medium.

Text Books

1. Engineering Physics, D.K. Bhattacharya and Poonam Tandon, New Delhi: Oxford University Press (2017)
2. Engineering Physics, Shatendra Sharma and Jyotsna Sharma, New Delhi: Pearson India Education Services Pvt. Ltd., (2019)

Reference Books

1. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition
2. Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman, Pearson Education, New Delhi (2018), Fourteenth Edition.
3. Engineering Physics, R.K. Gaur and S.L. Gupta, New Delhi: Dhanpat Rai Publications (P) Ltd. (2008)

19PH1010 - ENGINEERING PHYSICS - ELECTROMAGNETICS, OPTICS AND PROPERTIES OF MATTER LAB

Credits 0:0:2:1

Course objectives

Impart knowledge on

1. Electrostatics, magnetostatics and electromagnetism
2. Fundamentals of optics
3. Oscillations and waves

Course outcome

The student will be able to

1. Apply the basics of electromagnetism, optics and vibrations
2. Explain and interpret the concepts of electromagnetism, optics and vibrations
3. Apply the fundamentals of various laws concerning electricity and magnetism, principles of optics, oscillations and waves
4. Analyze, classify and compare the laws of electromagnetism, optics and vibrations
5. Enabled to evaluate and perceive the various laws governing electricity and magnetism, various optical phenomena and vibrations
6. Create products with innovations in the fields of electricity and magnetism, optics, oscillations and waves

List of experiments

1. Young's Modulus – Uniform bending
2. Young's Modulus – Non-Uniform bending
3. Young's Modulus - Cantilever
4. Rigidity Modulus – Torsional Pendulum
5. Melde's string – Oscillations
6. Particle size determination – LASER diffraction
7. Refractive index of a prism – Spectrometer
8. Wavelength of mercury spectrum – Diffraction grating – Spectrometer
9. Attenuation and numerical aperture measurement – Fibre Optics

10. Radius of curvature – Newton's rings
11. Thickness measurement – Single Optic Lever
12. Thickness of wire – Air Wedge
13. Demonstration of SEM, AFM, DSC, DTA, XRD, UV-VIS spectrometer

19PH1011 ENGINEERING PHYSICS –LASERS, FIBREOPTICS, WAVES AND ELECTROMAGNETICS

Credits 3:0:0:3

Course Objectives

Enable the student to

4. Impart knowledge on Lasers and Fibre Optics
5. Identify the significance of Oscillations and waves
6. Understand the modern practices related to Electromagnetic Theory and piezoelectrics

Course Outcome

The student will be able to

7. Understand the basics of Lasers
8. Explain and interpret the concepts of Optical Fiber Cables
9. Apply the fundamentals laws concerning Oscillations
10. Discern the laws governing Wave Motion
11. Evaluate and perceive the various concepts in piezoelectric Materials
12. Understand the basic principles Electromagnetic Theory

Module 1: Lasers (7 Hours)

Components of Laser – Principle of Laser Action – Properties of Laser – Spontaneous Emission and Stimulated Emission – Einstein's coefficients – Population inversion – Types of lasers – He-Ne laser –Nd-YAG laser – CO₂ laser – Semiconductor Laser – Industrial applications of laser – Holography.

Module 2: Fiber optics (7 Hours)

Propagation of Light in Optical Fibers – Numerical Aperture and Acceptance Angle – Types of Optical Fibers – Double Crucible Technique of Fiber Drawing – Splicing – Power Losses in Optical Fibers – Fiber Optic Communication Systems – Fiber Optic Sensors – Fibre endoscope.

Module 3: Oscillations (7 Hours)

Oscillatory Systems – Potential Energy Function and Restoring Force – Linear Harmonic Oscillations – Equation of Motion – Simple Pendulum – Physical Pendulum – Damped Harmonic Oscillations – Forced Vibrations – Chaos – Coupled Oscillations.

Module 4: Waves (8 Hours)

Waves – Wave Equation – Longitudinal and Transverse Waves – Standing Waves – Formation of Beats – String Motion – Waves in Pipes – Closed Pipes and Open Pipes – Reflection and Transmission at Boundary – Both Ends of Strings Fixed and One End of String Fixed.

Module 5: Piezoelectricity(8 Hours)

Piezoelectric property- Materials: crystals, ceramics, silicon- Synthesis- Inverse piezoelectricity- Medical applications.

Module 6: Electromagnetic Field Theory (8 Hours)

Vector Calculus – Gradient, Divergence and Curl – Gauss Divergence Theorem – Stoke's Theorem – Maxwell's Electromagnetic Wave Equations – Ampere's Circuital Law – Displacement Current – Electromagnetic Energy Density – Intensity of Electromagnetic Waves – Poynting Vector – Plane Waves in Dielectric Medium and Conducting Medium.

Text Books

1. Engineering Physics, D.K. Bhattacharya and Poonam Tandon, New Delhi: Oxford University Press (2017)

2. Engineering Physics, Shatendra Sharma and Jyotsna Sharma, New Delhi: Pearson India Education Services Pvt. Ltd., (2019)

Reference Books

1. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition
2. Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman, Pearson Education, New Delhi (2018), Fourteenth Edition.
3. Engineering Physics, R.K. Gaur and S.L.Gupta, New Delhi: Dhanpat Rai Publications (P) Ltd. (2008)

19PH1012 ENGINEERING PHYSICS – PROPERTIES OF MATTER, MECHANICS, LASERS AND FIBER OPTICS

Credits 3:0:0:3

Course Objectives

The course aims

1. To acquire knowledge on linear momentum and rotation of particles
2. To impart knowledge on the concept of stress strain and elasticity
3. To provide an insight into the theory and applications of lasers and fiber optics

Course outcome

The student will be able to

1. Demonstrate the basics of properties of matter and its applications
2. Apply Newtonian mechanics to solve problems
3. Demonstrate the ability to solve the problems based on modulus of elasticity
4. Apply the fundamentals laws concerning oscillations
5. Relate the application of fiber optics in optic devices
6. Discuss about the concepts of lasers and its applications

Module 1: Properties of Matter (8 Hours)

Elasticity-Stress-strain diagram and its uses-factors affecting elastic modulus and tensile strength – torsional stress and deformations- torsion pendulum: theory and experiment- bending of beams- bending moment-cantilever: theory and experiment-uniform bending: theory and experiment- I form girders

Module: 2: Newtonian Mechanics: (8 Hours)

Momentum, force, Newton's laws, applications- conservation of momentum, impulse, center of mass. work and Energy: integration of the equation of motion – work energy theorem, applications – gradient operator – potential energy and force - energy diagrams – law of conservation of energy.

Module 3: Elasticity and Elastic Constants (8 Hours)

Introduction – Stress and strain – Hooke's law – Three types of elasticity – Rigidity modulus – Young's modulus – Bulk modulus – Relation connecting elastic constants – Poisson's Ratio – Torsional pendulum

Module 4: Oscillations (7 Hours)

Oscillatory systems – Potential energy function and restoring force – Linear harmonic oscillations – Equation of motion – Simple pendulum – Physical pendulum – Damped harmonic oscillations – Forced vibrations – Chaos – Coupled oscillations.

Module 5: Lasers (7 Hours)

Components of laser – Principle of laser action – Properties of laser – Spontaneous emission and stimulated emission – Einstein's coefficients – Population inversion – Types of lasers – He-Ne laser –Nd-YAG laser – CO₂ laser – Semiconductor laser – Industrial applications of laser – Holography.

Module 6: Fiber optics (7 Hours)

Propagation of light in optical fibers – Numerical aperture and acceptance angle – Types of optical fibers – Double crucible technique of fiber drawing – Splicing – Power losses in optical fibers – Fiber optic communication systems – Fiber optic sensors – Fibre endoscope.

Text Books

1. Engineering Physics, D.K. Bhattacharya and Poonam Tandon, New Delhi: Oxford University Press (2017)
2. Engineering Physics, Shatendra Sharma and Jyotsna Sharma, New Delhi: Pearson India Education Services Pvt. Ltd., (2019)

Reference Books

1. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition
2. Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman, Pearson Education, New Delhi (2018), Fourteenth Edition.
3. Engineering Physics, R.K. Gaur and S.L.Gupta, New Delhi: Dhanpat Rai Publications (P) Ltd. (2008)

19PH1013 ENGINEERING PHYSICS- PROPERTIES OF MATTER, MECHANICS, LASERS AND FIBRE OPTICS LABORATORY

Credits: 0:0:2:1

Course objectives

The course aims

1. To acquire knowledge about properties of matter and fiber optics
2. To acquire knowledge on thermal and crystal physics
3. To impart knowledge on quantum physics and wave equation

Course outcome

The student will be able to

1. Demonstrate the basics of properties of matter and its applications
2. Understand the advanced physics concepts of quantum theory and its application in microscope
3. Acquire knowledge on the concepts of waves and oscillations and its applications
4. Understand the basics of crystals their structures and different crystal growth techniques
5. Acquire adequate knowledge on the concepts of thermal properties of materials and their applications in expansion joints and heat exchangers
6. Relate the application of fiber optics in optical devices

List of experiments

1. Young's Modulus –Non-Uniform bending
2. Rigidity Modulus – Torsional Pendulum
3. Melde's string – Oscillations
4. Particle size determination – LASER diffraction
5. Refractive index of a prism – Spectrometer
6. Wavelength of Mercury spectrum – Diffraction grating – Spectrometer
7. Attenuation and Numerical aperture measurement – Fibre Optics
8. Radius of Curvature – Newton's rings
9. Thickness measurement – Single Optic Lever
10. Thermal conductivity of a bad conductor – Lee's Disc
11. Demonstration of SEM, AFM, DSC, DTA, XRD, UV-VIS spectrometer

PHYSICS

LIST OF COURSES

S.No	Course Code	Name of the Course	Credits
1	17PH3034	Molecular Quantum Mechanics	3:0:0
2	18PH1001	Engineering Physics - Electromagnetism, Optics and Properties of Matter	3:1:0
3	18PH1002	Engineering Physics - Electromagnetism, Optics and Properties of Matter Lab	0:0:1.5
4	18PH1003	Engineering Physics - Semiconductors and Optics	3:1:0
5	18PH1004	Engineering Physics - Semiconductors and Optics Lab	0:0:1.5
6	18PH1005	Engineering Physics - Semiconductors, Optics and Quantum Mechanics	3:1:0
7	18PH1006	Engineering Physics - Semiconductors, Optics and Quantum Mechanics Lab	0:0:1.5
8	18PH1007	Engineering Physics - Mechanics	3:1:0
9	18PH1008	Engineering Physics - Mechanics Lab	0:0:1.5
10	18PH1009	Applied Physics and Properties of Matter	3:1:0
11	18PH1010	Applied Physics and Properties of Matter Lab	0:0:1.5

17PH3034 MOLECULAR QUANTUM MECHANICS

Credit: 3:0:0

Course Objectives:

1. Provide an in depth knowledge on the theory and practice of quantum computation.
2. Ability to understand and apply the principles of quantum mechanics to molecular systems.
3. To provide good knowledge on the basic theories of chemical bonds, intermolecular interaction and how they control the behavior of matter.

Course Outcome:

Students will be able to

1. Gain an understanding on how molecular phenomena can be related to model problems.
2. Know the connection between common approximation methods (Born-Oppenheimer approximation, molecular orbitals) and standard chemical frameworks (diatomic molecules).
3. Understand the electronic structure of many electron molecules and chemical bonding using various theorems and treatments.
4. Understand the ab initio method applied for polyatomic molecules to calculate the geometry and thermodynamic properties.
5. Apply the density functional theory in order to understand the behavior and properties of the chemical systems.
6. Able to perform simple quantum-chemical calculations applying density functional theory to study various reactivity parameters.

Unit I - Many-Electron Atoms: The Hartree-Fock self consistent field method - Electron correlation - The atomic Hamiltonian- The Condon-Slater rules - The Born-Oppenheimer approximation - Nuclear motion in diatomic molecules - The Hydrogen molecule ion - Approximate treatments of H_2^+ ground electronic state - Molecular orbitals for H_2^+ excited states - Molecular orbital configurations of homonuclear diatomic molecules - Electronic terms of diatomic molecules

Unit II - Many electron molecules: The hydrogen molecule – The valence bond treatment of H_2 – Comparison of the MO and VB theorems – MO and VB wave functions for homonuclear diatomic molecules – Electron probability density – The Hartree-Fock method for molecules – SCF wave functions for diatomic molecules – MO treatment of heteronuclear diatomic molecules – Variational principle for

the ground state - The viral theorem – The Viral theorem and chemical bonding – The Hellmann-Feynman theorem – The electrostatic theorem

Unit III - Ab initio method for polyatomic molecules: Ab initio methods and semi-empirical methods – The SCF MO treatment of polyatomic molecules – Rayleigh-Schrödinger many body perturbation theory - Basis functions – Population analysis – Dipole moment – Molecular geometry – Calculation of Vibrational frequencies and thermodynamic properties – Molecular conformations and barrier to rotation and inversion thermochemical stabilities of molecules

Unit IV - Density Functional Theory: Electron density - The original idea: The Thomas-Fermi model – The traditional Thomas Fermi and Thomas-Fermi-Dirac models – Three theorems in Thomas Fermi theory - Thomas-Fermi-Dirac-Weizsacker model – The Hohenberg-Kohn theorems – Kohn-Sham equations – Derivation of Kohn-Sham equations – Kinetic energy functional – Local density approximation (LDA) – Density gradient and kinetic energy density corrections – Adiabatic connection methods

Unit V - Density functional theory and Reactivity parameters: The chemical potential in the grand canonical ensemble at zero temperature – Physical meaning of the chemical potential – The chemical potential for a pure state and in the canonical ensemble – Change from one ground state to another – Electronegativity and electronegativity equalization – Hardness and softness – Reactivity index: Fukui function – Local softness, local hardness and softness and hardness kernels – Atoms in molecules – HSAB principle – Maximum hardness principle and its proof - Modeling the chemical bond: the bond-charge model

Books for study

1. Ira. N. Levine , Quantum Chemistry, Vth Edition; Prentice-Hall of India, New Delhi, 2000
2. W. J. Hehre, L. Radom, P. V. R. Schleyer and J. A. Pople, Ab initio molecular orbital theory , John Wiley & Sons, New York, 1985.
3. Christopher J. Cramer, Essential of Computational Chemistry - Theories and Models, IInd Edition, John Wiley & Sons, England, 2004.
4. Attila Szabo and Neil S. Ostlund , Modern quantum chemistry – Introduction to advanced electronic structure theory, Dover publications INC, New York, 1996.
5. R. G. Parr and W. Yang, Density functional theory of atoms and molecules, Oxford University press, New York, 1989.
6. P. K. Chattaraj, Chemical reactivity theory: A density functional view, RC press, 2008.

18PH1001	ENGINEERING PHYSICS - ELECTROMAGNETISM, OPTICS AND PROPERTIES OF MATTER	L	T	P	C
		3	1	0	4

Course objectives

Impart knowledge on

1. Dielectrics, electromagnetism and electromagnetic waves
2. Viscosity and surface tension and optics
3. Oscillations and waves and basic knowledge on analytical instruments

Course outcome

The student will be able to

1. Understand the basics of dielectrics, electromagnetics and superconductors
2. Explain and interpret the concepts of electromagnetic waves
3. Apply the fundamentals laws concerning viscosity and surface tension
4. Analyze, classify and compare the laws of optics with regards to reflection, refraction, interference, diffraction and polarization
5. Evaluate and perceive the various laws governing oscillations and waves
6. Create products with innovations in the fields of analytical instruments.

Module 1: Dielectrics, electromagnetics and superconductors (7 Hours)

Electric Dipoles – dielectric polarization - Types of polarization – Total Internal field - Clausius Mosotti equation - The Hall Effect – Magnetic Field of a Moving Charge – Magnetic Field of a Current Element – Magnetic Field of a Straight Current Carrying Conductor – Force between Parallel Conductors – Eddy Currents – Displacement Current – Superconductivity – High Temperature superconductors – MAGLEV.

Module 2: Electromagnetic Waves (7 Hours)

Maxwell's Equations and Electromagnetic Waves –The Electromagnetic Spectrum – Plane Electromagnetic Waves and the Speed of Light – Properties of Electromagnetic Waves – Derivation of the Electromagnetic Wave Equation – Energy and Momentum in Electromagnetic Waves – Waves in a conducting or dissipative medium

Module 3: Viscosity and Surface Tension (8 Hours)

Flow of liquids - Rate of flow of liquid – Lines and Tubes of flow – Energy of the liquid – Reynold's number - Bernoulli's theorem and its important applications – Viscosity – Co-efficient of viscosity – Critical velocity – Poiseuille's equation for flow of liquid – Stoke's method – Applications of Pascal's law in Hydraulics - Surface Tension - Definition and dimensions of surface tension - Rise of liquid in capillary tube – Experimental determination of surface tension

Module 4: Optics (8 Hours)

The Nature of Light – Reflection and Refraction – Total Internal Reflection – Dispersion – Polarization – Scattering of Light – Huygens's Principle – Reflection and Refraction at a Plane and Spherical Surfaces – Interference – Coherent Sources – Two Source Interference of Light – Intensity in Interference Patterns – Michelson Interferometer - Fresnel and Fraunhofer Diffraction – Diffraction from a Single Slit – Intensity in the Single Slit Pattern – Multiple Slits – The Diffraction Grating. Study of materials, thickness measurements, surface roughness.

Module 5: Oscillations and Waves (8 Hours)

Oscillations – Simple Harmonic Motion – Energy in a Simple Harmonic Motion – Applications – The Simple Pendulum – The Physical Pendulum – Harmonic oscillator; Damped harmonic motion – over-damped, critically damped and lightly-damped oscillators; Forced oscillations and resonance. Types of Mechanical Waves – Periodic Waves – Mathematical Description of a Wave – Speed of a Transverse Wave – Energy in Wave Motion – Wave Interference, Boundary Conditions and Superposition – Standing Waves on a String – Normal Modes of a String

Module 6: Introduction to analytical instruments (7 Hours)

Dual nature of matter - de-Broglie wave - Basic principles of Atomic Force Microscope - Scanning Electron Microscope - Transmission Electron microscope, X-ray diffraction, Absorption and Fluorescence spectrometers - Differential Scanning Calorimetry – Differential Thermal Analysis - applications

Text Books

1. Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman, Pearson Education, New Delhi (2018), Fourteenth Edition.
2. Elements of Properties of Matter by Mathur D.S., Shyamlal Charitable Trust, New Delhi, 2008

Reference Book

1. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition

18PH1002	ENGINEERING PHYSICS - ELECTROMAGNETISM, OPTICS AND PROPERTIES OF MATTER LAB	L 0	T 0	P 3	C 1.5

Course objectives

Impart knowledge on

1. Electrostatics, magnetostatics and electromagnetism
2. Fundamentals of optics

3. Oscillations and waves

Course outcome

The student will be able to

1. Apply the basics of electromagnetism, optics and vibrations
2. Explain and interpret the concepts of electromagnetism, optics and vibrations
3. Apply the fundamentals of various laws concerning electricity and magnetism, principles of optics, oscillations and waves
4. Analyze, classify and compare the laws of electromagnetism, optics and vibrations
5. Enabled to evaluate and perceive the various laws governing electricity and magnetism, various optical phenomena and vibrations
6. Create products with innovations in the fields of electricity and magnetism, optics, oscillations and waves

List of experiments

1. Young's Modulus – Uniform bending
2. Young's Modulus –Non-Uniform bending
3. Young's Modulus - Cantilever
4. Rigidity Modulus – Torsional Pendulum
5. Melde's string – Oscillations
6. Particle size determination – LASER diffraction
7. Refractive index of a prism – Spectrometer
8. Wavelength of mercury spectrum – Diffraction grating – Spectrometer
9. Attenuation and numerical aperture measurement – Fibre Optics
10. Radius of curvature – Newton's rings
11. Thickness measurement – Single Optic Lever
12. Thickness of wire – Air Wedge
13. Demonstration of SEM, AFM, DSC, DTA, XRD, UV-VIS spectrometer

18PH1003	ENGINEERING PHYSICS – SEMICONDUCTORS AND OPTICS	L	T	P	C
		3	1	0	4

Course Objectives

The course aims

1. To provide knowledge on the fundamentals of semiconductors
2. To explain the characteristics of operational amplifier for the application of integrated circuit technology
3. To provide information about the Lasers and optical fibers.

Course outcome

Students will be able to

1. Remember the fundamentals of semiconducting materials, op-amp optics, lasers and optical fibers.
2. Understand the principle on which semiconductor devices operate, differences in their characteristics, fabrication process and to understand the principle of optics laser and optical fiber.
3. Demonstrate the application of semiconductors in various electronic devices. To draw the differences in structure and performance of different types of lasers and optical fibers.
4. Analyse the application of Integrated circuit lasers and fibre optics in the various field of engineering.
5. Ability to explore the application of Lasers in various fields.
6. Design devices and circuits based on FET, MOSFET transistors.

Module: 1: Fundamentals of Semiconductors (9 Hours)

Crystalline and amorphous solids – band theory of solids – classification of solids based on band theory – types of semiconductors – Fermi distribution function - p-n junction diode – p-n junction biasing – LED - Zener diode - zener diode specifications, tunnel diode, applications of tunnel diode.

Module:2: Operational amplifier and Semiconductor devices fabrication (10 hours)

Ideal operational amplifier, operational amplifier stages and parameters, equivalent circuit of operational amplifier, open-loop op-amp configuration: open loop differential amplifier, inverting differential amplifier, evolution of integrated circuit, methods of fabricating integrated circuits: monolithic integrated circuit and hybrid integrated circuit, large-scale integration (LSI).

Module:3: Logic gates and Transistors (9 Hours)

Basic logic gates : AND gate, OR gate and NOT gate, De-Morgans's law, Transistors: bipolar junction transistor, basic construction of JFET, characteristic curves of the JFET, principles of operation of the JFET, depletion MOSFET, enhancement MOSFET, difference between JFET and MOSFET.

Module 4: Optics (8 Hours) The Nature of Light – Reflection and Refraction – Total Internal Reflection – Dispersion – Polarization – Scattering of Light – Huygens's Principle – Reflection and Refraction at a Plane and Spherical Surfaces – Interference –and Coherent Sources – Two Source Interference of Light – Intensity in Interference Patterns – Michelson Interferometer - Fresnel and Fraunhofer Diffraction – Diffraction from a Single Slit – Intensity in the Single Slit Pattern – Multiple Slits – The Diffraction Grating. Study of materials, thickness measurements, surface roughness.

Module 5: LASERS (9 Hours)

Spontaneous and stimulated emission, relation between Einstein's A and B coefficients, population inversion, pumping, main components of a laser, characteristics of laser beam, types of laser: Nd-YAG laser, He-Ne Laser, carbon dioxide laser, semiconductor laser, applications of laser: Holography.

Module 6: Fiber optics (9 Hours)

Introduction – Propagation of light in optical fiber – Total internal reflection – Principle of optical fiber – Fractional Refractive index - Numerical aperture and acceptance angle – Types of optical fibers based on materials, modes of propagation and refractive index profile – Power losses in optical fibers – Fiber optic communication system – Fiber optic sensors – Temperature and Displacement.

Text books

1. Shatendra Sharma, Engineering Physics, Pearson (2018)
2. Allen Mottershead, Electronic Devices and Circuits, Prentice Hall of India (2008)

References

1. Jacob Milliman ,Milliman's Electronic Devices and Circuits, 3rd edition, Tata McGraw-Hill (2010)
2. S. Salivahanan, N.Suresh Kumar, Electronic Devices and Circuits, Tata McGraw-Hill (1998)
3. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).

18PH1004	ENGINEERING PHYSICS - SEMICONDUCTORS AND OPTICS LAB	L T P C 0 0 3 1.5

Course objectives

Impart knowledge on

1. Semiconductors and diodes
2. Operational amplifiers Transistor and logic gates
3. Lasers and optical fiber cables

Course outcome

The student will be able to

1. Apply the basics of semiconductors, Lasers and Optical fibers
2. Explain and interpret the concepts of diodes, transistors, operational amplifier and logic gates

3. Apply the concepts behind the PN diode to study the types of rectifier.
4. Analyse the size of the particle using diffraction phenomena of Laser
5. Evaluate and understand the characteristics of transistors and diodes.
6. Create and verify the characteristics of operational amplifier and different logic gates.

List of experiments

1. Planck's constant – LED
2. Particle size determination – LASER diffraction
3. Attenuation and Numerical aperture measurement – Fibre Optics
4. Characteristics of Zener Diode- Forward and Reverse bias
5. Characteristics of PN diode
6. Halfwave and fullwave rectifier using PN diode
7. Characteristics of JFET
8. Characteristics of bipolar junction transistor
9. Verification of truth tables of logic gates AND, OR, NOT
10. Verification of truth tables of logic gates NAND and EX-OR gates
11. Verification of operational amplifier – Adder and Subtractor
12. Radius of curvature of a convex lens – Newton's Rings.

18PH1005	ENGINEERING PHYSICS-SEMICONDUCTORS,OPTICS AND QUANTUM MECHANICS	L 3	T 1	P 0	C 4

Course Objectives

The course aims

1. To impart knowledge on the basics of materials and its applications in different areas
2. To gain knowledge of fundamentals of semiconductors and its processes and to acquire the basic skills involved in oscillatory systems and waves
3. To impart knowledge on the principles of optics, sensors and to understand the importance of quantum mechanics principles

Course outcome

The student will be able to

1. Demonstrate the ability to solve the problems in various magnetic materials.
2. Identify and employ the principles involved in semiconductors for electronic applications
3. Demonstrate the principles of oscillations and waves and apply the concepts in device applications
4. Illustrate the basics of waves and to appraise the concepts in various fields
5. Identify the solution of optical principles and to practice it for various measurements
6. Ability to employ sensors and its concepts in device applications

Module 1: Materials (8 Hours)

Types of electronic materials: metals, semiconductors, and insulators, Dia, Para, Ferro magnetic materials properties, Temperature effects - Hysteresis curve, Hard and soft magnetic engineering materials - Applications: Magnetic recording and reading – Hard disc. Superconductors: Properties of superconducting materials - Type I and Type II superconductors-Applications: Maglev.

Module 2: Semiconductors and IC Fabrication (8 Hours)

Density of states, Occupation probability, Fermi level, Fermi function, Effective mass, Intrinsic and extrinsic semiconductors, Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction. Hall Effect - Silicon wafer based Integrated circuit fabrication process: oxidation, diffusion, ion implantation, Photolithography, etching

Module 3: Oscillations and Waves (8 Hours)

Oscillatory Systems, Simple harmonic oscillators, Equation of motion of linear harmonic, Simple pendulum, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped

harmonic oscillator, quality factor, Transverse wave, wave equation on a stretched string, Harmonic waves, reflection and transmission of waves at a boundary, standing waves, longitudinal waves and the wave equation, wave groups and group velocity.

Module 4: Optics (8 Hours)

Huygens' principle, Superposition of waves and interference of light by wave front splitting, Young's double slit experiment, Newton's rings, Michelson interferometer, Diffraction grating and their resolving power. Polarisation and its types, Polarisation by reflection and scattering, Malus law, Birefringence, Nicol Prism – Construction, principle and applications, Production of elliptical and circularly polarised light, Quarter and Half – wave plates, optical activity

Module 5: Sensors (6 Hours)

Magnetic sensors – Hall effect sensor, Acoustic sensors-surface acoustic wave sensor, Mechanical sensors – Chemical sensors - Fibre optic sensors - micro displacement, pressure and temperature sensors, Semiconductor sensors - gas sensors.

Module 6: Quantum Mechanics (6 Hours)

Wave nature of Particles, Debroglie waves, Time-independent Schrodinger wave equation, Uncertainty principle. Solution of stationary-state Schrodinger equation for one dimensional problems–particle in a box, Scanning Electron Microscope, Transmission Electron Microscope.

Text Books:

1. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition
2. D. K. Bhattacharya, Poonam Tandon, Engineering Physics – Oxford University Press

Reference Books:

1. Engineering Physics, H K Malik, A K Singh, Mc Graw Hill 2ndEdn, 2018
2. Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman, Pearson Education, New Delhi (2018), Fourteenth Edition.
3. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).

18PH1006	ENGINEERING PHYSICS - SEMICONDUCTORS, OPTICS AND QUANTUM MECHANICS LAB	L T P C 0 0 3 1.5

Course objectives

Impart knowledge on

1. Electrostatics, magnetostatics and electromagnetism
2. Fundamentals of optics
3. Oscillations and waves

Course outcome

The student will be able to

1. Apply the basics of electromagnetism, optics and vibrations
2. Explain and interpret the concepts of electromagnetism, optics and vibrations
3. Apply the fundamentals of various laws concerning electricity and magnetism, principles of optics, oscillations and waves
4. Analyze, classify and compare the laws of electromagnetism, optics and vibrations
5. Evaluate and perceive the various laws governing electricity and magnetism, various optical phenomena and vibrations.
6. Create products in the fields of electricity and magnetism, optics, oscillations and waves.

List of experiments

1. Melde's string – Oscillations
2. Planck's constant – LED
3. Particle size determination – LASER diffraction

4. Refractive index of a prism – Spectrometer
5. Wavelength of Mercury spectrum – Diffraction grating – Spectrometer
6. Attenuation and Numerical aperture measurement – Fibre Optics
7. Radius of Curvature – Newton's rings
8. Thickness of wire – Air Wedge
9. Hall Effect – p-type and n-type
10. Hysteresis Curve
11. Polarizer and Analyser
12. Demonstration of SEM, AFM, XRD

18PH1007	ENGINEERING PHYSICS-MECHANICS	L	T	P	C
		3	1	0	4

Course Objectives

The course aims to provide

1. To impart knowledge on the basics of the vector and scalar representation of forces and moments
2. To acquire knowledge on linear momentum and rotation of particles
3. To impart knowledge on the concept of stress strain and elasticity

Course outcome

The student will be able to

1. Demonstrate the ability to solve the problems in Newton's laws.
2. Appreciate to generate collisions in one and two dimensional bodies
3. Demonstrate the ability to solve the mechanics problems associated with friction forces.
4. Appreciate to understand rotational kinetic energy & angular momentum. Apply these concepts to problems involving rigid body rotation.
5. Solve practical problems through evaluating the relationship between stress and strain
6. Demonstrate the basic analytical instruments

Module: 1: Vector mechanics (8 Hours)

Vectors and Scalars – Newton's First Law – Force – Inertial Reference Frame – Mass – Newton's Second Law – Forces in Equilibrium – External Forces – Some Particular Forces – Gravitational Force – Weight – Normal Force – Newton's Third Law – Friction – Types of Friction – Properties of Friction – The Drag Force and Terminal Speed – Uniform Circular Motion

Module: 2: Rotation and Linear Momentum (10 Hours)

Center of Mass – Newton's Second Law for a System of Particles – Linear Momentum – Collision and Impulse – Conservation of Linear Momentum – Momentum and Kinetic Energy in Collisions – Collisions in One and Two Dimensions – Rotational Variables – Rotation with Constant Angular Acceleration – Relating the Linear and Angular Variables – Kinetic Energy of Rotation – Calculating the Rotational Inertia – Torque – Newton's Second Law for Rotation – Work and Rotational Kinetic Energy

Module: 3: Angular Momentum (7 Hours)

Rolling as Translation and Rotation Combined – Forces and Kinetic Energy of Rolling – Angular Momentum – Newton's Second Law in Angular Form – Angular Momentum of a Rigid Body – Conservation of Angular Momentum - Equilibrium – Requirements of Equilibrium – The Center of Gravity – Some Examples of Static Equilibrium

Module 4: Mechanics of Solids (9 Hours)

Introduction – Stress and strain – Hooke's law – Three types of Elasticity – Rigidity modulus – Young's modulus – Bulk modulus – Relation connecting elastic constants – Poisson's Ratio – Torsional pendulum – Moment of Inertia :Moment of Inertia and its physical significance – Expression for moment of inertia – Radius of Gyration – Torque – General theorems on moment of inertia – Calculation of the moment of inertia of a body and its Modules. Photoelasticity

Module: 5: Bending of Beams (7 Hours)

Bending of beams – Expression for bending moment – Uniform bending – Determination of Young's modulus by Uniform and Non Uniform bending using pin and microscope – Cantilever – Expression for depression at loaded end of cantilever.

Module 6: Introduction to analytical instruments (7 Hours)

Dual nature of matter - de-Broglie wave - Basic principles of Atomic Force Microscope - Scanning Electron Microscope - Transmission Electron microscope, X-ray diffraction, Absorption and Fluorescence spectrometers - Differential Scanning Calorimetry – Differential Thermal Analysis - applications

Text Books:

1. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition
2. D. S. Mathur, Elements of properties of matter, 2008, S.Chand and Co. New Delhi

Reference Books:

1. Physics for scientists and engineers, Randall D. Knight 3rdEdn, 2016, Pearson
2. An Introduction to the Mechanics of Solids, 2nd ed. with SI Module:s — SH Crandall, NCDahl & TJ Lardner

18PH1008	ENGINEERING PHYSICS-MECHANICS LAB	L	T	P	C
		0	0	3	1.5

Course Objectives

The course aims to provide

1. To impart knowledge on the basics of the vector and scalar representation of forces and moments
2. To acquire knowledge on linear momentum, friction and rotation of particles
3. To impart knowledge on the concept of stress strain and elasticity

Course outcome

The student will be able to

1. Demonstrate the ability to solve the problems based on modulus of elasticity
2. Appreciate to generate collisions in one and two dimensional bodies
3. Demonstrate the ability to solve the mechanics problems associated with friction forces.
4. Appreciate to understand rotational kinetic energy & angular momentum. Apply these concepts to problems involving rigid body rotation and equilibrium based applications
5. Solve practical problems through evaluating the relationship between stress and strain
6. Apply the concepts in solving the problems involving oscillation and resonance

List of experiments

1. Young's Modulus – Uniform bending
2. Young's Modulus –Non-Uniform bending
3. Young's Modulus - Cantilever
4. Moment of Inertia of different bodies - Torsional pendulum
5. Rigidity Modulus – Torsional Pendulum
6. Melde's string – Oscillations
7. Resonance of vibrations
8. Determination of direction and magnitude of resultant force
9. Equilibrium based experiment
10. Friction based experiment
11. Photoelasticity
12. Single optic lever – Thickness measurement
13. Demonstration of SEM, AFM, XRD

18PH1009	APPLIED PHYSICS AND PROPERTIES OF MATTER	L	T	P	C
		3	1	0	4

Course objectives

The course aims

1. To impart knowledge on the components and production of laser and fibre optics
2. To acquire knowledge of fundamentals of properties of matter
3. To impart knowledge on acoustics and ultrasonics

Course outcome

The student will be able to

1. To impart knowledge on the fundamentals of various lasers and its application in Fibre optics.
2. To understand the principle of fibre optics and lasers
3. Apply the relationship between properties of matter and the thermal physics.
4. To impart knowledge on the basic concepts of quantum mechanics and its application
5. To impart knowledge on principles of acoustics and application of ultrasonic waves
6. Design devices based on ultrasonic generators

Module 1: Lasers and Fiber optics (8 Hours)

Introduction – Components of laser – Principle of laser action – Properties of laser – Spontaneous emission and stimulated emission – Einstein's coefficients – Population inversion – Types of lasers – He-Ne laser – Nd-YAG laser – Semiconductor laser – Industrial applications of laser – Medical applications of laser – Holography

Module 2: Fiber optics (8 Hours)

Introduction – Propagation of light in optical fiber – Total internal reflection – Principle of optical fiber – Fractional Refractive index - Numerical aperture and acceptance angle – Types of optical fibers based on materials, modes of propagation and refractive index profile – Power losses in optical fibers – Fiber optic communication system – Fiber optic sensors – Temperature and Displacement – Fibre endoscope

Module 3: Properties of Matter and Thermal Physics (7 Hours)

Elasticity – Hooke's law – Stress-Strain diagram – Factors affecting elasticity – Bending moment – Depression of a cantilever – Young's Modulus by uniform bending – I shaped girders - Biomaterials applications

Thermal expansion – Thermal stress – Thermal conductivity – Heat conduction in solids – Flow of heat through compound media – Forbe's and Lee's disc method: Theory and Experiment - thermal properties of biomaterials.

Module 4 : Quantum physics and applications (8 Hours)

Introduction – Photoelectric effect – Einstein's photoelectric equation – De-Broglie wave equation – Experimental study of matterwave – Davisson and Germer Experiment – G. P. Thomson Experiment – Heisenberg's Uncertainty Principle – Physical significance of Wave function – Schrödinger time Independent and dependent wave equation – Stationary or quantum states and bound states of particles – Particle in an one dimensional box. Scanning electron microscope, TEM

Module 5 : Acoustics (8 Hours)

Introduction – Classification of sound – Characteristics of musical sound – Pitch – Loudness – Quality – Intensity of sound – Weber Fechner Law – Reverberation – Reverberation Time – Sabine's Formula – Factors affecting the acoustics of a building – Absorption Coefficient – Measurement of Absorption coefficient – Acoustic quieting – Methods of quieting . Acoustic properties of biomaterials

Module 6: Ultrasonics (10 Hours)

Introduction – Production of ultrasonic waves – Magnetostriction Effect – Magnetostriction generator – Piezoelectric Effect – Properties of ultrasonics – Cavitation – Detection of ultrasonics – Piezoelectric detectors – Kundt's tube method – Sensitive flame method – Thermal detector method – Acoustic grating – Velocity measurement – Applications of ultrasonics – Industrial applications – SONAR – NDT — Pulse Echo method – A scan, B scan, C scan - Medical Applications ,

Text Books:

1. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition
2. D. K. Bhattacharya, Poonam Tandon, Engineering Physics – Oxford University Press

Reference Books

1. Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman, Pearson Education, New Delhi (2018), Fourteenth Edition
2. Physics for scientists and engineers, Randall D. Knight 3rd Edn, 2016, Pearson

18PH1010	APPLIED PHYSICS AND PROPERTIES OF MATTER LAB	L	T	P	C
		0	0	3	1.5

Course Objectives

The course aims

1. To impart knowledge on the components and production of laser and fibre optics
2. To acquire knowledge of fundamentals of properties of matter and light.
3. To impart knowledge on acoustics and ultrasonics

Course outcome:

The student will be to

1. Demonstrate the ability to solve the problems based on modulus of elasticity
2. To impart knowledge on the working principle of various lasers and its application in fibre optics.
3. Apply the relationship between properties of matter and optics.
4. To solve problems based on the basic concepts of diffraction of sound and light
5. To appreciate the principles of acoustics and application of ultrasonic waves
6. Design devices based on ultrasonic generators

List of experiments

1. Young's Modulus – Uniform bending
2. Young's Modulus –Non-Uniform bending
3. Melde's string – Oscillations
4. Planck's constant – LED
5. Particle size determination – LASER diffraction
6. Wavelength of Mercury spectrum – Diffraction grating – Spectrometer
7. Attenuation and Numerical aperture measurement – Fibre Optics
8. Radius of Curvature – Newton's rings
9. Ultrasonic interferometer
10. Pulse echo method – A, B scan
11. Acoustic parameters of biomaterials

LIST OF COURSES

S.No	Course Code	Name of the Course	Credits
1	17PH1001	Applied Physics	3:0:0
2	17PH1002	Applied Physics Lab	0:0:2
3	17PH1003	Physics for Agricultural Engineers	3:0:1
4	17PH2001	Mechanics and properties of matter	3:0:0
5	17PH2002	Semiconductor Physics-I	3:0:0
6	17PH2003	Heat and Thermodynamics	3:0:0
7	17PH2004	Semiconductor Physics-II	3:0:0
8	17PH2005	Semiconductor Physics Lab-I	0:0:2
9	17PH2006	Semiconductor Physics Lab-II	0:0:2
10	17PH2007	Semiconductor logic devices	3:0:0
11	17PH2008	Spectroscopy	3:0:0
12	17PH2009	Physics of semiconductor memories and microprocessors	3:0:0
13	17PH2010	Physics of linear integrated circuits and VLSI design	3:0:0
14	17PH2011	Photonics	3:0:0
15	17PH2012	Vacuum and thin film technology	3:0:0
16	17PH2013	Condensed matter physics	3:0:0
17	17PH2014	Properties of matter lab	0:0:2
18	17PH2015	Electricity and Magnetism	3:0:0
19	17PH3001	Classical Mechanics	3:0:0
20	17PH3002	Statistical Mechanics and Thermodynamics	3:0:0
21	17PH3003	Mathematical Physics I	3:1:0
22	17PH3004	Semiconductor Physics	3:0:0
23	17PH3005	Quantum Mechanics-I	3:0:0
24	17PH3006	Physical Optics	3:0:0
25	17PH3007	Mathematical Physics-II	3:1:0
26	17PH3008	Atomic and Molecular Spectroscopy	3:0:0
27	17PH3009	Electromagnetic Theory	3:0:0
28	17PH3010	Quantum Mechanics-II	3:0:0
29	17PH3011	Nuclear and Particle Physics	3:0:0
30	17PH3012	Spectroscopy	3:0:0
31	17PH3013	Solid State Physics	3:0:0
32	17PH3014	Physics of Nanomaterials	3:0:0
33	17PH3015	Photonics	3:0:0
34	17PH3016	Thin Film Technology	3:0:0
35	17PH3017	Renewable energy sources	3:0:0
36	17PH3018	Radiation Treatment and Planning	3:0:0
37	17PH3019	Medical Radiation Dosimetry	3:0:0
38	17PH3020	Research Methodology	3:0:0
39	17PH3021	Material characterization	3:0:0
40	17PH3022	Crystal Growth Techniques	3:0:0
41	17PH3023	Radiation Physics	3:0:0
42	17PH3024	Nanofluids	3:0:0
43	17PH3025	General Physics Lab-I	0:0:2
44	17PH3026	General Physics Lab-II	0:0:2
45	17PH3027	Advanced Physics Lab-I	0:0:4
46	17PH3028	Advanced Physics Lab-II	0:0:4
47	17PH3029	Materials characterization lab	0:0:2
48	17PH3030	Computational Physics lab	0:0:2
49	17PH3031	Simulations in statistical physics Lab	0:0:2
50	17PH3032	Heat and Optics lab	0:0:2
51	17PH3033	Astrophysics	3:0:0

17PH1001 APPLIED PHYSICS

Credit: 3:0:0

Course Objective:

- To impart knowledge on the basic concepts of quantum mechanics and its applications
- To impart knowledge on the working principle of various lasers and its application in fibre optics
- To impart knowledge on principles of acoustics and applications of ultrasonic waves, magnetic materials

Course Outcome:

The students will be able to

- Appreciate the quantum principles in microscopic techniques
- Demonstrate laser working principles and types
- Apply Fibre optic principle in designing communication systems.
- Estimate the acoustical parameters of auditorium
- Apply the concepts of materials science in Superconductivity, magnetism.
- Design devices based on ultrasonic generators.

Unit I - QUANTUM PHYSICS: Wave nature of matter- De Broglie wave - De Broglie wavelength of Electrons - properties of matter waves - Experimental verification of matter waves: Davisson and Germer experiment - Heisenberg's uncertainty principle - Schrodinger's time independent wave equation - particle in a box - Application : Principle and working of Scanning Electron Microscope (SEM).

Unit II - LASERS: Principle of laser - Properties of laser beam- Einstein's quantum theory of radiation-Population inversion - Optical Resonator - Types of lasers: Nd :YAG, He:Ne - Application: Holography: Principle, recording and reconstruction.

Unit III - FIBRE OPTICS: Principle of optical fibre- Structure of optical fibres-Propagation in optical fibres- Acceptance angle and acceptance cone-Numerical aperture, Types of optical fibres based on material, mode and refractive index, Applications: Optical fibres for communication- Fibre endoscope.

Unit IV - ACOUSTICS AND ULTRASONICS: Classification of sound, Characteristic of musical sounds- Absorption coefficient- Reverberation time- Sabine's formula, Factors affecting acoustics of buildings and their remedies - Production of Ultrasonic waves: Magnetostriction and Piezoelectric methods- Applications: Acoustic grating - Pulse Echo Testing (NDT).

Unit V - MAGNETIC AND SUPERCONDUCTING MATERIALS: Dia, Para, Ferro magnetic materials properties, Hysteresis curve, Hard and soft magnetic materials - Application: Magnetic recording and reading. Superconductors: Properties of superconducting materials - Type I and Type II superconductors- Application: Maglev.

Text Book

1. B.K.Pandey , S.Chaturvedi – Applied Physics, Cengage Learning India private Ltd. New Delhi, 2012.

Reference Books

1. Engineering Physics, V.Rajendran, 2016.
2. John W.Jewett, Jr., Raymond A.Serway - Physics for Scientists and Engineers with Modern Physics, Cengage Learning India Private Ltd, 2008
3. M.N. Avadhanulu, P.G. Kshirshagar – A Text Book of Engineering Physics-,S.Chand & Co. Ltd, 2008
4. Hitendra K Malik, A K Singh – Engineering Physics, McGraw –Hill Publishing company Ltd,2008
2. G.Aruldas - Engineering Physics, PH1 Learning Pvt. Ltd , 2010

17PH1002 APPLIED PHYSICS LAB

Credits 0:0:2

Objective:

- To train engineering students on basis of measurements and the instruments
- To give practical training on basic Physics experiments which are useful to engineers
- To equip the students with practical knowledge in electronic, optics, and heat experiments

Outcome:

The students will be able to

- To demonstrate the measurement of frequency using Melde's apparatus.
- To demonstrate the measurement of light parameters using optical instruments
- To calculate the particle size through laser diffraction setup
- To estimate coefficient of viscosity of liquids using Poiseuille's apparatus
- To verify the planck's constant using Light emitting diodes
- To calculate the Numerical aperture

The faculty conducting the Laboratory will prepare a list of experiments [10/5 for 2/1 credit] and get the approval of HoD and notify it at the beginning of each semester.

17PH1003 PHYSICS FOR AGRICULTURAL ENGINEERS

Credits : 3:0:1

Course Objective:

- To know about the Basics of projectile and collision
- To learn about the properties of matter in different conditions
- To understand the viscosity of fluids and surface tension of liquids

Course Outcome:

The students will be able to

- Understanding of mechanics and properties of matter of materials
- Solve problems related to mechanics and properties of matter.
- Able to select materials for different applications
- Demonstrate the properties of materials through working models
- Appreciate the role of inertia in determining the properties of matter
- Differentiate between types of modulus and its applications

Unit I - PROJECTILE AND COLLISION: Projectile – range of a projectile on an inclined plane – collision between two bodies – impulse – laws of impact – coefficient of restitution – Elastic and inelastic collision – direct and oblique impact – transfer of energy in collisions between two equal masses.

Unit II - ELASTICITY: Introduction – Stress and strain – Hooke's law – Three types of Elasticity – Rigidity modulus – Young's modulus – Bulk modulus – Relation connecting elastic constants – Poisson's Ratio – Moment of Inertia :Moment of Inertia and its physical significance – Expression for moment of inertia – Radius of Gyration – Torque – General theorems on moment of inertia – Calculation of the moment of inertia of a body and its units.

Unit III - BENDING OF BEAMS: Bending of beams – Expression for bending moment – Uniform bending – Determination of Young's modulus by Uniform and Non Uniform bending using pin and microscope – Cantilever – Expression for depression at loaded end of cantilever.

Unit IV - VISCOSITY: Flow of liquids Rate of flow of liquid – Lines and Tubes of flow – Energy of the liquid – Bernoulli's theorem and its important applications – Viscosity – Co-efficient of viscosity – Critical velocity – Poiseuille's equation for flow of liquid – Stoke's method – Rotation viscometer.

Unit V

SURFACE TENSION: Surface Tension: Definition and dimensions of surface tension - Rise of liquid in capillary tube – Experimental determination of surface tension.

Text Books

1. Elements of Properties of Matter by Mathur D.S., Shyamlal Charitable Trust, New Delhi, 2008.

Reference:

1. Murugesan. R., 2007, Properties of Matter , S. Chand & Co Pvt. Ltd., New Delhi.
2. Gulati H.R., 1982, Fundamentals of General Properties of Matter, R. Chand & Co., New Delhi.
3. Subrahmanyam N. & Brij Lal, 1994, Waves & Oscillations, Vikas Publishing House Pvt. Ltd., New Delhi.
4. P.K. Chakrabarthy, 2001, Mechanics and General Properties of Matter, Books & Allied (P) Ltd.
5. D. Halliday, R. Resnick and J. Walker, 2001, Fundamentals of Physics, 6th Edition, Wiley, NY.
6. Gour R.K. and Gupta S.L., 2002, "Engineering Physics". Dhanpat Rai Publications, New Delhi.

17PH2001 MECHANICS & PROPERTIES OF MATTER

Credit: 3:0:0

Course Objectives

- To know about the Basic laws of Physics
- To learn about the properties of matter in different conditions
- To understand the mechanics of solids

Course Outcome

Students will be able to

- Gain knowledge and understand concepts related to mechanics and properties of matter.
- Understand earth's gravitation, elasticity of materials, mechanics of fluids.
- Solve problems related to mechanics and properties of matter.
- Differentiate between types of modulus and find its applications
- Apply the knowledge of properties of matter in solving problems associated with mechanics
- Appreciate the role of inertia in determining the properties of matter

Unit I - GRAVITATION: Kepler's laws – Newton's deductions from Kepler's laws – Newton's law of gravitation – Determination of gravitational constant – Law of Gravitation and theory of relativity – Gravitational potential at a point distant r from a body – Escape Velocity – Potential and Field intensity due to a solid sphere at a point inside the sphere and outside the sphere.

Unit II - PROJECTILE AND COLLISION: Projectile – range of a projectile on an inclined plane – collision between two bodies – impulse – laws of impact – coefficient of restitution – Elastic and inelastic collision – direct and oblique impact – transfer of energy in collisions between two equal masses

Unit III - ELASTICITY: Introduction – Stress and strain – Hooke's law – Three types of Elasticity – Rigidity modulus – Young's modulus – Bulk modulus – Relation connecting elastic constants – Poisson's Ratio – Torsional pendulum – Moment of Inertia :Moment of Inertia and its physical significance – Expression for moment of inertia – Radius of Gyration – Torque – General theorems on moment of inertia – Calculation of the moment of inertia of a body and its units.

Unit IV - BENDING OF BEAMS: Bending of beams – Expression for bending moment – Uniform bending – Determination of Young's modulus by Uniform and Non Uniform bending using pin and microscope – Cantilever – Expression for depression at loaded end of cantilever

Unit V - VISCOSITY AND SURFACE TENSION: Flow of liquids Rate of flow of liquid – Lines and Tubes of flow – Energy of the liquid – Bernoulli's theorem and its important applications – Viscosity – Co-efficient of viscosity – Critical velocity – Poiseuille's equation for flow of liquid – Stoke's method – Rotation viscometer
Surface Tension: Definition and dimensions of surface tension - Rise of liquid in capillary tube – Experimental determination of surface tension.

Text Books

1. Elements of Properties of Matter by Mathur D.S., Shyamlal Charitable Trust, New Delhi, 2008.
3. Properties of Matter by Murugesan. R., S. Chand & Co Pvt. Ltd., New Delhi. 2007.
4. Properties of Matter by Brij Lal & Subramaniam. N, Eurasia publishing Co., New Delhi, 1994.

Reference Books

1. Fundamentals of General Properties of Matter by Gulati H.R., R. Chand & Co., New Delhi, 1982.
2. Waves & Oscillations by Subrahmanyam N. & Brij Lal, Vikas Publishing House Pvt. Ltd., New Delhi, 1994.
3. Mechanics and General Properties of Matter by P.K. Chakrabarthy - Books & Allied (P) Ltd., 2001.
4. Fundamentals of Physics, 6th Edition, by D. Halliday, R. Resnick and J. Walker, Wiley, NY, 2001.
5. Physics, 4th Edition, Vols. I, II & II Extended by D. Halliday, R. Resnick and K.S. Krane, Wiley, NY, 1994.

17PH2002 SEMICONDUCTOR PHYSICS-I

Credits: 3:0:0

Course Objective

- Fundamental concepts of electronic devices
- Amplifier and oscillators and Integrated Circuits, Measuring instruments
- Applications of Microprocessor and Various communication techniques.

Course Outcome

Students will be able to

- Define the concepts of electronic devices
- Relate the amplifier and oscillators
- Infer about the Integrated Circuits
- Appraise the microprocessor and its applications
- Assess the measuring Instruments.
- Interpret the various communication techniques.

Unit I - Introduction to electronics, Passive and active devices - semiconductor devices – Diode, FET, basic op-amp – op amp 741- BJT, CE, CC, CB configuration, transistor as an amplifier and a switch.

Unit II - Oscillator principles – Positive feedback analysis, Barkhausen criterion principle - Digital System, Logic gates and truth table – OR, AND, NOT, NOR, NAND, Ex-OR, Ex-NOR – Simple digital circuits.

Unit III - Semiconductor memory- volatile and Nonvolatile memory – Integrated circuits –Microprocessor- Block diagram and architecture - transducers – signal conditioning unit – telemetry circuits.

Unit IV - Virtual instrumentation– Measuring instruments- Analog - voltmeter, ammeter and digital- Voltmeter & Ammeter, Multimeter-block diagram analysis- Advanced measuring instruments- – Micro and Nano electronics.

Unit V - Introduction to Communication system – Transmitter and receiver –Introduction to Noise – modulation & demodulation techniques – Amplitude – Frequency and phase modulation techniques-antenna principle –receiver & transmitter (audio/video)- Satellite communication – Fiber optics communication.

Text Book

1. Albert Paul Malvino, “Electronic Principles”, Tata McGraw Hill, 8th Edition, 2015.

Reference Books

1. Robert Boylestad and Louis Nashelsky,, “Electronic Devices & Circuit Theory”, Ninth Edition, PHI, 2013
2. Roody & Coolen, “Electronic Communication”, PHI, 1995
3. W.D. Cooper, A.D. Helfrick, “Modern Instrumentation and Measurement Techniques”, 5th Edition, 2002.
4. V.K.Metha.”Principles of Electronics”,Chand Publications,2008.
5. Anokh Singh, “Principles of Communication Engineering” S.Chand Co., 2001
6. Muthusubramanian R, Salivahanan S, Muraleedharan Ka , “Basic Electrical Electronics & Computer Engineering “Tata Mc.Graw Hill, 2005.
7. Nanoelectronics and Nanosystems: From transistors to Molecular and Quantum Devices by K. Gosser (Edition, 2004), Springer. London.

17PH2003 HEAT AND THERMODYNAMICS

Credit: 3:0:0

Course Objective

- Aims to gain fundamental understanding about the heat temperature and also energy and work.
- To understand thermo-physical properties of substances and introduce thermodynamics laws in system and control volumes.
- To gain knowledge on Energy and work relations.

Course Outcome

Students will be able to

- Appreciate the knowledge on thermodynamics in day-to-day life
- Gain the capability to evaluate thermo physical properties of substances
- Evaluate different thermodynamic systems
- Apply conservation of energy for the control mass and control volume processes
- Understand the second law of thermodynamics
- Understand Irreversibility's

Unit I - LOW TEMPERATURE PHYSICS: Ideal gas and real gas. Van der Waals equation of state. Porous-plug experiment and its theory. Joule-thomson expansion - expression for the temperature of inversion, inversion curve. Relation between Boyle temperature, temperature of inversion and critical temperature of a gas. Principle of regenerative cooling. Liquefaction of air by Linde's method. Adiabatic demagnetization.

Unit II - THERMODYNAMICS: Review of basic concepts, Carnot's theorem, thermodynamic scale of temperature and its identity with perfect gas scale. Clausius-Clapeyron first Latent heat equation, effect changes – Expression for work done , First law of Thermodynamics-mathematical formulation.

Unit III - SECOND LAW OF THERMODYNAMICS – Kelvin Planck statement and Clausius statement and their equivalence. The Carnot engine –expression for efficiency, The Carnot's theorem-its proof. Reversible and irreversible process, reversibility of carnot's cycle, Refrigerators-principle of working and coefficient of performance. Thermodynamic scale of temperature and its identity with perfect gas scale, Clausius-Clapeyron first latent heat equation.

Unit IV - ENTROPY : The concept of Entropy, Change of entropy in reversible and irreversible cycles. Entropy and non-available energy. Principle of increase of entropy –Clausius inequality, Entropy and II law of Thermodynamics, Entropy of ideal gas, T-S diagram , Probability and Entropy - Boltzmann relation , Concept of absolute zero and the third law of thermodynamics

Unit V - THERMODYNAMIC POTENTIALS: Internal Energy, Enthalpy, Helmholtz function, Gibbs function, relations among these functions, Gibbs-Helmholtz equations. Maxwell's Thermodynamic Relations: Derivation of Maxwell's thermodynamic relations, Tds equations, Internal energy equations, Heat capacity equations. Change of temperature during Adiabatic process using Maxwell's relations.

Text Books

1. Brijlal ,N. Subramanyam P.S. Hemne: Heat Thermodynamics and Statistical Physics, 1st edition. S Chand Publishing, 2007.
2. Halliday and Resnick: Fundamentals of Physics, 9th edition, Wiley India, 2011.

Reference Books

1. R. H. Dittaman and M. W. Zemansky: Heat and Thermodynamics, 7th edition, The McGraw-Hill companies, 2007.
2. S. J. Blundell and K. M. Blundell: Concepts in Thermal Physics, 2nd edition, Oxford University Press, 2006.
3. S C Gupta: Thermodynamics, 1st edition, Pearson, 2005.
4. Satya Prakash: Optics and Atomic Physics, 11th, Ratan Prakashan Mandir, 1994.
5. C. L. Arora: Refresher Course in Physics Vol I, S Chand publishing, 2011.
6. S. R. Shankara Narayana: Heat and Thermodynamics, 2nd edition, Sulthan Chand and Sons, 1990.

17PH2004 SEMICONDUCTOR PHYSICS II

Credits: 3:0:0

Course Objective

To impart knowledge on

- Mechanisms of current flow in semi-conductors.
- Diode operation and switching characteristics of Special devices
- Advanced measuring instruments

Course Outcome

Students will be able to

- Define the mechanisms of current flow in semi-conductors.
- Relate the diode operation and its switching characteristics
- Infer about the various discrete electron devices
- Categorize the various displays and its applications
- Estimate the special devices and its applications
- Interpret an Advanced measuring instruments

Unit I - Theory of PN Diodes - Open circuit junction – Forward and Reverse Characteristics - Diode Equation-Applications: Half wave rectifier, full wave rectifier, Bridge rectifier - Hall Effect.

Unit II - Theory of BJT – CE, CB and CC configurations, I-V analysis, Field Effect Transistor, I-V analysis of FET, MOSFET – Enhancement and Depletion Mode MOSFET, I-V analysis.

Unit III - Current-Voltage analysis of UJT and Thyristor - Special Semiconductor Devices – Zener Diode, Gunn Diode, Varactor diode, Tunnel Diode.

Unit IV - Light Emitting Diode, OLED, crystalline solar cells – Liquid Crystal Display –function and Applications of optocouplers- Transducers –Passive and Active transducer.

Unit V - Digital Instruments - Digital Voltmeters and Multimeters, - Data Display and Recording System - Computer Controlled Test System - Microprocessor based measurements.

Text Books

1. Millman & Halkias, "Electronic Devices & Circuits", Tata McGraw Hill, 2nd Edition, 2007.
2. W.D. Cooper, A.D. Helfrick, "Modern Instrumentation and Measurement Techniques", 5th Edition, 2002.

Reference Books

1. Albert Paul Malvino, "Electronic Principles", Tata McGraw Hill, 8th Edition, 2015.
2. Rangan C.S., "Instrumentation Devices and Systems", Tata McGraw Hill, Second Edition, 1998.
3. Robert Boylestad and Louis Nashelsky, "Electronic Devices & Circuit Theory", 9th Pearson Education Edition, 2009
4. Muthusubramanian R, Salivahanan S, Muraleedharan Ka , "Basic Electrical Electronics & Computer Engineering "Tata Mc.Graw Hill, 2005

17PH2005 SEMICONDUCTOR PHYSICS LAB I

Credit: 0:0:2

Course Objective

To impart practical knowledge on

- The Characteristics of diodes, and special diode
- I-V characteristics of BJT, FET and some special purpose devices.
- Rectifiers and regulators.

Course Outcome

Students will be able to

- Develop I-V characteristics of diodes
- Develop I-V characteristics of special diodes
- Built the I-V characteristics of BJT, FET
- Design circuits for rectifiers and regulators.
- Design and verify the digital circuits
- Analysis the attention of Fiber optic cable for the communication

The faculty conducting the Laboratory will prepare a list of 10 experiments and get the approval of HoD and notify it at the beginning of each semester

17PH2006 SEMICONDUCTOR PHYSICS LAB-II

Credit: 0:0:2

Course Objective:

To impart practical knowledge on

- Various Electron Devices and its operation
- Digital circuits design
- Programming of microprocessors.

Course Outcome:

Students will be able to

- Evaluate different electronic device characteristics
- Construct circuits using logic gates
- Built the combinational circuits
- Design the sequential circuits
- Design the communication circuits
- Programming of microprocessors.

Apply programming for various microprocessors' applications.

The faculty conducting the Laboratory will prepare a list of 10 experiments and get the approval of HoD and notify it at the beginning of each semester

17PH2007 SEMICONDUCTOR LOGIC DEVICES

Credits 3:0:0

Course objective:

To impart knowledge on

- Basic conversation systems and Digital circuit design methods
- Combinational logic circuits and Various flip flop
- Digital communications circuits

Course Outcome:

Students will be able to

- Define about basics of digital electronics
- Build the digital circuit design
- Develop the combinational circuits
- Design the digital communication circuits
- Identify about the various flip flop
- Construct synchronous and Asynchronous circuits

Unit I - Number Systems & Boolean Algebra - Karnaugh map - Quine Mcclusky method- Combinational Logic Design : Logic gates – Combinational Logic Functions Half adder, full adder, half subtractor, full subtractor– Sequential design and circuits.

Unit II - Encoders & Decoders logic circuits and lookup table analysis – Multiplexers (4X1) & De-multiplexers (1X4) logic and lookup table analysis – various Code Converters and its logical circuits – Comparator circuit.

Unit III - Combinational Adder circuit– Parallel Adder/Binary Adder – Parity Generator/Checker – Implementation of Logical Functions using Multiplexers.

Unit IV - **INTRODUCTION TO FLIP FLOPS:** RS, JK, D&T flip flops - Counters & Registers: Asynchronous Counters - Synchronous Counters.

Unit V - **LOGIC FAMILIES:** Resister Transistor Logic, Diode Transistor Logic, Transistor Transistor Logic (TTL) families, Programmable Array Logic– Programmable Gate Arrays – Field Programmable gate array.

Text Book

1. Morris Mano, "Digital logic and computer Design", 3rd edition Prentice Hall of India, 2002.

Reference Books

2. A. Anand Kumar, "Fundamental of Digital Circuits", PHI, 2nd Edition 2009.
3. Jain R.P, "Modern Digital Electronics", Third edition, Tata McGraw Hill, 2003
4. Floyd T.L., "Digital Fundamentals ", Prentice Hall, 9th edition, 2006.
5. V.K. Puri, "Digital Electronics: Circuits and Systems", Tata McGraw Hill, First Edition, 2006.

17PH2008 SPECTROSCOPY

Credit: 3:0:0

Course Objective

- To gain knowledge on different types of spectroscopy
- To understand the role of spectroscopy in determining the structure of molecules
- To understand the instrumentation part of different types of spectroscopy

Course Outcome

Students will be able to

- Students can understand how spectroscopic studies in different regions of the E.M spectrum probe different types of molecular transitions
- When the structure of the molecule is to be interpreted, students will apply suitable spectroscopic techniques
- To solve the structure of molecules using theory learned from the spectroscopic techniques
- To appreciate the advancements in instrumentation by overcoming the drawbacks in each spectroscopic technique
- To compare the spectroscopic techniques based on merits and demerits
- To identify the best method to solve the spectroscopic problems

Unit I - Atomic And Molecular Structure Central field approximation – Thomas – Fermi Statistical model – Spin-orbit interaction – Alkali atoms – Doublet separation – Intensities - Complex atoms – Coupling Schemes – Energy levels – Selection rules and intensities in dipole transition – Paschen back effect Hydrogen ion – Hydrogen molecule – Covalent bond – Heitler – London theory – Atomic and molecular hybrid orbitals.

Unit II - Raman Spectroscopy Semi classical treatment of emission and absorption of radiation: The Einstein Coefficients – Spontaneous and induced emission or radiation – Raman effect – Basic principles of Raman Scattering – Vibrational and Rotational Raman spectra – Experimental techniques of Raman spectroscopy – Molecular structural studies.

Unit III - Infrared And Microwave Spectroscopy Characteristic features of pure rotational, vibrational and Rotation – Vibration spectra of diatomic molecules – Theoretical considerations – Evaluation of molecular – constants – IR spectra of polyatomic molecules – Experimental techniques – dipole moment studies and molecular structural determinations – Microwave spectra of polyatomic molecules – experimental techniques - Maser principles – Applications of Masers.

Unit IV - Resonance Spectroscopy - I NMR – Basic principles – Classical and Quantum mechanical description – Bloch equation – Spin – Spin and spin lattice relaxation times – Experimental methods – Single Coil and double coil methods – Pulse method – ESR basic principles – High Resolution Karunya University ESR Spectroscopy – ESR spectrometer.

Unit V - Resonance Spectroscopy - II N Q R Spectroscopy – Basic Principles – Quadruple Hamiltonian Nuclear Quadrupole energy levels for axial and nonaxial symmetry – N Q R spectrometer – chemical bonding – molecular structural and molecular symmetry studies. Mossbauer spectroscopy: Principles of Mossbauer spectroscopy – Chemical shift – Quadrupole splitting – Applications.

Text Book

1. Elements of Spectroscopy, Gupta Kumar Sharma, Pragati Prakashan, 2006

Reference Books

1. Fundamentals of Molecular Spectroscopy, Banwell, Tata Mc Graw Hill, 1995
2. Spectroscopy, B.K.Sharma, Goel Publishing House, 2007.
3. Molecular Structure and Spectroscopy, G.Aruldas, PHI Learning private Ltd. 2008

17PH2009 PHYSICS OF SEMICONDUCTOR MEMORIES & MICROPROCESSORS

Credits 3:0:0

Course Objective:

To impart knowledge on

- Various amplifier and oscillator circuits,
- Operational amplifier and its applications
- Microprocessor and its applications, Memory and other interfacing circuits

Course Outcome:

Students will be able to

- Identify the various amplifier and oscillator circuits
- Analyze an operational amplifier and its applications
- Examine the Microprocessor and its applications
- Evaluate the various Memories and other interfacing circuits
- Estimate the Data transfer schemes between peripherals and microprocessor
- Design the assembly programming language

Unit I - Introduction to Electronic Circuits – current voltage analysis of Zener diode and Zener regulator analysis - I.C regulator – Transistor Amplifier — Power Amplifiers circuits – Class A, Class AB circuits.

Unit II - Oscillators – Barkhausen Criterion – Colpits oscillator-Wien bridge oscillator and phase shift oscillators analysis– Positive feedback analysis-OP-amp comparators.

Unit III - Block diagram of Microcomputer - Architecture of Intel 8085 - Instruction formats, Addressing methods-types of Instruction - Intel 8085 - Instruction set - Development of simple assembly language programs and examples.

Unit IV - Memory and I/O devices and interfacing RAM, ROM, EPROM –CRT terminals- Printers-I/O ports-Key boards-ADC/DACs-memory interfacing.

Unit V - Asynchronous and synchronous data transfer schemes-interrupt driven data transfer- DMA data transfer- Simple applications of Microprocessors.

Text Book

1. Ramesh.S.Gaonkar “Microprocessor Architecture, Programming & Applications With 8085/8080a”, Penram International, 2006.
2. Albert Paul Malvino, “Electronic Principles”, Tata McGraw Hill, 8th Edition, 2015.

Reference Book

1. Millman .J. &Halkias.C , "Electronic Devices And Circuits", Tata McGraw Hill, 2007.
2. Adithya P. Mathur, “ Introduction to Microprocessor”, Tata McGraw Hill, 3rd Edition, 2002.
3. Malvin Brown, Digital Computer Electronics (English) 3rd Edition, 2002.

17PH2010 PHYSICS OF LINEAR INTEGRATED CIRCUITS & VLSI DESIGN

Credits 3:0:0

Course objective:

To impart knowledge on

- Theoretical analysis of Operational amplifier and IC 741
- Basics of VLSI Design and analysis
- Various Design process of VLSI

Course outcome

Students will be able to

- Identify the Theoretical analysis of Operational amplifier
- Infer about the OP-Amp IC 741 and its analysis
- Develop the Various applications of IC 741
- Infer Basics of VLSI Design and analysis
- Build CMOS inverter circuit for various design
- Construct the Design process of VLSI

Unit I - Monolithic Integrated Circuit Technology – Planar process – Bipolar Junction Transistor fabrication – Fabrication of FET’s – CMOS Technology – Monolithic diodes.

Unit II - OP-AMP Characteristics and Applications: Characteristics of ideal op-amp. Pin configuration of 741 op-amp – Applications: inverting and non-inverting amplifiers.

Unit III - Inverting and non-inverting summers of OP-AMP, Differential amplifier - 555 Timer functional diagram, monostable and astable operation. Applications.

Unit IV - VLSI Design Process – Architectural Design – Logical Design – Physical Design – Layout Styles – Full Custom Semi Custom Approaches.

Unit V - NMOS, PMOS Inverter, CMOS Inverter - MOS & CMOS Layers – stick diagram – design rules & layout - Finite state machine – Hardware description Language - FPGA.

Text Book

1. Roy Choudhury.D., Shail Jain, “Linear Integrated Circuits”, New Age International Publications, 3rd Edition, 2007.
2. Douglas A. Pucknell, “Basic Vlsi Design”, Prentice-Hall Of India Pvt. Limited, 1994.

Reference Book

1. Gayakwad.A.R., ”Op-Amps & Linear IC’s”, PHI, 4th Edition, 2004
 2. Robert F. Coughlin, Frederick F. Driscoll, “Operational Amplifiers & Linear Integrated Circuits”, PHI 6th Edition, 2001.
 3. Sergio Franco, “Design with Operational Amplifier and Analog Integrated Circuits”, TMH, 3rd Edition, 2002.
- Millman & Halkias,” Integrated Electronics”, Mac Graw Hill, 1991

17PH2011 PHOTONICS

Credits 3:0:0

Course Objectives:

- To learn various processes involving in the development of laser.
- To understand the various applications using lasers To know the working and fabrication of optical fibers
- To learn modern experimental techniques in optics and photonics in the context of learning about optical fiber communication systems.

Course Outcome:

Students will be able to

- Students can understand the fabrication and application of various lasers and optical fiber.
- define and explain the propagation of light in conducting and non-conducting media;
- define and explain the physics governing laser behaviour and light matter interaction;
- apply wave optics and diffraction theory to a range of problems;
- apply the principles of atomic physics to materials used in optics and photonics;
- calculate the properties of various lasers and the propagation of laser beams;

Unit I - PROPERTIES OF GAUSSIAN BEAMS: The paraxial wave equation, Gaussian beams, the ABCD law for Gaussian beams, Gaussian beam modes of laser resonators. Higher order Gaussian beam modes. Diffraction theory of laser resonators, unstable resonators for high power lasers.

Unit II - LASERS: Quantum theory of laser: Lasers – Einstein A-B Coefficients, round trip gain, matrix method, He-Ne laser, Ruby, Nd: YAG, Nd: glass lasers, liquid lasers and dye laser amplifiers. Theory of Q-switching and mode locking process, devices for Q-switching and mode locking, high power Co₂ laser, Ti:Sapphire laser. Theory of semiconductor lasers and devices. Laser, Applications:

Unit III - NONLINEAR OPTICS-I: Introduction to nonlinear optics, nonlinear polarization and wave equation, second harmonic generation, phase matching, three-wave mixing, parametric amplifications, oscillations, tuning of parametric oscillators, nonlinear susceptibilities, nonlinear susceptibility tensor, nonlinear materials

Unit IV - NONLINEAR OPTICS-II: Propagation of light through isotropic medium, propagation light through anisotropic medium, theory of electro-optic, magneto-optic and acousto-optic effects and devices, integrated optical devices and techniques.

Unit V - FIBER OPTICS: Overview of Optical Fibers: Structure of optical fibers. Step-index and graded index fibers; Single mode, multimode and W-profile fibers. Ray Optics representation. Meridional and skew rays. Numerical aperture and acceptance angle. Multipath dispersion materials – Material dispersion -Combined effect of material and multipath dispersion – RMS pulse widths and frequencyresponse - Model Birefringence - Attenuation in optical fibers - Absorption - Scattering losses -Radiative losses

Text Book

1. Laser Fundamentals: W. T. Silfvast, Cambridge University Press, (2003)

Reference Books

1. Laser Spectroscopy- Basic Concepts: W. Demtroder, Springer-Verlag, (2003)
2. The Elements of Fibre Optics: S.L.Wymer and Meardon (Regents/Prentice Hall), (1993)
3. Lasers and nonlinear Optics: B. B. Laud, New Age International (P) Ltd. (2007)

17PH2012 VACUUM AND THIN FILM TECHNOLOGY

Credits: 3:0:0

Course Objective:

- To introduces students to the theory and practice of high vacuum systems as well as thin film deposition
- To study the physical behavior of gases and the technology of vacuum systems including system operation and design
- To learn the Thin film deposition techniques including evaporation and sputtering techniques

Course Outcome:

The students will be able to

- Understand the importance of vacuum in thin film technology
- Identify the suitable pumping systems to obtain the required level of vacuum

- Appreciate the measurement of vacuum using suitable pressure gauges
- Understand the process of thin film growth
- Compare the vacuum and non-vacuum techniques for thin film deposition
- Apply thin film technologies in fabricating various metal and optical coatings

Unit I - PROPERTIES OF GASES AT LOW PRESSURES: Introduction - The concept of vacuum - degrees of vacuum - Gas Pressure – unit of measurements - mean free path – particle flux - interaction of gas molecules with surfaces - adsorption time - saturation pressure - surface coverage with gas molecules .

Unit II - PUMPS AND PUMPING SYSTEMS: General characteristics of vacuum pumps – rotary pump – Diffusion pumps –pumping mechanism– Turbomolecular pumps – pumping mechanism – turbomolecular pump designs – Cryogenic pumps - pumping mechanism – speed pressure and saturation.

Unit III - MEASUREMENT OF VACUUM: Classification of measurement methods – Direct pressure measurement – Indirect pressure measurement – Pressure gauges – Direct reading gauges – Diaphragm & Bourdon gauge - capacitance manometer – Indirect reading gauges – pirani gauge - Ionization gauges – hot cathode gauge – cold cathode gauge – gauge calibration.

Unit IV - THIN FILM GROWTH PROCESS: Evaporation –evaporation rate – alloys – compounds– sources – transport – deposition monitoring. Deposition – adsorption – surface diffusion – nucleation – structure development – interfaces – temperature control. Chemical vapor deposition – gas supply –Reaction – chemical equilibrium – surface processes – Diffusion – diffusion limited deposition.

Unit V - THIN FILM DEPOSITION TECHNIQUES: Molecular Beam Epitaxy – basic MBE process – sputter deposition – physical sputtering theory – plasmas and sputtering systems –electro plating – sol gel coating – laser ablation – spray pyrolysis.

Text Books

1. Vacuum Technique by L. N. Rozanov, Taylor and Francis, London, 2002, ISBN No: 0-415- 27351-x.
2. Thin film deposition Principles & Practice, Donald L. Smith, McGraw Hill, 1995, ISBN No: 0-07-058502-4.

Reference Books

1. A user's guide to Vacuum Technology, John F. O' Hanlon, 3rd Ed., John Wiley & Sons Inc, 2003.
2. Modern Vacuum Physics, Austin Chambers, Chapman & Hall/CRC, Taylor and Francis, London, 2005, ISBN No: 0-8493-2438-6.
3. Hand book of thin film deposition processes & technologies Krishna Seshan, Noyes publications/William Andrew publishing, 2nd Ed., 2002
4. The materials Science of thin films, Milton Ohring, Academic Press, 1992, ISBN No: 0-12-524990-x.
5. Thin film materials – stress, defect formation & surface evolution, L.B. Freund & S. Suresh, Cambridge University Press, 2003, ISBN No: 0-521-822815. 6. Thin film Device Applications, K.L Chopra, Plenum Press, NY, 1983

17PH2013 CONDENSED MATTER PHYSICS

Credit: 3:0:0

Course Objective:

- To provide fundamental physics behind different materials we commonly see in the world around us.
- To study the materials and their properties using different theoretical and experimental methods.
- The class will demonstrate the link between microscopic structure and bulk properties in a variety of systems in hard and soft condensed matter.

Course outcome:

The students will be able to

- Understand the band theory of solids
- Interpret the different types of semiconductors
- Define and explain the properties of superconductors
- Gain knowledge on dielectrics
- Appreciate the properties of ferroelectrics
- Explain the different types of magnetic materials

The students will be able to understand how different kinds of matter are described mathematically and how material properties can be predicted based on microscopic structure.

Unit I - CONDUCTING MATERIALS: Introduction, Electron energies in metals and Fermi energy, Density of states, Band theory of solids, Effective mass of electron and concept of hole, Expression for electrical conductivity of conductors, Different types of conducting materials-zero resistivity, low resistivity and high resistivity materials.

Unit II - SEMICONDUCTING MATERIALS: Introduction, direct and indirect bandgap semiconductors, Intrinsic and extrinsic semiconductors, carrier concentration in n-type semiconductors and variation of Fermi level with temperature and concentration of donor atoms and carrier concentration in p-type and variation of Fermi level with temperature and concentration of donor atoms semiconductors, Hall effect and its applications.

Unit III - SUPERCONDUCTING MATERIALS: Superconductors-mechanism of superconductors, Meissner Effect, Type I and Type II Superconductors, BCS theory, Quantum tunnelling, Josephson's Tunneling, Theory of DC Josephson Effect, Applications.

Unit IV - DIELECTRIC PROPERTIES: The Microscopic concept of polarization, Internal field or local field in liquids and solids, Clausius mosotti relation, Ferroelectricity, Dipole theory of ferroelectricity, piezoelectricity, dielectric loss, effects of dielectrics.

Unit V - MAGNETIC PROPERTIES: Quantum theory of Paramagnetism, Weiss theory of ferromagnetism, Temperature dependence of magnetism, Exchange interaction, Ferromagnetic domains surfaces, Bloch Wall, Antiferromagnetism, Neel temperature, Ferrimagnetism.

Text Books

1. Introduction to Solid State Physics – Charles Kittel.7th edition 2000
2. Solid State Physics - S.O.Pillai – New Age International publishers.
3. Physics of semiconductor devices – S.M.Sze 2007

Reference Books

1. Basic Semiconductor Physics – Chihiro Hamaguchi 2nd Edition 2001
2. Complete guide to semiconductor devices – Kwok Kwok Ng, 2nd Edition 2002

17PH2014 PROPERTIES OF MATTER LAB

Credits 0:0:2

Course Objective:

- To train the students on various properties of matter experiments
- To learn about the refractive index and Newton's ring using light experiments
- To study about the rigidity modulus and moment of inertia of a disc

Course outcome:

Students will be able to

- Demonstrate the practical skills on measurements and instrumentation techniques through physics experiments.
- Describe the concepts and principles of light through practical experiments
- Analyze different measurements for effective understanding of the methods involved.
- Describe the concepts and principles of materials physical property analysis through experiments
- Workout the viscosity of various and its property analysis through experimental measurements and to bring results
- Apply the learned concepts for different applications related matter.

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

17PH2015 ELECTRICITY AND MAGNETISM

Credits 3:0:0

Course Objectives

The course aims to provide

- To learn the basics of electricity and magnetism and equations governing them.
- To acquire knowledge of fundamentals of magnetism
- To know the Maxwell's equations

Course outcome

- Ability to solve the problems in different EM fields.
- Ability to design a programming to generate EM waves subjected to the conditions
- Applications of EM Waves in different domains
- Ability to Solve Electromagnetic Relation using Maxwell Formulae
- Ability to Solve Electro Static and Magnetic to Static circuits using Basic relations
- Ability to Analyse moving charges on Magnetic fields

Unit I - Introduction, fundamental theory of charged particles, Electric fields and Electric forces, Electric dipoles, Coulomb's Law, Gauss's Law, Electric flux, Charges on conductors, Applications of Gauss's Law, Problems

Unit II - Electrostatic potential energy and energy density, Potential Gradient, Calculating Electric potential, Equipotential surfaces, Point charge in the presence of grounded conducting sphere, Point charge in the presence of charged, insulated, conducting sphere, Ohms law, electric circuits, Direct current circuits, Resistors in series and parallel, Resistors in series parallel combinations, Kirchhoff's rules

Unit III - Theories of magnetic field, Biot-Savart's law, Faraday's law, Flux density, field strength and magneto motive force, Magnetic field of a moving charge and Magnetic field of current carrying conductor, Motion of a charged particle and magnetic force on a current carrying conductor, Force between parallel conductors, Ampere's law and its applications

Unit IV - Maxwell's displacement current, Maxwell's equations, Derivation of Maxwell's equation for free space

Unit V - Electromagnetic Induction Introduction, Magnetic flux and induced emf, Faraday's law, Lenz law, Fleming's right hand rule, Self inductance and Mutual Inductance, Magnetic field energy and circuits, Dynamo- working principle, Theory of transformer's and its types

Text Books

1. Classical Electrodynamics, Third Edition, John David Jackson, John Wiley & Sons, Inc. New York 1999
2. Electromagnetic waves and radiating systems: E.C. Jordan and K.G. Balmain, Printice-Hall of India

Reference Books

1. Electromagnetic waves and fields, V.V. Sarwate, Wiley Eastern Ltd, or New Age International (1993)
2. Electromagnetic wave theory, J.R. Wait, Harper & Row

17PH3001 CLASSICAL MECHANICS

Credits: 3:0:0

Course Objective:

- To apply fundamental conservation principles to analyze mechanical systems with an emphasis on the central force problem and rigid body motion.
- To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulations of classical mechanics.
- To develop the capability to apply theoretical techniques like variation principle, and Hamilton Jacobi theory, to analyze elementary mechanical systems.

Course Outcome:

Students will be able to

- Apply summary properties of Lagrangian to interpret the physical significance of conserved quantities (linear momentum, angular momentum and energy).
- Apply advanced mathematical methods to deal with physical quantities and interpreting mathematical results in physical terms
- Apply hamilton's equation of motion for a standard problems and be able to recognize the resulting reduction of dimensionality of the problem
- Apply the techniques and results of classical mechanics to real world problems and novel situations
- Effectively communicate problems and their solutions relevant to classical mechanics
- Apply canonical transformation to find a solutions for a simple problem

Unit I - Mechanics of a System of Particles: Constraints – Generalized co-ordinates – D'Alembert's principle and Lagrange's equations – Simple applications of the Lagrangian Formulations. Hamilton's Principle – Deduction of Lagrange's equations from Hamilton's Principle, Applications.

Unit II - The Two Body Central Force Problem: Reduction to the equivalent one body problem – The equation of motion and first integral – Kepler Problem: Inverse square law of force – The motion in time in the Kepler problem – Scattering in a central force field.

Unit III - The Kinematics of Rigid Body Motion: The independent coordinates of a rigid body – orthogonal transformations – The Euler Angles – Symmetric top – Rate of change of a vector – angular velocity vector in terms of the Euler angles

Small Oscillation: Formulation of the problem – Eigen value equation and the principal axis transformation – frequencies of free vibration – Triatomic molecule.

Unit IV - The Hamilton Equations of Motion: Canonical Transformations and the Hamilton equation of motion – Cyclic coordinates – Routh's procedure and oscillations about steady motion – Derivation of Hamilton's equations from variational principle – The equations of canonical transformation – Examples of canonical transformation.

Unit V - Hamiltonian-Jacobi Theory: Hamilton-Jacobi equations for principle function-Harmonic Oscillator problem as an example of the Hamilton-Jacobi method-Hamilton-Jacobi equation for Hamilton's characteristic function- Actions angle variables in the Systems with one degree of freedom- The Kepler Problem in action angle variables

Reference Books

1. Classical Mechanics, H. Goldstein, Narosa publishing house, Second Edition 2001
2. Classical Mechanics- S.L.Gupta, V. Kumar & H.V.Sharma-Pragati Prakashan Meerut.,2003
3. Classical Mechanics, T. W. B. Kibble, Frank H. Berkshire, Imperial College Press, 2004
4. Classical Mechanics, J C Upadhyaya, Himalaya Publishing House, 2012
5. Introduction to Classical Mechanics, R. G. Takwale, P. S. Puranik, Tata McGraw-Hill, 2006
6. Classical Mechanics, John Robert Taylor, University Science Books, 2005
7. Classical Mechanics, Tai L.Chow, Taylor and Francis group, 2013

17PH3002 STATISTICAL MECHANICS AND THERMODYNAMICS

Credits 3:0:0

Course Objective:

- To explain the origin of the laws of thermodynamics from the fundamental principles of equilibrium statistical mechanics.
- To learn the basic principles of thermodynamics and statistical mechanics and apply them to describe equilibrium thermal properties of bulk matter.
- Creating a bridge between theory of the microworld (theory of individual molecules and their interactions) and theory of macroscopic phenomena

Course Outcome:

Students will be able to

- Knowing the basic concepts behind thermodynamics
- Understanding the laws of thermodynamics and their consequences
- Understanding the different types of thermodynamic systems
- Understanding the statistical approach towards thermodynamics
- Deriving the different types of statistical distribution
- Analyzing the thermal characteristics of the crystalline solids

Unit I - Review of the Laws of Thermodynamics and their Consequences: Energy and the first law of thermodynamics – Heat content and Heat capacity – Specific heat – Entropy and the second law of thermodynamics – Thermodynamic potentials and the reciprocity relations – Maxwell's relations – Deductions – Properties of thermodynamic relations – Gibb's – Helmholtz relation – Thermodynamic equilibrium – Nernst's Heat Theorem and third law – Consequences of third law – Nernst's - Gibb's phase rule – Chemical potential.

Unit II - Statistical Description of Systems of Particles: Statistical formulation of the state system – phase space – Ensemble – average value – density of distribution in phase space – Liouville Theorem – Equation of motion and Liouville's theorem – Equal apriori probability – Statistical equilibrium – Ensemble representations of situations of physical interest – isolated system – Systems in contact.

Unit III - Simple Applications of Statistical Mechanics: General Method of approach – Partition functions and their properties – Ideal Monatomic Gas – Calculation of Thermodynamic quantities – Gibb's Paradox. The equipartition theorem and proof – application to harmonic oscillator.

Statistical Thermodynamic Properties of Solids: Thermal characteristics of crystalline solids – Einstein model – Debye modification – Limitations of Debye theory – Paramagnetism – General calculation of Magnetization.

Unit IV - Quantum Statistics of Ideal Gases: Maxwell – Boltzman statistics, Bose-Einstein statistics and Fermi Dirac statistics; Calculation of distribution functions from the partition function for M-B, B-E, and F-D statistics – Quantum statistics in the classical limit – ideal Bose Gas – Bose – Einstein condensation – Ideal Fermi Gas – Degenerate Electron Gas.

Unit V - Phase Transitions in Statistical Mechanics: General remarks on the problem of phase transitions – Non ideal classical gas – Calculation of partition function for low densities – Equation of state and virial coefficients – The Vander – Waal's equation – Phase transitions of the second kind – ferromagnetism.

Reference Books

1. Fundamentals of Statistical and Thermal Physics, Frederick Reif, McGraw, Hill, 1985.
2. Statistical Mechanics – B. K. Agarwal and M. Einsner, John Wiley & Sons, 1988
3. Statistical Thermodynamics – M.C. Gupta, Wiley Eastern Ltd, 1990
4. Thermodynamics and statistical mechanics, By John M. Seddon, Julian D. Gale Royal Society of Chemistry, 2001
5. Introduction to statistical mechanics – S.K. Sinha, Alpha Science International, 2005
6. Elements of Statistical Mechanics, Kamal Singh & S.P. Singh, S. Chand & Company, New, 1999
7. An Introduction to Statistical Thermodynamics By Terrell L. Hill, 2007

17PH3003 MATHEMATICAL PHYSICS I

Credits: 3:1:0

Course Objective:

- To review the basics of vector analysis and move on to the advanced level treatment of Vectors and matrices
- To enable the students to solve the first and second order differential equations and have a sound knowledge about special functions
- To make the students to solve the problems in physics using mathematical principles.

Course Outcome:

Students will be able to

- Master the basic elements of complex mathematical analysis, including the integral theorems, obtain the residues of a complex function and to use the residue theorem to evaluate definite integrals
- Solve linear systems and find matrix inverses, eigen values and eigenvectors
- Solve ordinary differential equations of second order that are common in the physical sciences
- Formulate and express a physical law in terms of tensors, and simplify it by use of coordinate transforms
- Student learn the theory of probability, various distribution functions and errors and residuals
- The students can understand apply the mathematical concepts to solve the problems in physics.

Unit I - VECTOR ANALYSIS: Addition, Subtraction, multiplication of vectors – Simple Problems – Magnitude of Vectors – Linear Combination of vectors – Simple problems – Product of two vectors – Triple product of vectors - Simple applications of vectors to Mechanics – Work done by force - Torque of a force - Force on a particle in magnetic field - Force on a charged particle - Angular velocity - Differentiation of vectors – Scalar and vector fields - Gradient, Divergence and Curl operators – Integration of vectors – Line, surface and volume integrals – Gauss's Divergence theorem – Green's theorem – Stoke's theorem

Unit II - MATRICES: Equality of matrices – Matrix Addition, multiplication and their properties – Special matrices – Definitions: Square matrix, Row matrix, Null matrix, Unit matrix, Transpose of a matrix, Symmetric and skew symmetric matrices, Conjugate of matrix Adjoint of matrix (Simple problems) - Unitary matrix, Orthogonal matrix (simple problems) – Inverse of matrix – Problems - Rank of matrix – Problems - Solutions of linear equations – Cramer's rule – Cayley-Hamilton Theorem – Eigen Values and Eigen vectors of matrices and their properties – Quadratic forms and their reduction - Diagonalisation of matrices

Unit III - TENSOR ANALYSIS: Definition of tensors – Transformation of coordinates – The summation convention and Kronecker Delta symbol – Covariant Tensors – Contravariant tensors – Mixed Tensors - Rank of a tensor – Symmetric and anti-symmetric tensors – Quotient law of tensor - Invariant Tensors - Algebraic operations of tensors - Addition, subtraction and multiplication (inner and outer product) of tensors Derivative of tensors

Unit IV - LINEAR DIFFERENTIAL EQUATIONS:

Linear differential equations of second order with constant and variable coefficients – Homogeneous equations of Euler type – Equations reducible to homogeneous form – method of variation of parameter – Problems.

Unit V - PROBABILITY AND THEORY OF ERRORS: Definition of probability – Compound Probability – Total Probability – The multinomial law – Distribution functions - Binomial, Poisson and Gaussian distribution– Mean (Arithmetic - Individual observations ,Discrete series, Continuous series) – Median (Individual observations ,Discrete series, Continuous series) – Mode (Individual observations ,Discrete series, Continuous series) -Mean Deviation and Standard Deviation (Individual observations ,Discrete series, Continuous series) – Different types of errors – Errors and residuals —The principle of Least squares fitting a straight line.

Reference Books

1. Mathematical Physics – B.D.Gupta – Vikas Publishing House, 3rd edition, 2006
2. Mathematical Physics – B.S.Rajput – PragatiPrakashan – Meerut, 17th edition, 2004
3. Mathematical Methods for Engineers and Scientists – K.T.Tang – Springer Berlin Heidelberg New York ISBN,10 3,540,30273,5 (2007)
4. Mathematical Methods for Physics and Engineering – K.F.Riley, M.P.Hobson and S.J.Bence, Cambridge University Press – ISBN 0 521 81372 7 (2004)
5. Essential Mathematical Methods for Physicists – Hans J.Weber and George B.Arffen – Academic Press, U.S.A. – ISBN 0,12,059877,9 (2003)
6. Mathematical Physics Including Classical Mechanics, SatyaPrakash, Sultan Chand & Sons, New Delhi, ISBN,13: 9788180544668 (2007)

17PH3004 SEMICONDUCTOR PHYSICS

Credits: 3:0:0

Course Objective:

- To learn about the different semiconductor devices
- To understand the concept of manufacturing of resistors, diodes, capacitors and inductors in a chip for various applications
- To get a knowledge about the operational amplifiers and to know the architecture and functioning of 8085 microprocessor

Course Outcome:

Students will be able to

- Know about the semiconductor devices,
- Design IC manufacturing,
- Appraise different types of operational amplifiers,
- Program microprocessors
- Demonstrate the wave forms through multiplexers
- Design special purpose devices.

Unit I - Semiconductor Devices: Uni-Junction Transistor – Characteristics – Relaxation Oscillator FET Volt – Ampere Characteristics – MOSFET, N Channel – P Channel – FET as a voltage variable resistor –Common source amplifier – SCR – TRIAC – DIAC – Tunnel Diode – Characteristics – Basic applications.

Unit II - Fabrication of Integrated Circuits: Integrated circuits fabrication and characteristics – Integrated circuit technology, basic monolithic integrated circuits – epitaxial growth, masking and etching – Diffusion of impurities – Monolithic diodes, integrated resistors, integrated capacitors and inductors monolithic layout, addition isolation methods, large scale integration (LSI), medium scale integration (MSI) and small scale integration (SSI) – The metal semiconductor contact.

Unit III - Linear Integrated Circuits: Op. Amp characteristics – Parameters – Basic, application – summing – integrating Differentiating – Logarithmic – Antilogarithmic amplifier – Sinusoidal, square – Triangular and ramp

wave generation – Multivibrator – Bistable – Monostable – Schmit trigger – Solution of differential equation – Analog computation.

Unit IV - Microwaves: Microwave generation and application, Klystron, Magnetron, travelling wave tube – Microwave propagation in rectangular and cylindrical wave guides. H₀₁, E₀₁ modes – Attenuators – Crystal detection – measurement of SWR.

Unit V - Digital Electronics: Boolean Algebra – Demorgan Theorem Arithmetic circuits Karnaugh map simplifications, (synchronous and asynchronous) counters registers – Multiplexures – Demultiplexures memories (EPROM, PROM, S-RAM) – LSI, VLSI Devices (PLD, PGAS)

Reference Books

1. Integrated Electronics – Millmaan. J. and Halkias C.C
2. Electronic Devices and Circuits – Allen Mottershead
3. Microwaves – Gupta K.C
4. Digital Principles and Applications – Malvino and Leach.

17PH3005 QUANTUM MECHANICS I

Credits 3:0:0

Course Objective:

- To understand the general formulation of quantum mechanics
- To acquire working knowledge of the postulate in quantum mechanics on the physical systems
- To get knowledge on the theoretical aspects of perturbation of atoms due to electric and magnetic fields

Course Outcome:

Students will be able to

- Gain an in depth understanding on the central concepts and principles of quantum mechanics: the Schrödinger equation, the wave function and its physical interpretation, stationary and non-stationary states and expectation values.
- Improved mathematical skills necessary to solve differential equations and eigenvalue problems using the operator formalism
- Quantum mechanical solution of simple systems such as the harmonic oscillator and a particle in a potential well
- Grasp the concepts of spin and angular momentum, as well as their quantization- and addition rules.
- Student forms a mental picture on the meaning of linear combination of states within quantum mechanics
- Solutions to perturbation problems and many electron systems

Unit I - GENERAL FORMALISM OF QUANTUM MECHANICS: Linear vector space- Linear operator- Eigenfunctions and Eigenvalues - Normalisation of wave function-Probability current density - Hermitian operator- Postulates of quantum mechanics- Simultaneous measurability of observables- General uncertainty relation- Dirac's notation- Expectation values - Equations of motion; Schrodinger, Heisenberg and Dirac representation- Momentum representation.

Unit II - ENERGY EIGEN VALUE PROBLEMS: Particle in a box – Linear Harmonic oscillator- Tunnelling through a barrier- particle moving in a spherically symmetric potential- System of two interacting particles-Rigid rotator- Hydrogen atom.

Unit III - ANGULAR MOMENTUM: Orbital angular momentum-Spin angular momentum-Total angular momentum operators- Commutation relations of total angular momentum with components-Ladder operators- Commutation relation of J_z with J_+ and J_- - Eigen values of J^2 , J_z - Matrix representation of J^2 , J_z , J_+ and J_- - Addition of angular momenta - Clebsch Gordon coefficients(no derivation) – properties.

Unit IV - APPROXIMATE METHODS: Time independent perturbation theory in non-degenerate case-Ground state of helium atom-Degenerate case-Stark effect in hydrogen – Spin-orbit interaction-Variation method & its application to hydrogen molecule- WKB approximation

Unit V - MANY ELECTRON ATOMS: Indistinguishable particles – Pauli principle- Inclusion of spin – spin functions for two electrons - The Helium Atom – Central Field Approximation - Thomas-Fermi model of the Atom - Hartree Equation- Hartree-Fock equation.

Reference Books

1. Quantum Mechanics – G. Aruldas - Prentice Hall of India, 2006
2. Quantum mechanics, Satya Prakah & Swati Saluja, kedar Nath Ram Nath & Co, Meerut, 2007
3. A Text Book of Quantum Mechanics-P.M. Mathews & K. Venkatesan – Tata McGraw Hill 2007
4. Introduction to Quantum Mechanics – David J.Griffiths Pearson Prentice Hall 2005
5. Quantum Mechanics – L.I Schiff - McGraw Hill 1968
6. Principles of Quantum Mechanics-R.Shankar, Springer 2005

17PH3006 PHYSICAL OPTICS

Credits: 3:0:0

Course Objective

- To learn the working of various optical elements like lenses and mirrors.
- To understand the properties of light as a wave
- To learn the fundamental principles of classical physical optics.

Course Outcome

- Students demonstrate the usage of various optical elements like lenses and mirrors.
- Students apply the properties of light on research oriented problems.
- An ability to apply knowledge of mathematics, science, and engineering.
- An ability to design a optical system, component, or process to meet desired needs within realistic constraints such as economic, health and safety, manufacturability, and sustainability.
- An ability to identify, formulate, and solve optical physics and engineering problems.
- An ability to use the techniques, skills, and modern tools necessary for optical physics and engineering careers

Unit I - GEOMETRICAL OPTICS: Lenses- Thin Lens Equations- Mirrors- Mirror Formula-Prisms-Dispersing and Reflecting- Thick Lenses and Lens Systems-Analytical Ray Tracing-Matrix Methods for Lenses and Mirrors-Optical Cavity

Unit II - SUPERPOSITION OF WAVES: Addition of Waves of same Frequency- Addition of Waves of different Frequency- Group Velocity- Anharmonic Periodic Waves- Fourier Series

Unit III - POLARIZATION: Linear Polarization- Circular and Elliptical Polarization- Polarizers-Malus's Law-Dichroism- Birefringence- Polarization by Scattering and Reflection-Brewster's Law- Wave plates- Full- Wave, Half-Wave and Quarter-Wave Plates- Optical Activity

Unit IV - INTERFERENCE AND DIFFRACTION: Interference-General Considerations- Conditions for Interference- Temporal and Spatial Coherence- Amplitude-Splitting Interferometers-Michelson and Mach-Zehnder Interferometer- Multiple Beam Interference- Fabri-Perot Interferometer-Diffraction- Huygens- Fresnel Principle-Fraunhofer and Fresnel Diffraction- Fraunhofer Diffraction- Single, Double and Many Slits- Diffraction Grating-Fresnel Diffraction.

Unit V - FOURIER OPTICS: Fourier Transforms- One- and Two-Dimensional Transforms- Dirac Delta Function-Optical Applications- Spectra and Correlation

Reference Books

1. Optics: Eugene Hecht and A. R. Ganesan, Dorling Kindersely (India) (2008)
2. Optics: A. K. Ghatak, Tata McGraw Hill, (2008)
3. Principles of Physical Optics, Charles A. Bennett, Wiley, (2008)

17PH3007 MATHEMATICAL PHYSICS II

Credits 3:1:0

Course Objective:

- To impart a thorough knowledge about elements of complex analysis and transforms
- To grasp the idea of group theory and its implications.
- To have a thorough knowledge about numerical methods

Course Outcome:

Students will be able to

- Expand a function in terms of a Fourier series, with knowledge of the conditions for the validity of the series expansion
- Apply integral transform (Fourier and Laplace) to solve mathematical problems of interest in physics, use Fourier transforms as an aid for analyzing experimental data
- Solve partial differential equations of second order by use of standard methods like separation of variables, series expansion (Fourier series) and integral transforms
- Students should know the fundamental concepts of group theory.
- Be familiar with numerical interpolation and approximation of functions, numerical integration and differentiation
- The students can understand, apply the mathematical concepts to solve the problems in physics.

Unit I - COMPLEX VARIABLES: Functions of a complex variable– Analytic functions – Cauchy – Riemann conditions and equation – Conjugate functions – Complex Integration – Cauchy’s integral theorem, integral formula – Taylor’s series and Laurent Series – Poles, Residues and contour integration - Cauchy’s residue theorem – Computation of residues - Evaluation of integrals.

Unit II - FOURIER SERIES AND FOURIER TRANSFORMS:

Fourier series – Dirichlet conditions – Complex representations – Sine and Cosine series – Half range series – Properties of Fourier Series – Physics applications of Fourier series – The Fourier Transforms – Applications to boundary value problems

Unit III - APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS & GREENS FUNCTION:

Solutions of one dimensional wave equation- one dimensional equation of heat conduction-Two dimensional heat equations – Steady state heat flow in two dimensions – Green’s Function – Symmetry properties - Solutions of Inhomogeneous differential equation - Green’s functions for simple second order differential operators.

Unit IV - GROUP THEORY: Basic definition of a group – Subgroups – Classes – Isomorphism Homomorphism – Cayley’s theorem – Endomorphism and automorphism – Important Theorems of Group representations – Unitary theorem – Schur’s Lemma – Equivalent Theorem – Orthogonality Theorem – Some special groups – Unitary Group – Point Group – Translation Group – Homogenous and Inhomogenous Lorentz groups – Direct product group

Unit V - NUMERICAL METHODS: Finite Differences – Shifting Operator – Numerical Interpolations – Newton’s forward and backward formula – Central Difference interpolation – Lagrange’s Interpolation – Numerical Differentiation – Newton’s and Stirling’s Formula – Numerical Integration – Trapezoidal Rule – Simpson’s 1/3 and 3/8 rule – Numerical Solution of ordinary differential equations – Runge-Kutta methods – Piccard’s Methods

Reference Books

1. B.D.Gupta – Mathematical Physics –Vikas Publishing House, 3rd edition, 2006
2. B.S.Rajput – Mathematical Physics –Pragati Prakashan – Meerut, 17th edition, 2004
3. K.T.Tang – Mathematical Methods for Engineers and Scientists –Springer Berlin Heidelberg New York ISBN,10 3,540,30273,5 (2007)
4. K.F.Riley, M.P.Hobson and S.J.Bence, Mathematical Methods for Physics and Engineering – Cambridge University Press – ISBN 0 521 81372 7 (2004)
5. Hans J.Weber and George B.Arffken – Essential Mathematical Methods for Physicists – Academic Press, U.S.A. – ISBN 0,12,059877,9 (2003)
6. Satya Prakash, Mathematical Physics Including Classical Mechanics, Sultan Chand & Sons, New Delhi, ISBN,13: 9788180544668 (2007).

17PH3008 ATOMIC AND MOLECULAR SPECTROSCOPY

Credits 3:0:0

Course Objective:

- Students will understand that physical and chemical properties of matter result from subatomic particles that behave according to physical rules not apparent in the behavior of macroscopic objects, and they must realize the importance of spectroscopy in establishing this behavior.
- Students must be able to know the need for spectroscopy in solving the structure of molecules
- Students will study the principles and the theoretical framework of different spectroscopic techniques.

Course Outcome:

Students will be able to

- Understand how spectroscopic studies in different regions of the E.M spectrum probe different types of molecular transitions
- Apply suitable spectroscopic techniques to interpret the structure of the molecule
- Solve the structure of molecules using theory learned from the spectroscopic techniques
- Appreciate the advancements in instrumentation by overcoming the drawbacks in each spectroscopic technique
- Compare the spectroscopic techniques based on merits and demerits
- Identify the best method to solve the spectroscopic problems

Unit I - Atomic and Molecular Structure: Central field approximation – Thomas – Fermi Statistical model – Spin-orbit interaction – Alkali atoms – Doublet separation – Intensities - Complex atoms – Coupling Schemes – Energy levels – Selection rules and intensities in dipole transition – Paschen back effect

Unit II - Microwave Spectroscopy - Rotation of molecules- Diatomic Molecules- Intensities of Spectral Lines- Effect of Isotope Substitution- Non-rigid Rotator- Polyatomic Molecules- Techniques and Instrumentation

Unit III - Infra-red Spectroscopy - Vibration of Diatomic Molecules- Anharmonic Oscillator- Vibrating Rotator- Vibration- Rotation Spectrum of Carbon Monoxide-Breakdown of Born-Oppenheimer Approximation- Vibration of Polyatomic Molecules- Vibration-Rotation Spectra of Polyatomic Molecules-Techniques and Instrumentation

Unit IV - Raman Spectroscopy: Quantum Theory of Raman Effect- Classical Theory- Molecular Polarizability- Rotational Raman Spectra-Vibrational Raman Spectra-Polarization of Light and Raman Effect- Structural Determination- Techniques and Instrumentation

Unit V - Electronic Spectroscopy: Electronic Spectra of Diatomic Molecules- Born-Oppenheimer Approximation- Franck-Condon Principle- Dissociation Energy- Rotational Fine Structure- Fortrat Diagram- Predissociation- Polyatomic Molecules- Re-emission from Excited Molecules.

Reference Books:

1. Modern Spectroscopy; J.M.Hollas, John Wiley, (2004)
2. Introduction to Atomic Spectra, Harvey Elliot White. McGraw-Hill, 1934
3. Fundamentals of Molecular Spectroscopy by C. N. Banwell, Tata McGraw-Hill Publ.Comp. Ltd. (2010)
4. Molecular Spectra and Molecular Structure: G. Herzberg Van Nostrand, 1950

17PH3009 ELECTROMAGNETIC THEORY

Credits 3:0:0

Course Objective

The course aims to provide

- To learn the basics of electricity and magnetism and equations governing them.
- To acquire the knowledge of Electromagnetic field theory that allows the student to have a solid theoretical foundation to be able in the future to design emission , propagation and reception of electro magnetic wave systems
- To identify , formulate and solve fields and electromagnetic waves propagation problems in a multi disciplinary frame individually or as a member of a group

Course outcome:

Students will be able to

- Solve the problems in different EM fields.
- Design a programming to generate EM waves subjected to the conditions
- Do the applications of EM Waves in different domains and to find the time average power density
- Solve Electromagnetic Relation using Maxwell Formulae
- Solve Electro Static and Magnetic to Static circuits using Basic relations
- Analyse moving charges on Magnetic fields

Unit I - ELECTRO STATICS: Electric field, Gauss Law – Scalar potential – Multipole expansion of electric fields – The Dirac Delta function – Poisson's equation – Laplace's equation – Green's theorem – Uniqueness theorem – electrostatic potential energy and energy density. Electrostatics in matter- Polarization and electric displacement vector- Electric field at the boundary of an interface- Clausius - Mossotti equation.

Unit II - MAGNETO STATICS: Biot and Savart law – Differential equations of magnetostatics and Ampere's law – The magnetic vector potential – The magnetic field of distant circuit – Magnetic moment – The magnetic scalar potential – Macroscopic magnetization – Magnetic field.

Unit III - TIME VARYING FIELDS: Electromagnetic induction – Faraday's law – Maxwell's equations – Displacement current – Vector and Scalar potentials – Gauge transformation – Lorentz gauge – Columb's gauge – Gauge invariance – Poynting's theorem.

Unit IV - PLANE ELECTROMAGNETIC WAVES: Plane wave in a non conducting medium – Boundary conditions – Reflection and refraction of e.m. waves at a plane interface between dielectrics – Polarization by reflection and total internal reflection - Waves in a conducting or dissipative medium.

Unit V - ELECTRODYNAMICS: Radiation from an oscillating dipole – Radiation from a half wave antenna – Radiation damping – Thomson cross section – Lienard – Wiechert Potentials – The field of a uniformly moving point charge.

Reference Books

1. Classical Electrodynamics, J. D. Jackson, John Wiley & Sons, 1998
2. Foundations of Electro Magnetic Theory – John R. Reits, Fredrick J. Milford & Robert W. Christy. Narosa Publishing House (1998)
3. Electromagnetics: B. B. Laud, New Age International 2nd Edition (2005)
4. Electromagnetic Waves and Radiating Systems, E. C. Jordan, K. G Balmain, PHI Learning Pvt. Ltd., 2008
5. Engineering Electromagnetics, W. H. Hayt, J. A., Buck, Tata McGraw-Hill, 2011.

17PH3010 QUANTUM MECHANICS II

Credits 3:0:0

Course Objective

- Learn how to apply quantum mechanics to solve problems in atomic physics
- Understand time dependent perturbation theory using quantum mechanics
- Get knowledge on the formulation of quantum field theory

Course Outcome:

Students will be able to

- Understand, evaluate and describe the theories, concepts and principles of the current knowledge for the chosen topic
- Ability to use the perturbation theory and other approximations to solve questions in atomic physics.
- Familiarity on the principles of adiabatic approximation and use these principles to explain time evolution in simple quantum systems
- Understanding of the advanced quantum mechanical concepts on scattering and radiation.
- Knowledge of quantum mechanical solution of relativistic problems and quantum fields
- Have appropriate skill in analytical, theoretical and/or practical techniques to further their understanding in the chosen topic.

Unit I - TIME DEPENDENT PERTURBATION THEORY: Time Dependent Perturbation Theory-First and Second Order Transitions-Transition to Continuum of States-Fermi Golden Rule-Constant and Harmonic Perturbation-Transition Probabilities-Selection Rules for Dipole Radiation-Collision-Adiabatic Approximation.

Unit II - SCATTERING THEORY: Scattering Amplitude - Expression in terms of Green's Function - Born approximation and its validity- Partial wave analysis - Phase Shifts - Scattering by coulomb and Yukawa Potential.

Unit III - THEORY OF RADIATION (SEMI CLASSICAL TREATMENT): Einstein's Coefficients- Spontaneous and Induced Emission of Radiation from Semi Classical Theory- Radiation Field as an Assembly of Oscillators-Interaction with Atoms-Emission and Absorption Rates-Density Matrix and its Applications.

Unit IV - RELATIVISTIC WAVE EQUATION: Klein Gordon Equation-Plane Wave Equation- Charge and Current Density-Application to the Study of Hydrogen Like Atom-Dirac Relativistic Equation for a Free Particle-Dirac Matrices -Dirac Equation in Electromagnetic Field -Negative Energy States.

Unit V - QUANTUM FIELD THEORY: Quantization of Wave Fields- Classical Lagrangian Equation- Classical Hamiltonian Equation - Field Quantization of the Non-Relativistic Schrodinger Equation-Creation, Destruction and Number Operators-Anti Commutation Relations- Quantization of Electromagnetic Field Energy and Momentum.

Reference Books

1. A Text Book of Quantum Mechanics -P.M. Mathews & K. Venkatesan-Tata McGraw Hill 2007
2. Quantum Mechanics – G Aruldas - Prentice Hall of India 2006
3. Introduction to Quantum Mechanics – David J.Griffiths Pearson Prentice Hall 2005
4. Quantum mechanics, Satya Prakash & Swati Saluja, kedar Nath Ram Nath & Co,Meerut, 2007
5. Quantum Mechanics – L.I Schiff - McGraw Hill 1968
6. Quantum Mechanics - A.K. Ghatak and S. Loganathan-McMillan India,2004

17PH3011 NUCLEAR AND PARTICLE PHYSICS

Credits: 3:0:0

Course Objective:

- To help the students understand the basic properties and structure of the nucleus.
- To understand the basis of nuclear stability with relation to Weizsacker Semi Empirical mass formula and various nuclear models
- To make the students learn about various radioactive decay modes

Course Outcome:

Students will be able to

- Understand about the structure of nucleus
- Comprehend the forces inside the nucleus.
- Have knowledge about fission and fusion reactions
- Know various radioactive decay modes.
- Clearly understand the classification scheme of fundamental particles.
- Know about the the four fundamental forces of interaction.

Unit I - Nuclear Structure: Basic properties – magnetic moments – Experimental determination – Quadrupole moments – Experimental techniques – Systems of stable nuclei – Semi empirical mass formula of Weizsacker – Nuclear stability – Mass parabolas – liquid drop model – Shell model.

Unit II - Nuclear Forces: Ground state of Deuteron – magnetic dipole moment of Deuteron – charge independence and spin dependence of nuclear forces – Meson theory – Spin orbit and tensor forces – Exchange forces.

Unit III - Radio Activity: Alpha emission – Geiger – Nuttall law – Gamow's theory – Fine structure of alpha decay – Neutrino hypothesis – Fermi's theory of beta decay – Curie plot – Energies of beta spectrum – Fermi and G.T. Selection rules – Non-conservation of parity – Gamma emission – selection rules – Transition probability – Internal conversion – Nuclear isomerism.

Unit IV - Nuclear Reactions: Level Widths in nuclear reaction – Nuclear Reaction cross sections – Partial wave analysis – Compound nucleus model – Resonance Scattering – Breit – Wigner one level formula – Optical model – Direct reactions – Stripping and pick-up reactions – Fission and Fusion reactions: Elementary ideas of fission reaction – Theory of fission – Elementary ideas of fusion – Controlled Thermonuclear reactions, Swimming pool type reactor –Fusion power.

Unit V - Particle Physics: Classification of fundamental forces and elementary particles – Isospin, strangeness – Gell-Mann Nishijima's formula – Quark model, SU (3) Symmetry, CPT invariance in different interactions parity non conservation – K meson.

Reference Books

1. Concepts of Nuclear Physics – B.L. Cohen – McGraw-Hill – 2001.
2. Introduction to Nuclear Physics – H.A. Enge – Addison-Wesley, 1983.
3. Introduction to Particle Physics : M. P. Khanna Prentice Hall of India (1990)
4. Nuclear and particle Physics : W. Burcham and M. Jobes, Addison-wesley (1998)
5. S N Ghoshal, Nuclear Physics 1st Edition, S.Chand Publishing, 1994.
6. Irving Kaplan, Nuclear Physics 2nd Edition, Narosa Publishing House, 2002.
7. Kenneth S.Krane, Introductory Nuclear Physics 1st Edition, Wiley India Pvt Ltd, 2008.
8. S L Kakani, Nuclear and Particle Physics, Viva Books Pvt Ltd.-New Delhi, 2008.
9. Gupta, Verma, Mittal, Introduction to nuclear and particle physics, 3/E 3rd Edition, PHI Learning Pvt. Ltd-New Delhi, 2013.
10. Samuel S. M. Wong, Introductory Nuclear Physics 1st Edition, PHI Learning, 2010.

17PH3012 SPECTROSCOPY

Credits 3:0:0

Course Objective:

- Students will understand that physical and chemical properties of matter result from subatomic particles that behave according to physical rules not apparent in the behavior of macroscopic objects, and they must realize the importance of spectroscopy in establishing this behavior.
- Students must be able to know the need for spectroscopy in solving the structure of molecules
- Students will learn how the resonance spectroscopic techniques are used in atomic and molecular structure determination

Course Outcome:

Students will be able to

- Understand how spectroscopic studies in different regions of the E.M spectrum probe different types of molecular transitions
- When the structure of the molecule is to be interpreted, students will apply suitable spectroscopic techniques
- Solve the structure of molecules using theory learned from the spectroscopic techniques
- Appreciate the advancements in instrumentation by overcoming the drawbacks in each spectroscopic technique
- Compare the spectroscopic techniques based on merits and demerits
- Identify the best method to solve the spectroscopic problems

Unit I - NMR Spectroscopy: NMR – Basic principles – Classical and Quantum mechanical description – Bloch equation – Spin – Spin and spin lattice relaxation times – Experimental methods – Single Coil and double coil methods – Pulse method

Unit II - ESR Spectroscopy: ESR basic principles – High Resolution ESR Spectroscopy – Double Resonance in ESR- ESR spectrometer.

Unit III - Nuclear Quadrupole Resonance Spectroscopy: N Q R Spectroscopy – Basic Principles – Quadrupole Hamiltonian Nuclear Quadrupole energy levels for axial and nonaxial symmetry – N Q R spectrometer – chemical bonding – molecular structural and molecular symmetry studies.

Unit IV - Mossbauer Spectroscopy: Basic principles, spectral parameters and spectrum display, applications to the study of bonding and structure of Fe²⁺ compounds. Isomer shift, quadrupole splitting, hyperfine interaction, instrumentations and applications.

Unit V - Mass Spectroscopy: Introduction- ion production- fragmentation- ion analysis- ion abundance- common functional groups- high resolution mass spectroscopy- instrumentation and application.

Reference Books:

1. Fundamentals of Molecular Spectroscopy by C. N. Banwell, Tata McGraw-Hill Publ. Comp. Ltd. (2010)
2. Modern Spectroscopy; J.M.Hollas, John Wiley, (2004)High Resolution NMR- Pople,
3. Schneidu and Berstein. McGraw-Hill, (1959)
4. Principles of Magnetic Resonance - C.P. Slitcher, Harper and Row, (1963)
5. Basic Principles of Spectroscopy R. Chang, R.E. Krieger Pub. Co.(1978)
6. Nuclear Quadrupole Resonance Spectroscopy - T.P. Das and Hahn , Supplement, (1958)

17PH3013 SOLID STATE PHYSICS

Credit: 3:0:0

Course Objective:

- To study about various solid state properties and its functions
- To understand the fundamental concepts of solid state physics and the methods available to determine their structure and properties
- To gain knowledge about the various theories of solid state physics in the development of materials and its properties

Course Outcome:

Students will be able to

- Describe the elementary models for bonding of atoms and molecules and the Classifications used in solid state physics; relate the general properties (electrical, thermal and optical) to the mechanical properties.
- Give a detailed description of the features of the vibrations of monatomic and of diatomic linear chains
- Describe various solid state phenomena theories and discuss the scattering of phonons, and the concepts of Brillouin zone, Density of States, Fermi energy, effective mass and holes
- Describe the theories involved in the magnetic and superconducting materials phenomena
- Distinguish between various types magnetic and superconducting materials and its applications
- apply the various solid state physical phenomena in the development of materials for specific applications

Unit I - Lattice Vibrations: Elastic vibration – Mono atomic lattice – Linear diatomic lattice – optic and acoustic modes – infrared absorption – localized vibration – quantization of lattice vibration – Phonon momentum. Band Theory of Solids Energy bands in solids – Nearly free electron model – Bloch's theorem – Kronig and Penny model – Tight bound approximation – Brillouin zone – Fermi surface – density of states – de Hass – Van Alphen effect.

Unit II - Dielectric And Ferroelectric Properties: Dielectric constant and polarisability – Local field – different types of polarization – Langevin function – Clausius – Mosotti relation – Dipolar dispersion – Dipolar polarization in solids – Ionic Polarisability, Electronic Polarisability – Measurement of dielectric constant. Ferroelectricity – General properties – Dipole theory.

Unit III - Magnetic Properties: Quantum theory of Paramagnetism – Paramagnetism of ionic crystals – Rare earth ions – Ferromagnetism – Weiss theory – Temperature dependence of magnetism – Exchange interaction – Ferromagnetic domains surfaces – Bloch Wall – Antiferromagnetism – Molecular field theory – Neel temperature – Ferrimagnetism.

Unit IV - Optical Properties: Point defects in crystals - Colour centres – Photoconductivity – Electronic Transitions in photoconductors – Trap capture, recombinations centres – General mechanism – Luminescence – Excitation and emission – Decay mechanism – Thermo luminescence and glow curves – Electroluminescence.

Unit V - Super Conductivity: Zero resistance – Behavior in magnetic field – Meissner effect – thermodynamics of super conductive materials – Electro dynamics – London equations – B.C.S. theory (qualitative) - Tunneling A.C. and D.C. Josephson effect – Type I and II superconductors – High T_c super conductors (basic ideas)

Reference Books

1. Introduction to Solid State Physics- Kittel, John wiley, 8th edition, 2004
2. Elementary Solid State Physics, M. Ali Omar, Pearson Education, 2004
3. Introductory solid state Physics, H.P.Myers, Second edition, Taylor and Francis, 2009
4. Advanced Solid State Physics, P.Philips, Cambridge University Press, 2012
5. Solid State Physics, Neil W. Ashcroft, N. David Mermin, Cengage Learning, 2011
6. Solid State Physics, R.J.Sing, Pearson, 2012.
7. Introduction to Solid State Physics, Kittel, John Wiley, 8th edition, 2004
8. Solid State Physics, S.O. Pillai New Age Publications, 2002

17PH3014 PHYSICS OF NANOMATERIALS

Credits 3:0:0

Course Objective:

- To recall the Quantum concepts and density of states
- To compare the different thin film coating techniques
- To understand the theoretical concepts of nanomaterials

Course Outcome:

Students will be able to

- Apply the knowledge to prepare Nano materials
- Interpret different nano structures
- Examine the characteristics of nanomaterials
- Design nano devices for sensing

- Measure the properties of nanomaterials through different techniques
- Appraise the MEMS and NEMS technology

Unit I - INTRODUCTION TO NANO: Basic concepts of nano materials – Density of states of 1,2 and 3D quantum well, wire, dot-Schrodinger wave equation for quantum wire, Quantum well, Quantum dot-Formulation of super lattice- Quantum confinement- Quantum cryptography

Unit II - FABRICATION OF NANOSCALE MATERIALS: Top-down versus Bottom-up –Thin film deposition -Epitaxial growth -CVD, MBE, plasma - Lithographic, photo, e-beam - Etching -Synthesis -Colloidal dispersions - Atomic and molecular -manipulations –Self assembly -Growth modes, Stransky-Krastinov etc –Ostwald ripening

Unit III - ELECTRICAL AND MAGNETIC PROPERTIES : Electronic and electrical properties-One dimensional systems-Metallic nanowires and quantum conductance -Carbon nanotubes and dependence on chirality -Quantum dots –Two dimensional systems -Quantum wells and modulation doping -Resonant tunnelling –Magnetic properties Transport in a magnetic field - Quantum Hall effect. -Spin valves -Spin-tunnelling junctions -Domain pinning at constricted geometries -Magnetic vortices.

Unit IV - MECHANICAL AND OPTICAL PROPERTIES :Mechanical properties hardness – Nano indentation - Individual nanostructures -Bulk nanostructured materials-Ways of measuring- Optical properties-Two dimensional systems (quantum wells)-Absorption spectra -Excitons - Coupled wells and superlattices -Quantum confined Stark effect

Unit V - NANODEVICES : Background -Quantization of resistance -Single-electron transistors - Esaki and resonant tunneling diodes -Magnetic Nanodevices -Magnetoresistance –Spintronics- MEMS and NEMS

Reference Books

1. Introduction to Nanotechnology, Charles P.Poole, Jr. and Frank J.Owens, Wiley, 200
1. Silicon VLSI Technologies, J.D.Plummer, M.D.Deal and P.B. Griffin, Prentice Hall, 2000
2. Introduction to Solid State Physics, C.Kittel, a chapter about Nanotechnology, Wiley, 2004

17PH3015 PHOTONICS

Credits 3:0:0

Course Objectives:

- To learn various processes involving in the development of laser.
- To understand the various applications using lasersTo know the working and fabrication of optical fibers
- To learn modern experimental techniques in optics and photonics in the context of learning about optical fiber communication systems.

Course Outcome:

Students will be able to

- Understand the fabrication and application of various lasers and optical fiber
- Define and explain the propagation of light in conducting and non-conducting media
- Define and explain the physics governing laser behaviour and light matter interaction
- Apply wave optics and diffraction theory to a range of problems
- Apply the principles of atomic physics to materials used in optics and photonics
- Calculate the properties of various lasers and the propagation of laser beams

Unit I - PROPERTIES OF GAUSSIAN BEAMS: The paraxial wave equation, Gaussian beams, the ABCD law for Gaussian beams, Gaussian beam modes of laser resonators. Higher order Gaussian beam modes. Diffraction theory of laser resonators, unstable resonators for high power lasers.

Unit II - LASERS: Quantum theory of laser: Lasers – Einstein A-B Coefficients, round trip gain, matrix method, He-Ne laser, Ruby, Nd: YAG, Nd: glass lasers, liquid lasers and dye laser amplifiers. Theory of Q-switching and mode locking process, devices for Q-switching and mode locking, high power Co₂ laser, Ti:Sapphire laser. Theory of semiconductor lasers and devices. Laser, Applications

Unit III - NONLINEAR OPTICS-I: Introduction to nonlinear optics, nonlinear polarization and wave equation, second harmonic generation, phase matching, three-wave mixing, parametric amplifications, oscillations, tuning of parametric oscillators, nonlinear susceptibilities, nonlinear susceptibility tensor, nonlinear materials

Unit IV - NONLINEAR OPTICS-II: Propagation of light through isotropic medium, propagation light through anisotropic medium, theory of electro-optic, magneto-optic and acousto-optic effects and devices, integrated optical devices and techniques.

Unit V - FIBER OPTICS: Overview of Optical Fibers: Structure of optical fibers. Step-index and graded index fibers; Single mode, multimode and W-profile fibers. Ray Optics representation. Meridional and skew rays. Numerical aperture and acceptance angle. Multipath dispersion materials – Material dispersion -Combined effect of material and multipath dispersion – RMS pulse widths and frequency response - Model Birefringence - Attenuation in optical fibers - Absorption - Scattering losses -Radiative losses.

Reference Books

1. Laser Spectroscopy- Basic Concepts: W. Demtroder, Springer-Verlag, (2003)
2. The Elements of Fibre Optics: S.L.Wymer and Meardon (Regents/Prentice Hall), (1993)
3. Lasers and nonlinear Optics: B. B. Laud, New Age International (P) Ltd. (2007)
4. Laser Electronics: J. T. Verdeyen, Prentice-Hall Inc. (1995).
5. Laser Fundamentals: W. T. Silfvast, Cambridge University Press, (2003)

17PH3016 THIN FILM TECHNOLOGY

Credits 3:0:0

Course Objective:

- To gain knowledge on vacuum pumps and its functioning
- To compare different vacuum measuring gauges
- To Analyse the growth process of thin film

Course Outcome:

Students will be able to

- To create vacuum to a particular order
- Measure the vacuum level
- Illustrate the mechanism behind thin film deposition
- Analyse the thin film characteristics through different tools
- Apply thin films in fabricating electronics devices
- Appraise the latest technology of MEMS and NEMS

Unit I - Vacuum system: Categories of deposition process, basic vacuum concepts, pumping systems- rotary, diffusion and turbo molecular , monitoring equipment –McLeod gauge, pirani, Penning , Capacitance diaphragm gauge - Evaporation – deposition mechanism, evaporation sources- tungstenhelical, hair pin, basket, molybdenum boat, process implementation, deposition condition

Unit II - Thin film coating techniques: Molecular beam epitaxy, sputtering - dc, rf, magnetron, chemical vapour deposition, electroplating- potentiostat, galvanostat, pulsed plating, sol gel coating, LASER ablation, spray Pyrolysis-Substrate materials, material properties – surface smoothness, flatness, porosity, mechanical strength, thermal expansion, thermal conductivity, resistance to thermal shock, thermal stability, chemical stability, electrical conductivity -Substrate cleaning, substrate requirements, buffer layer, metallization

Unit III - Growth process: Adsorption, surface diffusion, nucleation, surface energy, texturing, structure development, interfaces, stress, adhesion, temperature control - Epitaxy-semiconductor devices, growth monitoring, composition control, lattice mismatch, surface morphology

Unit IV - Structural, Optical and electrical studies on thin films: X- Ray Diffraction studies –Bragg's law – particle size – Scherrer's equation – crystal structure – UV Vis NIR Spectroscopy - absorption and reflectance- Optical constants of a thin film by transmission and reflectance at normal incidence for a system of an absorbing thin film on thick finite transparent substrate, Photoluminescence (PL) studies –Fourier Transform Infrared Spectroscopy(FTIR) - Electrical properties: dc electrical conductivity as a function of temperature - Hall effect – types of charge carriers – charge carrier density

Unit V - Thin film applications: Material selection, Design and Fabrication of Thin film resistor – Thin film capacitor – Thin film diode – Thin film transistor – Transparent conducting oxide Thin films – Semiconducting Thin films – Thin film solar cells – CdS and Cu₂S based solar cells – CdS - Cu₂S and CdS or Cu In Se₂ solar cells – Thin film mask blanks for VLSI – Thin films sensors - for gas detectors. Magnetic sensors- storage device- magnetic thin films for MEMS and NEMS application

Reference Books

1. Thin Film Technology Handbook by Aicha Elshabini, Aicha Elshabini-Riad, Fred D. Barlow, McGraw-Hill Professional, 1998
2. Thin film Technology, Chopra, Tata McGraw-Hill, 1985
3. Handbook of Thin-film Deposition Processes and Techniques: Principles, Method, equipment and Applications By Krishna SeshanWilliam Andrew Inc., 2002
5. Handbook of thin film technology, L.I.Maissel and R.Glang, McGraw Hill Book Company, New York (1983).
6. Thin-film deposition: principles and practice by Donald L. Smith, McGraw-Hill Professional, 1995
7. An Introduction to Physics and Technology of Thin Films by Alfred Wagendristel,

17PH3017 RENEWABLE ENERGY SOURCES

Credits 3:0:0

Course Objective:

- To give an overview of the energy problem faced by the current generation
- To give a thorough knowledge about various renewable energy technology and to give a glimpse of cutting edge research technology that is happening place in the field of renewable energy sources. Convert units of energy—to quantify energy demands and make comparisons among energy uses, resources, and technologies.
- Collect and organize information on renewable energy technologies as a basis for further analysis and evaluation.

Course Outcome :

Students will be able to

- List and generally explain the main sources of energy and their primary applications in the world.
- Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment.
- Discuss remedies/potential solutions to the supply and environmental issues associated with
- Understand about fossil fuels and other energy resources.
- List and describe the primary renewable energy resources and technologies.
- Describe/illustrate basic electrical concepts and system components.

Unit I - BASIC CONCEPTS OF ENERGY SOURCES: Available Energy Sources – Classification of Energy Sources – Commercial and Noncommercial Energy Sources – Fossil Fuels and Climate Change issues – Renewable Energy Resources – Advantages and Limitations of Renewable Energy sources.

Unit II - SOLAR ENERGY: Solar radiation at the Earth's Surface – Solar Radiation Measurements – Solar Cell – Solar Energy Collectors – Flat-plate Collectors, Concentrating Collector: Focusing Type – Solar Energy Storage – Applications of Solar Energy – Solar Water Heating, Solar Pumping, Solar Furnace, Solar Cooking.

Unit III - WIND-ENERGY: Wind Energy Technology – Aerodynamics – Wind Energy Conversion – Basic Components Of a WECS (Wind Energy Conversion System) – Classification of WECS – Wind Energy Collectors – Wind Energy Storage – Applications of Wind Energy.

Unit IV - ENERGY FROM BIO-MASS: Photosynthesis Process – Bio Fuels – Bio mass Resources – Bio-mass Conversion Technologies – Wet processes and Dry Processes – Classification of Bio-gas plants – Bio-gas from plant Wastes – Materials Used For Bio-gas generation – Utilization of Bio-gas -- Methods for Obtaining energy from Bio-mass.

Unit-V - ENERGY FROM OTHER SOURCES: Energy From The Oceans – Energy And Power from the Waves – Tide and Wave Energy conversion – Advantages and Disadvantages Of Wave Energy – Ocean Thermal Energy Conversion - Geothermal Energy - Chemical Energy Sources – Fuel Cells and Batteries – Hydrogen Energy – Thermionic and Thermoelectric Generators – Micro Hydel Powers

Reference Books

1. Non-Conventional Energy Sources, G.D. Rai, Standard Publishers Distributors, ISBN 9788186308295 (2004)
2. Non-Conventional Energy Sources, B.H.Khan, Tata McGraw Hill (2006) ISBN 07- 060654-4

3. Renewable Energy, Godfrey Boyle, Oxford University Press in association with the Open University, (2004), ISBN 9780199261789
4. Renewable energy: sources for fuels and electricity, Thomas B. Johansson, Laurie Burnham, Island Press, (1993), ISBN 9781559631389
5. Renewable energy: sustainable energy concepts for the future, Roland Wengenmayr, Thomas Bührke, Wiley-VCH, (2008), ISBN 9783527408047
6. Renewable Energy: Sources and Methods, Anne Maczulak, Infobase Publishing, (2009), ISBN 9780816072033

17PH3018 RADIATION TREATMENT AND PLANNING

Credits: 3:0:0

Course Objective:

- To gain knowledge on radiotherapy machines
- To understand the interaction of photon beam on matter
- To learn about various calibration methods

Course Outcome:

Students will be able to

- The students will gain knowledge on radiotherapy machines
- The students will be able to understand the interaction of photon beam on matter
- The students will be enabled to undertake various calibration methods to ensure better quality treatment using machines.
- The students will be able to execute clinical treatment planning
- Various radiation treatment modalities will be learnt by the students.
- Knowledge on electron beam therapy and advanced radiotherapy treatment methods will have been learnt by the students.

Unit I - RADIOTHERAPY MACHINES: X-rays and Gamma rays - Linear accelerator-Components of modern linacs - Injection system - RF power generation system - Accelerating wave guide - Microwave power transmission - Auxiliary system - Electronic beam transport – Linac treatment head - Production of photon and electron beams from linac - Beam collimation - Cobalt-60 versus linac - Radiation therapy simulators.

Unit II - PHYSICAL ASPECTS OF EXTERNAL PHOTON BEAMS: Photon beam sources - Inverse square law - Penetration of photon beams into phantom or patient - Surface dose - Build up - Skin sparing effect - Percentage depth dose - Tissue air ratio – Back scattering factor - Tissue phantom ratio - Tissue maximum ratio - Scatter air ratio - Total scatter factor - Isodose distribution in water phantom - Isodose charts and factors effecting – Correction of irregular counters - Missing tissue compensation - Correction of tissue inhomogeneity – Clarkson's method - Dose calculation.

Unit III - CLINICAL TREATMENT PLANNING IN PHOTON BEAMS AND RECENT ADVANCES: Treatment planning - Volume definition - ICRU 50, ICRU 62 concepts – GTV – CTV – ITV – PTV – OAR - Dose specification - Patient data acquisition – Simulation – Conventional simulation - Isodose curves - Wedge filters – Bolus - Compensating filters - Field separation

Unit IV - PHYSICAL ASPECTS OF ELECTRON BEAM THERAPY: Production of electron beams - Interaction of electron with matter - Range concept – Percentage depth dose - Electron energy specification - Scattering power - Rapid dose fall off – Electron shielding - Dose prescription and thumb rule - Field inhomogeneity - Dose build up – Photon contamination - Back scatter – Collimation - Virtual SSD - Oblique incidence.

Unit V - ADVANCED RADIOTHERAPY TREATMENT METHODS: Treatment planning system - Imaging in radiotherapy - Image fusion - CT simulation - Basics of 3-Dimensional conformal therapy - Beams eye view - Digitally reconstructed radiograph - 3-D Conformal Radiotherapy – Plan evaluation methods - Dose volume histograms – Treatment evaluation – Introduction to Intensity Modulated Radiotherapy and Image Guided Radiotherapy - Stereotactic Radiosurgery and Stereotactic Radiotherapy- Tomotherapy - Particle beam therapy.

Reference Books

1. Review of Radiation Oncology Physics - A Hand book for Teachers and Students, EB. Podgorsak, International Atomic Energy Agency, 2005
2. Radiation therapy Physics, WR. Hendee and GS. Ibbott, J. Wiley, 2004

3. The Physics of Radiation Therapy, FM. Khan, Wolters Kluwer, 2003
4. Treatment Planning in Radiation Oncology, FM. Khan and RA. Potish, Williams & Wilkins, 1998
5. Introduction to Radiological Physics and Radiation Dosimetry, FH. Attix, Wiley, 1986

17PH3019 MEDICAL RADIATION DOSIMETRY

Credit 3:0:0

Course Objective:

- To learn the basic concepts of atoms and nucleus
- To understand the different types of radiation emitted from nuclear sources
- To help the students understand the interaction of radiation with matter

Course Outcome:

Students will be able to

- Thorough with the basic concepts of atoms and nucleus
- Understand the different types of radiation emitted from nuclear sources
- Understand the interaction of radiation with matter and apply the same in novel applications for peaceful purposes.
- Learn about various basic units of radiation measurements.
- Have knowledge on radiation detection and measurement.
- Impart the types and applications about dosimetry systems

Unit I - BASIC RADIATION PHYSICS: Atoms and nuclei – Fundamental particles - Atomic and nuclear structure - Mass defect and binding energy – Radiation - Classification of radiation - Electromagnetic spectrum – Radioactivity - Alpha, beta and gamma rays - Methods of decay – Isotopes - Radiation sources.

Unit II - INTERACTION OF RADIATION WITH MATTER: Types of indirectly ionizing radiation - Photon beam attenuation – Types of photon interactions - Types of electron interactions - Types of neutron interactions - Photo electric effect – Coherent scattering - Compton effect - Pair production - Photo nuclear disintegration - Effect following radiation interaction.

Unit III - RADIATION QUANTITIES AND UNITS: Radiometric, interaction, protection and dosimetric quantities - Particle and energy fluence - Linear and mass attenuation coefficient - Stopping power – Linear energy transfer – Absorbed dose - Kerma – Exposure – Activity - Equivalent dose - Effective dose - Electronic or charged particle equilibrium – Bragg gray cavity theory.

Unit IV - RADIATION DETECTION: Properties of dosimeters - Methods of radiation detection - Ionization chamber dosimetry system - Proportional counters - Geiger Muller counters – Semiconductor detector - Solid and liquid scintillation counters - Film dosimetry – Thermoluminescent dosimetry - Calorimetry – Chemical dosimetry

Unit V - CALIBRATION OF PHOTON AND ELECTRON BEAMS: Calibration chain – Ionization chambers - Electro meter and power supply – Phantoms – Chamber signal corrections for influence quantities - Calibration of mega voltage photon beams based and mega voltage electron beams based on standard national and international protocols.

Reference Books

1. Radiation Detection and Measurement, Glenn F. Knoll, John Wiley & Sons, 2010.
2. Review of Radiation Oncology - A Hand book for Teachers and Students by EB. Podgorsak, International Atomic Energy Agency, 2005
3. Radiation therapy Physics by WR. Hendee and GS. Ibbott, J. Wiley, 2004
4. Physics of Radiation Therapy by FM. Khan, Wolters Kluwer, 2003
5. Treatment Planning in Radiation Oncology by FM. Khan and RA. Potish, Williams & Wilkins, 1998
6. Introduction to Radiological Physics and Radiation Dosimetry by FH. Attix, Wiley, 1986

17PH3020 RESEARCH METHODOLOGY

Credits: 3:0:0

Course Objective

- To gain knowledge on various research tools available for carrying out research
- To identify the information source for literature review and data collection

- To develop understanding the basic framework and skills of research process.

Course Outcome

Students will be able to

- Describe the microscopic and spectroscopic methods and various data analysis.
- Give detailed description of mathematical tools to solve various research problems.
- Apply different mathematical concepts in numerical and statistical problem solving skills
- Apply and solve problems with computer programming languages like c and c++
- Solve quadratic equations and various first principle calculations
- Describe mathematical equations for effective research problem solving and analysis

Unit I - Structural Characterization: Production and properties of X-rays, X-ray analysis: X-ray diffraction; Effect of texture, particle size, micro and macro strain on diffraction lines. Scanning electron microscopy: construction, interaction of electrons with matter, modes of operation, image formation, Atomic probe microscopy and scanning tunneling microscopy: principles and practice

Unit II - Optical characterization: Ultraviolet and visible Spectroscopy: UV visible Spectrophotometers- Measurement of Absorption-Infrared Spectroscopy- Fluorescence and Phosphorescence : Measurement of Fluorescence-Spectrofluorometers – Photoluminescence: light-matter interaction, instrumentation- Electroluminescence: instrumentation, Applications

Unit III - Statistical Methods: Correlation- comparison of two sets of data- comparison of several sets of data- Chi squared analysis of data- characteristics of probability distribution- some common probability distributions- Measurement of errors and measurement process – sampling and parameter estimation- propagation of errors- curve fitting- group averages – equations involving three constants- principle of least squares- fitting a straight line, parabola and exponentials curve method of moments

Unit IV - Numerical methods\: Solution of differential equations – simple iterative method- Newton Raphson method – Numerical by integration – Simpson rule – Gaussian quadrature- solution of simultaneous equation – Gauss Jordan elimination method- Eigenvalue and eigenvectors by matrix diagonalization (Jacobian method)

Unit V - Application of Numerical and statistical methods using C++ Programming Solving quadratic equations — solution of equation by Newton Raphson method – matrix diagonalization (Jacobian method) – Integration by Simpson's rule – Fitting of a straight line using principle of least square

Reference Books

1. B.K.Sharma, Spectroscopy Goel publishing house, 2007
2. Elements of X-ray Diffraction by B.D. Cullity (II edition), Addison-Wesley Publishing Co. Inc., Reading, USA, 1978.
1. Electron Microscopy and Analysis by P.J. Goodhew and F.J. Humphreys, Taylor and Francis, London, 1988
2. Electron Microscopy: Principles And Fundamentals, S. Amelinckx, D. van Dyck, J. van Landuyt and G. van Tendeloo (Editors), VCH, Weinheim, 1997.
3. Atomic Force Microscopy / Scanning Tunneling Microscopy, S.H. Cohen and Marcia L. Lightbody (Editors), Plenum Press, New York, 1994.
4. Computer applications in Physics- Suresh Chandra, Narosa publishing hours (2003)
5. Numerical methods for Mathematics, Science and Engineering – John H. Mathews, Prentice Hall, India (2000)

17PH3021 MATERIAL CHARACTERIZATION

Credits: 3:0:0

Course Objective

- To introduce basic techniques for materials characterization.
- To introduce the working principles and instrumentation of main techniques.
- To understand the analysis of materials using electron microscopy and optical methods

Course Outcome

Students will be able to

- Identify suitable techniques for specific materials characterization.

- Use various instrumentations to scan and test materials for electrical, mechanical and thermal property analysis
- Analyse the structural and compositional properties of materials using XRD, SEM, XPS, EDAX and AFM
- Apply the microscopic and macroscopic property analysis for various materials
- Analyse the magnetic properties of materials and functions
- Practice the testing of materials for various thermal property analysis.

Unit I - MICROSCOPIC METHODS: Optical Microscopy: Optical Microscopy Techniques – Bright & dark field optical microscopy- phase contrast microscopy- Differential interference contrast microscopy – Fluorescence Microscopy- Scanning probe microscopy (STM, AFM) – Scanning new field optical microscopy – X-Ray Diffraction methods - Rotating crystal- Powder method – Debye- Scherrer camera- Structure factor calculations- EBSD & ED.

Unit II - SPECTROSCOPIC METHODS: Principles and Instrumentation for UV-Vis-IR, FTIR Spectroscopy, Raman Spectroscopy, NMR, XPS, AES and SIMS-proton induced X-Ray Emission spectroscopy (PIME) – Rutherford Back Scattering (RBS) analysis – application.

Unit III - ELECTRON MICROCOPY AND OPTICAL CHARACTERISATION: SEM, EDAX, EPMA, TEM, STEM working principle and Instrumentation- sample preparation- data collection, processing and analysis- Photoluminescence-light-matter interaction- instrumentation- Electroluminescence-instrumentation- Applications

Unit IV - THERMAL ANALYSIS: Introduction- Thermogravimetric analysis (TDA)- instrumentation- determination of weight loss and decomposition products- differential thermal analysis (DTA) – cooling curves – differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermomechanical parameters- Chromatography- Liquid & Gas Chromatography.

Unit V - ELECTRICAL, MECHANICAL & MAGNETIC ANALYSIS: Two probe and four probe methods- van der Pauw method- Hall probe and measurement scattering mechanism- C-V characteristics- Schottky barrier capacitance- impurity concentration- Mechanical and Magnetic Analysis: Vickers Hardness test - Vibrating Sample Magnetometer- Working principle of VSM- Instrumentation.

Reference Books

1. Atomic Force Microscopy/ Scanning Tunneling Microscopy, S.H.Cohen & Marcia L.Lightbody (Editors), plenum press, Newyork, 1994.
2. Principles of Thermal analysis and calorimetry by P.J.Haines (Editor), Royal Society of chemistry (RSC), Cambridge, 2002.
3. B.D.Cullity, “Elements of X-Ray diffraction” (II Edition) Addison Wesley publishing Co., 1978.
4. Lawrence E.Murr, Electron and Ion Microscopy and Microanalysis principles and Applications, Mariel Dekker Inc., Newyork, 1991.
5. B.D.Cullity, “Elements of X-Ray diffraction” (II Edition) Addison Wesley publishing Co., 1978
6. Lawrence E.Murr, Electron and Ion Microscopy and Microanalysis principles and Applications, Mariel Dekker Inc., Newyork, 1991.

17PH3022 CRYSTAL GROWTH TECHNIQUES

Credits 3:0:0

Course Objective

- To study the basic knowledge about the nucleation mechanism involved in crystal growth
- To understand the broad areas of crystal growth methods such as melt, solution, vapour transport.
- To understand some of the advanced crystal growth systems such as CVD and PVD.

Course Outcome:

Students will be able to

- Students can understand the different techniques used for growing crystals
- To review physics and chemistry in the context of materials science & engineering.
- To describe the different types of bonding in solids, and the physical ramifications of these differences.
- To describe and demonstrate diffraction, including interpretation of basic x-ray data.
- To describe introduction to metals, ceramics, polymers and electronic materials in the context of a molecular level understanding of bonding.

- To give an introduction to the relation between processing, structure and physical properties.

Unit I - FUNDAMENTALS OF CRYSTAL GROWTH: Importance of crystal growth – classification of crystal growth methods -Theories of nucleation – Classical theory – Gibbs Thomson equation for vapor solution and melt energy of formation of a nucleus –Adsorption at the growth surface – Nucleation – Homogeneous andHeterogeneous nucleation – Growth surface.

Unit II - GROWTH FROM LOW TEMPERATURE SOLUTIONS: Solution – selection of solvents – solubility and super solubility – Saturation and super saturation – Meir’s solubility diagram – Metastable zone width – measurement and its enhancement – Growth by (i) restricted evaporation of solvent, (ii) slow cooling of solution and (iii) temperature gradient methods – Growth in Gel media, Electrocrystallization.

Unit III - GROWTH FROM FLUX AND HYDROTHERMAL GROWTH: Flux Growth – principle – choice of flux – Growth kinetics – phase equilibrium and phase diagram – Growth techniques – solvent evaporation technique – slow cooling technique - transport in a temperature gradient technique – Accelerated crucible rotation technique – Top seeded solution Growth – Hydrothermal Growth.

Unit IV - GROWTH FROM MELT: Basis of melt growth – Heat and transfer – Growth techniques – conservative processes – Bridgman – Stockbarger method – pulling from the melt – Czochralski method (CZ) – cooled seed Kyropoulos method – Non- conservative processes – zone refining – vertical, horizontal floatzone methods –Skull melting Process – Vernueil method – flame fusion, plasma and arc image methods.

Unit V - GROWTH FROM VAPOUR: Basic principle – physical vapour deposition (PVD) – Evaporation and Sublimation processes – sputtering – chemical vapour Deposition (CVD) – Advantages and disadvantages – chemical vapour transport – Fundamentals – Growth by chemical vapour transport (CVT) Reaction.

Reference books

1. Ichiro Sunagawa, Crystal Growth, Morphology and performance, Cambridge University press, (2005).
2. Mullin, J. N, ‘Crystallization’, Butternmths, London (2004)
3. Hand book of crystal growth, Volume 1, 2 & 3. Edited by D. T. J. Hurle North Holland – London (1993)
4. Brice, J. C. Crystal Growth processes – Halsted press, John Wiley & sons, (1986)
5. Elwell. D and Scheel. H. J, crystal growth from High Temperature solutions, Academic press, London (1975)

17PH3023 RADIATION PHYSICS

Credits: 3:0:0

Course Objectives:

- To review the basic physics principles of atomic and nuclear physics
- To know about the basic radiation detection mechanisms and various types of detectors.
- To illustrate the importance of counting statistics and other statistical tools in radiation measurements.

Course Outcome:

Students will be able to

- Understand the basic physics principles of atomic and nuclear physics
- Know the basics of radiation physics and interaction of radiation with matter
- The various absorption mechanisms of radiation and particles will be known by the students.
- Know about the basic radiation detection mechanisms and various types of detectors.
- The importance of counting statistics and other statistical tools in radiation measurements will be learnt by the students.
- The peaceful applications of radiation will be understood by the students.

Unit I - REVIEW OF PHYSICAL PRINCIPLES :Mechanics – Units and dimensions – Work and energy – Relativity effects – Electricity – Electrical charge: the statcoulomb – ElectricPotential: the statvolt – Electric Field – Energy Transfer – Elastic and inelastic collision –Electromagnetic waves – Excitation and ionization – Periodic table of the elements – Thewave mechanics atomic model – The nucleus – The neutron and the nuclear force – Isotopes –The atomic mass unit – Binding energy – Nuclear models - Nuclear stability

Unit II - RADIOACTIVITY AND INTERACTION OF RADIATION WITH MATTER:

Radioactivity and decay mechanism – Kinetics of decay – The units of radioactivity – Seriesdecay – Alpha rays – Range-energy relationship – Energy transfer – Beta rays – Range energyrelationship – Mechanism of energy loss –

ionization and excitation – Gamma rays – Exponential absorption – Absorption mechanisms – Pair production – Compton scattering – Photoelectric effects – Neutrons – Production – Classification – Interaction

Unit III - METHODS OF MEASURING RADIATION: Gas filled detectors – Ionization chamber – Proportional counters – Geiger Muller Counter – Scintillation detection systems – Photomultipliers – Scintillators – Semiconductor detectors – Principles of operation – Charged particle detectors – Thermoluminescent detectors – High purity Germanium Detectors – Track devices – Photographic emulsion – Track etch dosimeters – Spark counters and spark chambers – Miscellaneous detectors

Unit IV - COUNTING STATISTICS AND CALIBRATION OF INSTRUMENTS: Uncertainty in the measuring process – Various types of distribution – Error Propagation – Accuracy of counting measurements – Significance of data from statistical view point – Calibration and standards – Source calibration – Neutron sources – X-ray machines – Calibration of detection equipment

Unit V - RADIATION IN THE ENVIRONMENT AND THEIR APPLICATIONS : Types of radiation sources – Natural radiation sources – Artificial sources of radiation – Applications of radiations – Medical applications – Industrial applications – Radiation in food processing industry – Agricultural applications – Isotope hydrology – Miscellaneous applications

Reference Books

1. Nicholas Tsoulfanidis, Sheldon Landsberger, Measurement and Detection of Radiation, Third Edition, CRC Press; 2010
2. Radiation Detection and Measurement, Glenn F. Knoll, John Wiley & Sons, 2010,
3. Radiation Physics for Medical Physicists, Ervin B. Podgorsak, Springer, New York (2010)
4. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed, Academic Press, Elsevier (2007)
5. Environmental Radioactivity From Natural, Industrial & Military Sources, Merrill Eisenbud and Thomas F. Gesell, Academic Press, (1997, Fourth Edition)
6. G.G. Eicholz and J.W. Poston, Principles of nuclear radiation detection, ANN Arbor Science, 1985

7PH3024 NANOFLUIDS

Credit: 3:0:0

Course Objective:

- To know the basics of nanofluids
- To understand the basics of conductive and convective heat transfer
- To learn the application of nanofluids

Course Outcome:

Students will be able to

- Understand the fundamentals of cooling and thermal support
- Synthesis nanofluids
- Understand the conduction of heat transfer
- Analyse the fundamentals of convective heat transfer
- Know about boiling and various cooling mechanism
- Find the various industrial application of nanofluids

Unit I - INTRODUCTION TO NANOFLUIDS: Fundamentals of Cooling - Fundamentals of Nanofluids – Making Nanofluids – Materials for Nanoparticles and Nanofluids – Methods of Nanoparticle Manufacture – Dispersion – Milestones in Thermal conductivity measurements – Milestones in Convection Heat Transfer – Mechanism and Models for enhanced thermal support: Structure based Mechanism and Models – Dynamics based Mechanism and Models

Unit II - SYNTHESIS OF NANOFLUIDS: Single step method – Two step method – Synthesis of colloidal Gold nanoparticles : Turkevich method – Brust method – Microwave Assisted Synthesis – Sonolysis – Electrochemical Reduction – Thermal Decomposition – Chalcogenides – Solvothermal Synthesis – Magnetic Nanofluids – Inert Gas Condensation

Unit III - CONDUCTION HEAT TRANSFER IN NANOFLUIDS: Conduction Heat Transfer Steady Conduction: Conduction in slab – Hollow cylinder – composite cylinder- Transient conduction: Lumped-parameter method – One Dimension Transient Conduction - Measurement of Thermal Conductivity of Liquids : Guarded Hot

Plate method – Transient Hot wire – Temperature oscillation method (No derivation) – Thermal conductivity of Oxide nanofluids – Hamilton Crosser Theory (Al_2O_3 – Water and Al_2O_3 – Ethylene Glycol)

Unit IV - CONVECTION IN NANO FLUIDS: Fundamentals of Convective Heat Transfer – Newton's law of cooling – equations of fluid flow and heat transfer: Navier-Stokes equations, Reynolds number - Prandtl number - Nusselt number - Natural convection : Grashof number, Rayleigh number – Experimental study of natural convection - Convection in Suspensions and Slurries: Eulerian-Eulerian approach – Eulerian-Lagrangian approach

Unit V - POOL BOILING AND APPLICATION OF NANOFLUIDS: Fundamentals of Boiling : Nukiyama curve - Nucleate boiling –Experimental study of Pool Boiling of Water- Al_2O_3 Nanofluids – Applications of nanofluids: Vehicle cooling , Transformer cooling, Biomedical applications

Reference Books

1. Nanofluids: Science and Technology, Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep, John Wiley sons, 2007
2. Holman J.P., 'Heat Transfer', SI Metric Ed., Mc Graw Hill, ISE, 1972.
3. Heat and Mass Transfer, R.K. Rajput, S. Chand, 2008
4. Heat transfer Principles and applications, Binay K. Dutta, Prentice, Hall of India Pvt. Ltd, New Delhi, 2001.

17PH3025 GENERAL PHYSICS LAB I

Credits: 0:0:2

Course Objective:

- To get practical skill on basic optical experiments.
- To get practical skill on non-ideal elements, such as lasers and optics in experiments..
- To get practical skill on basic sound and ultrasonic experiments.

Course Outcome:

Students will be able to

- Apply knowledge on basic Physics experiments to solve practical problems.
- Apply experimental principles and error calculations to electromagnetism.
- Analyze basic quantities in electromagnetism.
- Present concepts and describe scientific phenomena.
- Design experiments, and analyze and interpret data.
- Get practical skill on analyzing the Magnetic properties of the material

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

17PH3026 GENERAL PHYSICS LAB II

Credits: 0:0:2

Course Objective:

- To get practical skill on digital electronics.
- To get practical skill in studying the characteristics of low power semiconductor devices.
- To get practical skill on analyzing the characteristics of Diode and transistor.

Course Outcome:

Students will be able to

- Understand the practical difficulties in measuring the standard parameters.
- Architecture of microprocessors and methodology of programming
- Design basic electric circuits using software tools.
- Identify, formulate and solve engineering problems with simulation.
- Experience in building and troubleshooting electronic circuits.
- Write simple program using microprocessor for practical applications.

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

17PH3027 ADVANCED PHYSICS LAB I

Credits: 0:0:4

Course Objective:

To learn practical skills on

- Thin film coating devices
- Operation of physical method of thin film preparation
- Synthesis of thin films through chemical route

Course Outcome:

Student will be able to

- Apply the knowledge preparation of thin films
- Demonstrate physical method of thin film preparation
- Demonstrate the chemical method of thin film preparation
- Evaluate the electrical properties of thin films
- Estimate the hall measurements
- Characterize the optical properties and to find the band gap.

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

17PH3028 ADVANCED PHYSICS LAB II

Credits 0:0:4

Course Objective:

- To get practical skill on various deposition techniques
- to prepare thin films and
- Crystals having nanostructures

Course Outcome:

Student will be able to

- Fabricate novel nano structures
- Fabricate nano thin films
- Fabricate nano devices
- Fabricate electronics devices
- solve the output properties of the devices
- evaluate the efficiency of the devices

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

17PH3029 MATERIALS CHARACTERIZATION LAB

Credit: 0:0:2

Course Objective:

To train the students to operate

- Spectrophotometer
- X-Ray diffractometer
- Scanning electron microscope

Course outcome:

Students will be able to

- Demonstrate optical properties through Spectrophotometer
- Evaluate the structure through XRD
- Identify the morphology through SEM
- Appraise the surface roughness through AFM
- Calculate the dielectric constant through Impedance analyser
- Plot the IV characteristics through NI work station.

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

17PH3030 COMPUTATIONAL PHYSICS LAB

Credits: 0:0:2

Course Objective:

- To provide students with an opportunity to develop knowledge and understanding of the key principles of computational physics.
- Synchronising computational skills acquired with requirements of theoretical physics courses.
- Developing numerical, computational and logical skills relevant for solution of theoretical and experimental physics problems.

Course Outcome:

Students should be able to:

- Demonstrate knowledge in essential methods and techniques for numerical computation in physics
- Apply the programming skills to solve practical problems.
- Apply numerical and statistical problem solving skills and computer programming skills to solve research problems.
- Use appropriate numerical method to solve the differential equations governing the dynamics of physical systems
- Apply different methods to solve deterministic as well as probabilistic physical problems
- Employ appropriate numerical method to interpolate and extrapolate data collected from physics experiments

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

17PH3031 SIMULATIONS IN STATISTICAL PHYSICS LAB

Credit: 0:0:2

Course Objective:

- To introduce nonlinear statistical modeling methods to the students.
- To understand the molecular simulation for various materials structures
- To give students both theoretical and practical capabilities to design and analyse various structural models

Course Outcome:

- Gain knowledge in simulation software and become expertise in molecular simulations
- Analyze the behavior of the structural models after simulation
- Identify the suitable simulation method for the selected structural model
- Provide statistical information through simulation and thereby aid in solving the practical problem
- To make student understand the advantages and limitations of various simulation
- To make student understand the advantages of methods commonly used in physics and engineering using simulation

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

17PH3032 HEAT AND OPTICS LAB

Credit: 0:0:2

Course Objective:

- To train the students on Optics and Heat experiments to understand the basic concepts.
- To learn about the light and diffraction phenomena using prism experiment
- To study about the Heat experiments to understand the conduction phenomena

Course outcome:

Students will have the ability to

- Demonstrate the practical skills on measurements and instrumentation techniques through physics experiments.
- Describe the concepts and principles of heat through practical experiments

- Analyze different measurements for effective understanding of the methods involved.
- Describe the concepts and principles of light and its phenomena through practical experiments
- Workout calculations, property analysis of heat and optic measurements and to bring results
- Apply the learned concepts for different applications related heat and optics

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

17PH3033 ASTROPHYSICS

Credits: 3:0:0

Course Objective:

- To impart the knowledge about ancient astronomy and solar system models
- To make the students understand about our immediate cosmic surroundings that is our solar system.
- To provide with a fundamental understanding about the stars and their properties

Course outcome:

- The students will have knowledge about ancient astronomy and solar system models
- The students will learn more intricate details about our solar system.
- The life cycle of a star, the birth, the life and a death of a star and different types of stars will be understood by the students.
- The students will have knowledge about various windows to explore the heavens.
- The students will understand cosmology on a larger scale like the evolution of a galaxy and clusters of galaxies.
- Various theorems regarding the formation of the universe till be learnt by the students.

UNIT I - THE SOLAR SYSTEM : Various Solar System Models – The Solar System in Perspective: Planets, Moons, Rings and Debris – Other Constituents of Solar System – Kepler's laws of planetary motion.

Unit II - THE STARS : The Sun – Important Properties of stars – Measuring the distances of a star – The Parallax Method – The Formation of Stars and Planets – Types of Stars – White dwarfs, Neutron Stars and Black Holes – Star Clusters – Supernovae and their types

Unit III - TELESCOPES AND DETECTORS : Optical Telescopes – The Hubble Space Telescope – Detectors and Image Processing: Photography, Phototubes, Charge Couple Devices, Signal to Noise – The New Generation of Optical Telescopes. – Other Windows to Heaven

Unit IV - THE MILKY WAY GALAXY : Interstellar Matter - The Shape and Size of the Galaxy – The Rotation and Spiral Structure of Galaxy – The Center of Galaxy – Stellar Populations – Different types of Galaxies – The Cosmological Distance Scale – The Local Group

Unit V - THE UNIVERSE: Clusters of Galaxies – Super Clusters of Galaxies - Hubble's Law – Cosmological Models – The Standard Big Bang Model – The Big Bounce Theory – The Fate of the Universe – The Big Crunch Theory – The Big Rip Theory – Life in the Universe

Reference Books

1. Michael Zeilik, Stephen .A. Gregory, Introductory Astronomy and Astrophysics, Fourth Edition, Saunders College Pub., Michigan, U.S.A, 1998 ISBN 9780030062285
2. A. B. Bhattacharya, S. Joardar, R. Bhattacharya, Astronomy and Astrophysics, Jones and Barlett Publishers, U.S.A., (2010) ISBN 978-1-934015-05-6
3. Martin V. Zombeck, Book of astronomy and Astrophysics, Cambridge University Press, U.K. (2007) ISBN 978-0-521-78242-5
4. Thanu Padmanabhan, Theoretical Astrophysics (Vol. I, II, II): Cambridge University Press, U.S.A., (2002) ISBN 0 521 56242 2
5. Wolfgang Kundt, Astrophysics: A new approach, Second edition, Springer, 2006
6. Introduction to AstroPhysics The Stars, Jean Dufay, Dover publications, 2012
Astrophysics for Physicists, Chaudhuri, University Press, 2010.

LIST OF COURSES

S.No.	Course Code	Name of the Course	Credits
1	16PH1001	Applied Physics for Engineers	3:0:1
2	16PH2001	Semiconductor Physics I	3:0:0
3	16PH2002	Properties of Matter Lab	0:0:2
4	16PH2003	Semiconductor Physics II	3:0:0
5	16PH2004	Semiconductor Logic Devices	3:0:0
6	16PH2005	Semiconductor Physics Lab-I	0:0:2
7	16PH2006	Semiconductor Physics Lab-II	0:0:2
8	16PH2007	Physics of Semiconductor Memories & Microprocessors	3:0:0
9	16PH2008	Physics of Linear Integrated Circuits & VLSI Design	3:0:0
10	16PH2009	Photonics	3:0:0

16PH1001 APPLIED PHYSICS FOR ENGINEERS

Credits: 3:0:1

Course objective

- To impart knowledge on aspects of applied physics in the areas of light, sound, electron wave, magnetism, superconductors and nuclear physics through experiments and hands on project.

Course outcome

Ability to

- Understand the uses of lasers
- Appreciate the acoustic and its use in buildings and medical field.
- To demonstrate the quantum mechanics in the applications of electron devices like LED's and in scanning electron microscopes.
- Appreciate the magnetic levitation and the applications of smart materials.
- Appreciate the applications of nuclear physics in power plants and radiation therapy.

Course Description

Light amplification in laser pointers, lasik surgery, Laser writing in compact disc. Propagation of light in optical fiber. fiber endoscope and optical fiber communication. Sound waves and musical instruments. acoustics of buildings, uses of ultrasound in medical scanning. Applications of quantum principles in light emitting diodes and display devices. Matter waves and its application in scanning electron microscope, magnetic properties of materials and storage devices, superconducting phenomena and magnetic levitation, shape memory alloys in arteries stent. Nuclear power plants based on nuclear fission, applications of nuclear concepts in radiation therapy and isotope dating.

References:

1. Jewet/Serway, Physics for Scientists and Engineers, 7th Edition, 2012.
2. Arthur Beiser, Shobhit Mahajan, Rai Choudry, Concepts of Modern Physics, 7th Edition, 2015.
3. Ashcroft, Mermin, Solid State Physics, 14th Edition, 2014.
4. W. Thomas Griffith, Juliet W.Brosing, The Physics of Every Day Phenamena, 8th Edition, 2014.
5. Rajendran, Engineering Physics, Tata McGraw Hill, 2014.

16PH2001 SEMICONDUCTOR PHYSICS I

Credits: 3:0:0

Course Objective:

To impart knowledge on

- Fundamental concepts in electronics and some electronic devices.
- Various analog communication techniques.

Course Outcome:

Ability to

- Understand about working mechanism of electronic devices.
- Gain knowledge about the semiconductor, integrated circuits
- Compare the various communication and its applications.

Course Description:

Basics of electronics - semiconductor devices, basic op-amp - transistor as an amplifier and a switch – oscillator principles - Digital System – Semiconductor memory – Integrated circuits -Microprocessor - transducers – signal conditioning unit – telemetry circuits – virtual instrumentation– Measuring instruments – communication system - Introduction to Noise – modulation & demodulation techniques – antenna principle –receiver & transmitter (audio/video) - Satellite communication – Fiber optics communication – Micro and Nano electronics.

Reference Books:

1. Albert Paul Malvino, “ Electronic Principles”, Tata McGraw Hill, 8th Edition, 2015.
2. Robert Boylestad and Louis Nashelsky,, “Electronic Devices & Circuit Theory”, Ninth Edition, PHI, 2013
3. Albert Paul Malvino, Donald P Leach, “Digital Principles and Applications”, Tata McGraw Hill, VII Edition, 2010.
4. Roody & Coolen, “Electronic Communication”, PHI, 1995
5. W.D. Cooper, A.D. Helfrick, “Modern Instrumentation and Measurement Techniques”, 5th Edition, 2002.
6. V.K.Metha.”Principles of Electronics”,Chand Publications,2008.
7. Anokh Singh, “Principles of Communication Engineering” S.Chand Co., 2001
8. Muthusubramanian R, Salivahanan S, Muraleedharan , “Basic Electrical Electronics & Computer Engineering “Tata Mc.Graw Hill, 2005.
9. Nanoelectronics and Nanosystems: From transistors to Molecular and Quantum Devices by K. Gosser (Edition, 2004), Springer. London.

16PH2002 PROPERTIES OF MATTER LAB

Credits 0:0:2

Course Objective:

To impart practical knowledge on

- Basic measurements
- Interpreting physics principles

Course Outcome:

Ability to

- Demonstrate measurements for various materials

- Apply the knowledge in measuring different properties of materials

The faculty conducting the Laboratory will prepare a list of 10 experiments and get the approval of HoD and notify it at the beginning of each semester

16PH2003 SEMICONDUCTOR PHYSICS II

Credits: 3:0:0

Course Objective:

To impart knowledge on

- Mechanisms of current flow in semi-conductors.
- Diode operation and switching characteristics
- Various instrumental Measurements

Course Outcome:

Ability to

- Analyze the principle of operation, capabilities and limitation of various electronic devices.
- Design circuits and analyze various components with the instruments.
- Apply the electronics circuits to design their electronics projects for general applications

Course Description:

Theory of PN Diodes - Open circuit junction – Forward and Reverse Characteristics - Diode Equation- Applications: Half wave rectifier, full wave rectifier, Bridge rectifier - Hall Effect - Theory of BJT, FET, UJT and Thyristor - Special Semiconductor Devices – LED, OLED, crystalline solar cells – LCD – optocouplers – Gunn diodes - Varactor diode – Transducers - Digital Instruments - Digital Voltmeters and Multimeters, - Data Display and Recording System - Computer Controlled Test System - Microprocessor based measurements.

Reference Books:

1. Millman & Halkias, "Electronic Devices & Circuits", Tata McGraw Hill, 2nd Edition, 2007.
2. Albert Paul Malvino, "Electronic Principles", Tata McGraw Hill, 8th Edition, 2015.
3. Rangan C.S., "Instrumentation Devices and Systems", Tata McGraw Hill, Second Edition, 1998.
4. W.D. Cooper, A.D. Helfrick, "Modern Instrumentation and Measurement Techniques", 5th Edition, 2002.
5. Robert Boylestad and Louis Nashelsky, "Electronic Devices & Circuit Theory", 9th Pearson Education Edition, 2009
6. Muthusubramanian R, Salivahanan S, Muraleedharan K, "Basic Electrical Electronics & Computer Engineering", Tata McGraw Hill, 2005

16PH2004 SEMICONDUCTOR LOGIC DEVICES

Credits 3:0:0

Course objective:

To impart knowledge on

- Number systems, binary codes and the basic postulates of Boolean algebra.
- Procedures for the analysis and design of combinational and sequential circuits
- Implementation of digital circuits in programmable logic devices and about different logic families.

Course Outcome:

Ability to

- Understands number systems, binary codes and the basic postulates of Boolean algebra.
- Acquire knowledge to design various combinational and sequential circuits.
- Implement digital circuits in programmable logic devices and different logic families

Course Description:

Number Systems & Boolean Algebra - Karnaugh map - Quine Mcclusky method- Combinational Logic Design : Logic gates – Combinational Logic Functions – Encoders & Decoders – Multiplexers & Demultiplexers –Code Converters – Comparator - Half Adder and Full Adder – Parallel Adder/Binary Adder – Parity Generator/Checker – Implementation of Logical Functions using Multiplexers, Flip flops: RS, JK, D&T flip flops - Counters &Registers: Asynchronous Counters - Synchronous Counters.

Reference Books

1. Morris Mano, "Digital logic and computer Design", 3rd edition Prentice Hall of India, 2002.
2. A. Anand Kumar, "Fundamental of Digital Circuits", PHI, 2nd Edition 2009.
3. Jain R.P, "Modern Digital Electronics", Third edition, Tata McGraw Hill, 2003
4. Floyd T.L., "Digital Fundamentals ", Prentice Hall, 9th edition, 2006.
5. V.K. Puri, "Digital Electronics: Circuits and Systems", Tata McGraw Hill, First Edition, 2006.

16PH2005 SEMICONDUCTOR PHYSICS LAB-I

Credit: 0:0:2

Course Objective:

To impart practical knowledge on

- The Characteristics of diodes, BJT, FET and some special purpose devices.
- Rectifiers, amplifiers, oscillators and regulators.
- Basic Network theorems.

Course Outcome:

Ability to

- Understand the characteristics of diodes, BJT, FET and special purpose devices
- Design circuits for rectifiers, amplifiers and regulators.
- Analyze different Network theorems.

The faculty conducting the Laboratory will prepare a list of 10 experiments and get the approval of HoD and notify it at the beginning of each semester

16PH2006 SEMICONDUCTOR PHYSICS LAB-II

Credit: 0:0:2

Course Objective:

To impart practical knowledge on

- Various Electron Devices and its operation
- Digital circuits design and programming of microprocessors.

Course Outcome:

Ability to

- Evaluate different electronic device characteristics
- Construct circuits using logic gates
- Apply programming for various microprocessors' applications.

The faculty conducting the Laboratory will prepare a list of 10 experiments and get the approval of HoD and notify it at the beginning of each semester

16PH2007 PHYSICS OF SEMICONDUCTOR MEMORIES & MICROPROCESSORS

Credits 3:0:0

Course Objective

To impart knowledge on

- Various semiconductor devices, transducers and measuring Instruments
- Microprocessor architecture and its functionalities
- Microprocessor programming for different applications

Course Outcome

Ability to

- Design and Analyze different electronic circuits
- Write simple microprocessor based programs.
- Apply microprocessor program for a simple applications

Course Description:

Electronic Circuits – zener regulator-I.C – Transistor Amplifier – CB, CE, CC – Power Amplifiers – Oscillators – Barkhausen Criterion - Colpits-Wien bridge and phase shift oscillators-OP-amp comparators – Block diagram of Microcomputer - Architecture of Intel 8085 - Instruction formats, Addressing methods- types of Instruction - Intel 8085 - Instruction set - Development of simple assembly language programs and examples - Memory and I/O devices and interfacing RAM, ROM, EPROM –CRT terminals- Printers-I/O ports-Key boards-ADC/DACs-memory interfacing-Asynchronous and synchronous data transfer schemes-interrupt driven data transfer- DMA data transfer- Simple applications of Microprocessors.

Reference Books

1. Albert Paul Malvino, “ Electronic Principles”, Tata McGraw Hill, 8th Edition, 2015.
2. Adithya P. Mathur, “ Introduction to Microprocessor”, Tata McGraw Hill, 3rd Edition, 2002.
3. Gaonkar R. S. , “ Digital computer electronics”, Willey Eastern,1991
4. Malvin Brown, Digital Computer Electronics (English) 3rd Edition, 2002.

16PH2008 PHYSICS OF LINEAR INTEGRATED CIRCUITS & VLSI DESIGN

Credits 3:0:0

Course objective:

To impart knowledge on

- Operational amplifier and its applications.
- Timer IC and its applications.
- Basics of VLSI Design.

Course outcome

Ability to

- Analyze Operational Amplifiers for arithmetic operations.
- Analyze timer IC for various application
- Utilize knowledge on IC fabrication.

Course Description:

OP-AMP Characteristics and Applications: Characteristics of ideal op-amp. Pin configuration of 741 op-amp – Applications: inverting and non-inverting amplifiers - inverting and non-inverting summers- VLSI Design Process- Layout Styles – Full Custom Design-Semi Custom Approach – NMOS, PMOS Inverter, CMOS Inverter - MOS & CMOS Layers – stick diagram – design rules & layout - Finite state machine – Hardware description Language - FPGA.

Reference Books

1. Roy Choudhury.D., Shail Jain, “Linear Integrated Circuits”, New Age International Publications, 3rd Edition,2007.
2. Gayakwad.A.R., ”Op-Amps & Linear IC’s”, PHI, 4th Edition,2004
3. Robert F. Coughlin, Frederick F. Driscoll, “Operational Amplifiers & LinearIntegrated Circuits”, PHI 6th Edition, 2001.
4. Sergio Franco, “Design with Operational Amplifier and Analog Integrated Circuits”,TMH, 3rd Edition, 2002.
5. Millman & Halkias,” Integrated Electronics”, Mac Graw Hill, 1991.

16PH2009 PHOTONICS

Credits: 3:0:0

Course Objective:

To impart knowledge on

- Basic principles of lasers and various types of lasers
- Basics of propagation of light in fibre optics.
- Photonics and its applications

Course Outcome:

Ability to

- Comprehend the laser principle and its applications.
- Demonstrate the photonics concepts in fiber optics and laser developments.

Course Description:

Characteristics of Lasers, Einstein’s coefficients and their relations, Lasing action, Working principle and components of CO₂ Laser, Nd-YAG Laser, Semiconductor diode Laser, Excimer Laser and Free electron Laser, Applications in Remote sensing, holography and optical switching, Mechanism of Laser cooling and trapping, optical fibers, Basic structure and optical path of an optical fiber, Acceptance angle and acceptance cone, Numerical aperture(NA) (General), Modes of propagation, Number of modes and cut-off parameters of fibers, Attenuation in optic fibers, classification of optical fibers, Fiber optic communication , Fiber optic sensors, Important features of photonic crystals , Dielectric mirrors and interference filters, photonic crystal laser, Photonic crystal fibers (PCFs) - Photonic crystal sensing.

References:

1. Ghatak and Tyagrajan, Introduction to Fiber Optics, Cambridge University Press. 2009
2. V. Rajendran, Engineering Physics, McGraw Hill Publishing company Ltd, 2014.
3. E. A. Saleh, A. C. Teich, Fundamentals of Photonics, John Wiley and Sons, 193
4. M. K. Ohtsu, Kobayashi, T. Kawazoe, T. Yatsui, Principles of Nanophotonics, Optics and Optoelectronics, CRC press, 2003.
5. Alberto Sona, Lasers and their Applications, Gordon and Breach Science Publishers Ltd., 1976.

LIST OF SUBJECTS

Sub. Code	Subject name	Credits
15PH3001	Advanced Mechanics of Solids	3:0:0
15PH3002	Classical Mechanics	3:0:0
15PH3003	Statistical Mechanics and Thermodynamics	3:0:0
15PH3004	Mathematical Physics I	3:1:0
15PH3005	Semiconductor Physics	3:0:0
15PH3006	Quantum Mechanics I	3:0:0
15PH3007	Physical Optics	3:0:0
15PH3008	Mathematical Physics II	3:1:0
15PH3009	Atomic and Molecular Spectroscopy	3:0:0
15PH3010	Electromagnetic Theory	3:0:0
15PH3011	Quantum Mechanics II	3:0:0
15PH3012	Nuclear and Particle Physics	3:0:0
15PH3013	Spectroscopy	3:0:0
15PH3014	Solid State Physics	3:0:0
15PH3015	Physics of Nanomaterials	3:0:0
15PH3016	Advanced Statistical Mechanics	3:0:0
15PH3017	Photonics	3:0:0
15PH3018	Thin Film Technology	3:0:0
15PH3019	Principles of Renewable Energy	3:0:0
15PH3020	Physics of Nanoscale Systems	3:0:0
15PH3021	Radiation Treatment and Planning	3:0:0
15PH3022	Medical Radiation Dosimetry	3:0:0
15PH3023	Research Methodology	3:0:0
15PH3024	Material Characterization	3:0:0
15PH3025	Crystal Growth Techniques	3:0:0
15PH3026	Radiation Physics	3:0:0
15PH3027	Nanofluids	3:0:0
15PH3028	Physics of Advanced Materials	3:0:0
15PH3029	Solitons in Optical Fibers	3:0:0
15PH3030	General Physics Lab I	0:0:2
15PH3031	General Physics Lab II	0:0:2
15PH3032	Advanced Physics Lab I	0:0:2
15PH3033	Advanced Physics Lab II	0:0:2
15PH3034	Materials Characterization Lab	0:0:2
15PH3035	Computational Physics Lab	0:0:2
15PH3036	Simulations in Statistical Physics Lab	0:0:2
15PH3037	Heat and Optics Lab	0:0:2
15PH3038	Properties of Matter Lab	0:0:2
15PH3039	Simulations of Nanoscale Systems	3:0:0
15PH3040	Astrophysics	3:0:0

15PH3001 ADVANCED MECHANICS OF SOLIDS

Credit: 3:0:0

Course Objective:

- To understand the kinematics of rigid bodies regarding force, energy, Impulse and momentum
- To learn about the translational and rotational motion of rigid bodies
- To learn about mechanical vibration

Course Outcome:

- Ability to relate the knowledge on mechanics to real bodies in motion
- Ability to understand and predict the motion of rigid bodies in space
- Ability to relate mechanical vibration of dynamic systems

Course Description:

Reduction of a System of Forces to One Force and One Couple,, Equivalent Systems of Forces, Systems of Vectors, Equilibrium of a Rigid Body in Two and three Dimensions,, Partial Constraints, Center of Gravity of two and three Dimensional Body, Centroid of a Volume, Composite Bodies, Moments of Inertia of Areas, Mass Products of Inertia, Ellipsoid of Inertia, Translational motion, Rotational motion about a Fixed Axis, General Plane Motion, Three-Dimensional Motion of a Particle. Coriolis Acceleration, Frame of Reference, Angular Momentum in Plane Motion, D'Alembert's Principle, Principle of Work and Energy, Principle of Impulse and Momentum for the Plane Motion, Conservation of Angular Momentum, Impulsive Motion, Eccentric Impact, Motion of an Asymmetrical Body, Mechanical vibration

Reference Books

1. Ferdinand P.Beer, E.Russell Johnston Jr. Phillip J. Cornwell, Vector Mechanics for Engineers :Statics and Dynamics, Ninth edition, McGraw-Hill, Higher education, 2010.
2. C. Goyal and G.S. Raghuvanshi, Engineering Mechanics, Second Edition, PH1 Learning, 2011.
3. J. L. Meriam, L. G. Kraige, Engineering Mechanics: Dynamics, John Wiley, 2012.
4. R. C. Hibbeler, Ashok Gupta Engineering Mechanics - Statics and Dynamics, Eleventh Edition, Pearson India, 2009.
5. R. S. Khurmi, A Textbook of Engineering Mechanics, S. Chand Publication, 2012

15PH3002 CLASSICAL MECHANICS

Credits: 3:0:0

Course Objective:

- To increase in the conceptual understanding of classical mechanics and develop problem solving skills
- To gain more experience and increased ability with the mathematics associated with Classical Mechanics

Course Outcome:

- To apply the techniques and results of classical mechanics to real world problems
- Effectively communicate problems and their solutions relevant to classical mechanics
- To apply physics principles to novel situations

Course Description

Constraints, Generalized coordinates, D'Alembert's principle and Lagrange's equations, Hamilton's Principle, Calculus of variation, Deduction of Lagrange's equations from Hamilton's Principle, applications, Reduction to the equivalent one body problem, differential equations of orbit, integrable power-law potentials, Kepler's problem: motion under inverse square force, Scattering in a central force field, The independent coordinates of a rigid body, orthogonal transformations, The Euler Angles, angular velocity vector in terms of the Euler angles, Small oscillation, Eigenvalue equation and the principal axis transformation, frequencies of free vibration, Triatomic molecule, Canonical transformations and the Hamilton equation of motion, Cyclic coordinates, Routh's procedure, Derivation of Hamilton's equations from variational principle, The equations of canonical transformation, Examples of canonical transformation, Hamilton-Jacobi equations for principle function, Harmonic Oscillator problem, Action angle variable.

Reference Books

1. Classical Mechanics, H. Goldstein, Narosa publishing house, Second Edition 2001
2. Classical Mechanics, S.L.Gupta, V. Kumar & H.V.Sharma, Pragati Prakashan, Meerut., 2003
3. Classical Mechanics, T. W. B. Kibble, Frank H. Berkshire, Imperial College Press, 2004
4. Classical Mechanics, J C Upadhyaya, Himalaya Publishing House, 2012
5. Introduction to Classical Mechanics, R. G. Takwale, P. S. Puranik, Tata McGraw-Hill, 2006
6. Classical Mechanics, John Robert Taylor, University Science Books, 2005
7. Classical Mechanics, Tai L.Chow, Taylor and Francis group, 2013

15PH3003 STATISTICAL MECHANICS AND THERMODYNAMICS

Credits 3:0:0

Course Objective:

- To explain the origin of the laws of thermodynamics from the fundamental principles of equilibrium statistical mechanics.
- To learn the basic principles of thermodynamics and statistical mechanics and apply them to describe equilibrium thermal properties of bulk matter.

Course Outcome:

- Students will understand the laws of thermodynamics and their consequences.
- Students will know about the applications of Statistical mechanics in thermodynamics

Course Description:

Laws of thermodynamics and their consequences, thermodynamic potentials, Maxwell Relations, Chemical potential, phase equilibria, Gibb's – Helmholtz relation, Nernst's, Gibb's phase rule, Phase space, micro and macrostates, Microcanonical, canonical, and Grand,canonical ensembles, Liouville theorem, Equal A priori Probability, partition Functions, properties, Ideal mono atomic gas, calculation of thermodynamic quantities, Gibbs paradox, Equipartition theorem,proof, Thermal characteristics of crystalline solids, Einstein and Debye model, Classical and Quantum statistics: Maxwell,Boltzmann statistics, Bose,Einstein statistics, Fermi,Dirac statistics, Black body radiation and Planck's distribution law, Bose,Einstein condensation, Ideal Fermi gas, degenerate electron gas, First order and second order phase transitions;

Reference Books

1. Fundamentals of Statistical and Thermal Physics, Federick Reif, McGraw,Hill, 1985.
2. Statistical Mechanics – B. K. Agarwal and M. Einsner, John Wiley & Sons,1988
3. Statistical Thermodynamics – M.C. Gupta, Wiley Eastern Ltd, 1990
4. Thermodynamics and statistical mechanics, By John M. Seddon, Julian D. Gale
Royal Society of Chemistry, 2001
5. Introduction to statistical mechanics – S.K.Sinha, Alpha Science International, 2005
6. Elements of Statistical Mechanics,Kamal Singh & S.P. Singh, S. Chand & Company,
New, 1999
7. An Introduction to Statistical Thermodynamics By Terrell L. Hill, 2007

15PH3004 MATHEMATICAL PHYSICS I

Credits 3:1:0

Course Objective:

- To review the basics of vector analysis and move on to the advanced level treatment of Vectors
- To give the students enough problems in matrices so as to prepare them for competitive exams
- To impart on the students the elementary knowledge about Tensors
- To enable the students to solve the first and second order differential equations and have a sound knowledge about special functions
- To give a basic understanding about the theory of probability and theory of errors.

Course Outcome:

- The students can understand and apply the mathematical concepts to solve the problems in physics.

Course Description

Vector analysis, Applications of vectors to Mechanics, Gauss's Divergence theorem, Green's theorem, Stoke's theorem, Matrices, Solutions of linear equations, Eigenvalues and Eigenvectors of matrices and their properties, Tensors, The summation convention and Kronecker Delta symbol, Covariant Tensors, Contra variant tensors, Mixed Tensors, Rank of a tensor, The Fourier Transforms, Applications to boundary value problems, Solutions of one dimensional wave equation, Green's Function, Solutions of Inhomogeneous differential equation, Green's functions for simple second order differential operators. Analytic functions, Cauchy – Riemann conditions and equation, Complex Integration, Cauchy's integral theorem, integral formula, Taylor's series and Laurent Series, Poles, Residues and contour integration, Cauchy's residue theorem, Special functions, Green's functions, Laplace transforms.

Reference Books

1. Mathematical Physics – B.D.Gupta – Vikas Publishing House, 3rd edition, 2006
2. Mathematical Physics – B.S.Rajput – PragatiPrakashan – Meerut, 17th edition, 2004
3. Mathematical Methods for Engineers and Scientists – K.T.Tang – Springer Berlin Heidelberg New York ISBN,10 3,540,30273,5 (2007)
4. Mathematical Methods for Physics and Engineering – K.F.Riley, M.P.Hobson and S.J.Bence, Cambridge University Press – ISBN 0 521 81372 7 (2004)
5. Essential Mathematical Methods for Physicists – Hans J.Weber and George B.Arflken – Academic Press, U.S.A. – ISBN 0,12,059877,9 (2003)
6. Mathematical Physics Including Classical Mechanics, SatyaPrakash, Sultan Chand & Sons, New Delhi, ISBN,13: 9788180544668 (2007)

15PH3005 SEMICONDUCTOR PHYSICS

Credits: 3:0:0

Course Objective:

- To learn about the different semiconductor devices
- To understand the concept of manufacturing of resistors, diodes, capacitors and inductors in a chip for various applications
- To get a knowledge about the operational amplifiers and to know the architecture and functioning of 8085 microprocessor
- To acquire the knowledge about the Boolean algebra and different memories

Course Outcome:

- Students gain knowledge about the semiconductor devices, IC manufacturing, different types of operational amplifiers, microprocessors and Boolean theorems.

Course Description

Fermi-level energy band diagrams, Uni-Junction Transistor, Relaxation Oscillator, FET, MOSFET, Common source amplifier, SCR, TRIAC, DIAC, Tunnel Diode, Integrated circuit technology, Basic monolithic integrated circuits, Monolithic diodes, integrated resistors, integrated capacitors and inductors large scale integration (LSI), medium scale integration (MSI) and small scale integration (SSI), Op. Amp characteristics, summing, integrating, Differentiating, Logarithmic, Antilogarithmic amplifier, wave generation, Multivibrators, Schmit trigger, Solution of differential equation, Analog computation, Microprocessor (μP) 8085 Architecture, Assembly language programming, Instruction classification, addressing modes, op code and operand, fetch and execute cycle, timing diagram, machine cycle, instruction cycle and T states, Boolean Algebra, Karnaugh map simplifications, counters, registers, Multiplexers, Demultiplexers.

Reference Books

1. Millman's Electronics Devices & Circuits by Jacob Millman, Christos C Halkias, Satyabrata, Tata McGraw-Hill Publishing Company Pvt. Ltd. 2008
2. Integrated Electronics – Millman. J. and Halkias C.C, McGraw Hill, 2004
3. Electronic Devices and Circuits – Allen Mottershead, Prentice Hall of India, 2009
4. Digital Principles and Applications – Malvino and Leach, Tata McGraw Hill, Co. 2008.
5. Principles of Electronics by V.K.Metha, Rohit Metha. 2006

15PH3006 QUANTUM MECHANICS I

Credits 3:0:0

Course Objective:

- To understand the general formulation of quantum mechanics
- To solve eigenvalue equations for specific physical problems
- To understand the operator concept of angular momentum, ladder operators and applications
- To get knowledge on the theoretical aspects of perturbation of atoms due to electric and magnetic fields
- Understand the theory of many electron systems

Course Outcome:

- Improved mathematical skills necessary to solve differential equations and eigenvalue problems using the operator formalism
- Quantum mechanical solution of simple systems such as the harmonic oscillator and a particle in a potential well.
- Solutions to perturbation problems and many electron systems

Course Description

Linear vector space, Linear operator, Normalisation of wavefunction, Probability current density, Hermitian operator, Postulates of quantum mechanics, General uncertainty relation, Dirac's notation, Expectation values, Equations of motion: Schrodinger, Heisenberg and Dirac representation, Momentum representation, Particle in a box, Linear Harmonic oscillator, Tunneling through a barrier, particle moving in a spherically symmetric potential, System of two interacting particles, Rigid rotator, Hydrogen atom, Orbital, Spin and Total angular momentum operators, Commutation relations of total angular momentum with components, Ladder operators, Commutation relation of J_z with J_+ and J_- , Eigenvalues of J^2 , J_z , Matrix representation of J^2 , J_z , J_+ and J_- , Time independent perturbation theory in nondegenerate case, Ground state of helium atom, Degenerate case, Stark effect in hydrogen atom, Spin-orbit interaction, Variation method & its application to hydrogen molecule, WKB approximation, Indistinguishable particles, Pauli principle, Inclusion of spin, spin functions for two electrons, Central Field Approximation, Thomas Fermi model of the Atom, Hartree Equation, Hartree Fock equation.

Reference Books

1. G. Aruldas, Quantum Mechanics, Prentice Hall of India, 2006
2. A Text Book of Quantum Mechanics, P.M. Mathews & K. Venkatesan – Tata McGraw Hill 2007
3. Quantum mechanics, Satya Prakash & Swati Saluja, Kedar Nath Ram Nath & Co, Meerut, 2007
4. Introduction to Quantum Mechanics – David J. Griffiths Pearson Prentice Hall 2005
5. Principles of Quantum Mechanics, R. Shankar, Springer 2005
6. Quantum mechanics, K.T. Hecht, Springer, 2000
7. Quantum mechanics theory and applications, Ajoy Ghatak and Lokanathan . S, Macmillan, 2004.

15PH3007 PHYSICAL OPTICS

Credits: 3:0:0

Course Objective

- To learn the working of various optical elements like lenses and mirrors.
- To understand the properties of light as a wave

Course Outcome

- Students demonstrate the usage of various optical elements like lenses and mirrors.
- Students apply the properties of light on research oriented problems.

Course Description

Analytical Ray Tracing, Matrix Methods for Lenses and Mirrors, Optical Cavity, Group Velocity, Anharmonic Periodic Waves, Linear Polarization, Circular and Elliptical Polarization, Polarizers, Birefringence, Polarization by Scattering and Reflection, Wave plates, Optical Activity, Interference, Conditions for Interference, Temporal and Spatial Coherence, Amplitude, Splitting Interferometers, Michelson and Mach Zehnder Interferometer, Multiple Beam Interference, Fabri-Perot Interferometer, Holography. Fraunhofer and Fresnel Diffraction, Single, Double and Many Slits, Diffraction Grating, Kirchhoff's Scalar Diffraction Theory. Fourier Transforms, One and Two, Dimensional Transforms, Optical Applications, Spectra and Correlation

Reference Books

1. Charles A. Bennett, Principles of Physical Optics, Wiley, (2008)
2. Eugene Hecht and A. R. Ganesan, Optics, Dorling Kindersely (India) (2008)
3. A. K. Ghatak, Optics, Tata McGraw Hill, (2008).
4. A.Lipson, S.G.Lipson and H.Lipson, Optical Physics, FRS, Cambridge University Press, 2011

15PH3008 MATHEMATICAL PHYSICS II

Credits: 3:1:0

Course Objective:

- To impart a thorough knowledge about elements of complex analysis
- To train the students in Fourier, series and Transforms and enable them to solve physics problems
- To give an understanding about integral Transforms and to understand Green's function and its applications to physics problems.
- To grasp the idea of group theory and its implications.
- To have a thorough knowledge about numerical methods

Course Outcome:

- The students can understand and apply the mathematical concepts to solve the problems in physics.

Course Description

Analytic functions, Cauchy – Riemann conditions and equation, Complex Integration, Cauchy's integral theorem, integral formula, Taylor's series and Laurent Series, Poles, Residues and contour integration, Cauchy's residue theorem, Fourier series, The Fourier Transforms, Applications to boundary value problems, Solutions of one dimensional wave equation, Green's Function, Solutions of Inhomogeneous differential equation, Green's functions for simple second order differential operators. Subgroups, Isomorphism Homomorphism, Cayley's theorem, Orthogonality Theorem, Direct product group, Finite Differences, Numerical Interpolations – Newton's forward and backward formula, Central Difference interpolation, Lagrange's Interpolation, Numerical Differentiation, Newton's and Stirling's Formula, Numerical Integration, Trapezoidal Rule, Simpson's 1/3 and 3/8 rule, Runge-Kutta methods, Piccard's Methods

Reference Books

1. B.D.Gupta – Mathematical Physics –Vikas Publishing House, 3rd edition, 2006
2. B.S.Rajput – Mathematical Physics –Pragati Prakashan – Meerut, 17th edition, 2004
3. K.T.Tang – Mathematical Methods for Engineers and Scientists –Springer Berlin Heidelberg New York ISBN,10 3,540,30273,5 (2007)
4. K.F.Riley, M.P.Hobson and S.J.Bence, Mathematical Methods for Physics and Engineering – Cambridge University Press – ISBN 0 521 81372 7 (2004)
5. Hans J.Weber and George B.Arffen – Essential Mathematical Methods for Physicists – Academic Press, U.S.A. – ISBN 0,12,059877,9 (2003)
6. Satya Prakash, Mathematical Physics Including Classical Mechanics, Sultan Chand & Sons, New Delhi, ISBN,13: 9788180544668 (2007)

15PH3009 ATOMIC AND MOLECULAR SPECTROSCOPY

Credits 3:0:0

Course Objective:

- To learn how these spectroscopic techniques are used in atomic and molecular structure determination
- To understand the principles and the theoretical framework of different Spectroscopic techniques
- To know the instrumental methods of different spectroscopic techniques

Course Outcome:

- Students can understand how spectroscopic studies in different regions of the E.M spectrum probe different types of molecular transitions

Course Description:

Electronic angular momentum, Spectrum of Hydrogen, Helium and Alkaline atoms, LS & JJ coupling, Zeeman, Paschen Bach and Stark effect, Hyperfine structure, Photoelectron spectroscopy, Characteristic of X-ray spectra and Moseley's law. Line broadening mechanisms, Fourier transform spectroscopy, Rotation of molecules, Diatomic and polyatomic molecules, Intensities of spectral Lines, Effect of Isotopic substitution, Non-rigid rotator, Simple Harmonic oscillator, Anharmonic oscillator, vibrating rotator, vibration of polyatomic molecules, vibration rotation-spectra of polyatomic molecules, Classical and Quantum Theory of Raman Effect, Rotational Raman spectra, Vibrational Raman spectra –Vibrational study of surfaces, Electronic Spectra of Diatomic Molecules, Vibrational Coarse structure, Franck-Condon Principle, Dissociation Energy, Rotational Fine Structure, Fortrat Diagram, Pre-dissociation, Electronic spectra of Polyatomic Molecules, Electronic spectroscopy of surfaces, Introduction to resonance spectroscopy

Reference Books:

1. C. N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy, 5th Edn. Tata McGraw-Hill Pub. Company Ltd. 2013
2. J.M.Hollas, Modern Spectroscopy; 4th Edition; John Wiley & Sons Ltd, 2004
3. G.Aruldas, Molecular Structure and Spectroscopy; Prentice Hall of India Pvt. Ltd., New Delhi, 2008
4. S.Wartewig; IR and Raman Spectroscopy: Fundamental Processing. WILEY-VCH Verlag GmbH & Co. 2003.
5. Pavia, Lapman and Kriz; Introduction to Spectroscopy; Thomson Learning Inc. 2001
6. B.H.Bransden and C.J.Joachain Physics of Atoms and Molecules, 2nd edition, Pearson Education, 2003.
7. P.Larkin, IR and Raman Spectroscopy; Principles and Spectral Interpretation, Elsevier Pub. 2011,
8. B.Stuart, Infrared Spectroscopy: Fundamentals and Applications; John Wiley & Sons, Ltd, 2004
9. Yong, Cheng Ning, Interpretation of organic spectra ; John Wiley & Sons (Asia) Pvt. Ltd., 2011
10. Peter Larkin; Infrared and Raman spectroscopy: principles and spectral interpretation; Elsevier Inc. 2011

15PH3010 ELECTROMAGNETIC THEORY

Credits 3:0:0

Course Objective

The course aims to provide

- To learn the basics of electricity and magnetism and equations governing them.
- To acquire knowledge of fundamentals of magnetism
- To know the Maxwell's equations
- To learn about the electromagnetic waves.

Course outcome:

- Students can know about the use of the fundamental concepts of electricity and
- magnetism in day to day life

Course Description:

Gauss Law, Scalar potential, Multipole expansion of electric fields, The Dirac Delta function, Poisson's equation, Laplace's equation, Green's theorem; Biot, Savart law; Ampere's law, Magnetic vector potential; Electromagnetic induction, Faraday's law, Displacement current, Maxwell's equations, Gauge transformations, Poynting's theorem; Plane wave in vacuum, Boundary conditions, Reflection and refraction of e.m. waves at a plane interface between dielectrics, Polarization by reflection and total internal reflection, E.M. Waves in a conducting and dissipative medium. Radiation from an oscillating dipole, Radiation from a half wave antenna, Radiation damping, Thomson cross section, Lienard- Wiechert Potentials.

Reference Books

1. J.D. Jackson. Classical electrodynamics, 3rd Edition, John & Wiley Sons, Inc. 2014.
2. David J. Griffiths. Introduction to Electrodynamics, 3rd Edition, Prentice-Hall, 2012.
3. Ashok Das Lectures on Electromagnetism, 2nd Edition, World Scientific, 2013.
4. Mathew N.O. Sadiku, Principles of Electromagnetics, 4th Edition, Oxford University Press, 2010.
5. William Hayt and John A Buck, Engineering Electromagnetics, 8th Edition, Mc-Graw Hill, 2006.
6. Jordon and Balmain Electromagnetic waves and radiating systems, 2nd Edition, Prentice Hall, 2001.
7. David K Cheng, Fundamental of electromagnetic, 2nd Edition, Pearson International Publishers, 2014.

15PH3011 QUANTUM MECHANICS II

Credits 3:0:0

Course Objective

Students will be able to

- understand time dependent perturbation theory using quantum mechanics get knowledge on theory of scattering and induced emission and absorption of radiation
- Understand the formulation of relativistic wave equation
- Get knowledge on the formulation of quantum field theory

Course Outcome:

Students will attain

- Understanding of advanced quantum mechanical concepts on perturbation, scattering and radiation
- Knowledge of Quantum mechanical solution of relativistic problems and quantum fields

Course Description:

Time Dependent Perturbation Theory, Transition to Continuum of States, Fermi Golden Rule, Transition Probabilities, Selection Rules for Dipole Radiation, Collision, Adiabatic Approximation; Scattering Amplitude, Born Approximation and Its validity, Partial wave analysis, Phase Shifts, Scattering by coulomb and Yukawa Potential; Semi Classical Theory, Radiation Field, Density Matrix and its Applications; Relativistic Schrödinger equations, Dirac Relativistic Equation for a Free Particle, Dirac matrices, Quantization of wave fields, Field Quantization of the Non-Relativistic Schrodinger Equation, Creation, Destruction and Number Operators, Anti Commutation Relations, Quantization of Electromagnetic Field Energy and Momentum.

Reference Books

1. P.M. Mathews & K. Venkatesan, A Text Book of Quantum Mechanics, Tata McGraw Hill 2007
2. G Aruldas, Quantum Mechanics Prentice Hall of India 2006
3. David J.Griffiths, Introduction to Quantum Mechanics Pearson Prentice Hall 2005
4. Addison-Wesley- Richard L. Liboff, Introductory Quantum Mechanics (4th edition ed.). (2002).
5. E. Merzbacher, Quantum Mechanics, 3rd Edition, John & Wiley Sons. Inc. 1998
6. Ashok Das, Lectures on Quantum Mechanics, 2nd Edition, Taylor & Francis, 2012
7. A. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, Springer-Verlag 2004

15PH3012 NUCLEAR AND PARTICLE PHYSICS

Credits: 3:0:0

Course Objective:

- To make the students understand the constituent particles and the forces existing inside the nucleus
- To give an idea about the nuclear reaction and nuclear reactors
- To give a brief idea about the elementary particles

Course Outcome:

- Students will understand about the structure of nucleus and the forces inside the nucleus. They learn about fission and fusion reactions and conditions for the controlled nuclear reaction which are applied in the reactors.

Course Description:

Nuclear Structure, Basic properties, Quadrupole moments, Systems of stable nuclei, Weizsacker Semi-empirical mass formula, Nuclear stability, Nuclear Models, Nuclear Forces, Ground state of Deuteron, charge independence and spin dependence of nuclear forces, Meson theory, Spin orbit and tensor forces, Exchange forces, Radio Activity, Gamow's theory of Alpha decay, Neutrino hypothesis, Fermi's theory of beta decay, Energies of beta spectrum, Gamma emission, selection rules, Nuclear isomerism. Nuclear Reactions, Level Widths in nuclear reaction, Nuclear Reaction cross sections, Partial wave analysis, Compound nucleus model, Resonance Scattering, Breit-Wigner one level formula, Optical model, Direct reactions, Stripping and pick-up reactions, Theory of fission and fusion, Controlled Thermonuclear reactions, Classification of fundamental forces and elementary particles, Isospin, strangeness, Gell-Mann Nishijima's formula, Quark model, SU (3) Symmetry, CPT invariance in different interactions, parity non-conservation, K meson.

Reference Books

1. Concepts of Nuclear Physics – B.L. Cohen – McGraw-Hill – 2001.
2. Introduction to Nuclear Physics – H.A. Enge – Addison-Wesley, 1983.
3. Introduction to Particle Physics : M. P. Khanna Prentice Hall of India (1990)
4. Nuclear and particle Physics : W. Burcham and M. Jobes, Addison-wesley (1998)
5. S N Ghoshal, Nuclear Physics 1st Edition, S.Chand Publishing, 1994.
6. Irving Kaplan, Nuclear Physics 2nd Edition, Narosa Publishing House, 2002.
7. Kenneth S.Krane, Introductory Nuclear Physics 1st Edition, Wiley India Pvt Ltd, 2008.
8. S L Kakani, Nuclear and Particle Physics, Viva Books Pvt Ltd.-New Delhi, 2008.
9. Gupta, Verma, Mittal, Introduction to nuclear and particle physics, 3/E 3rd Edition, PHI Learning Pvt. Ltd-New Delhi, 2013.
10. Samuel S. M. Wong, Introductory Nuclear Physics 1st Edition, PHI Learning, 2010.

15PH3013 SPECTROSCOPY

Credits 3:0:0

Course Objective:

- To learn how the resonance spectroscopic techniques are used in atomic and molecular structure determination
- To understand the principles and the theoretical framework of different Spectroscopic techniques
- To know the instrumental methods of different spectroscopic techniques

Course Outcome:

- Students will gain a fundamental understanding of the different resonant spectroscopic techniques as the most important tool in understanding molecular structure and its characteristics

Course Description:

Symmetry operations and symmetry elements in molecules, Matrix representation of symmetry operations, reducible and irreducible representations, the Great Orthogonality Theorem, Construction of character tables for point groups C_{2v} , and C_{3v} . The nature of spinning particles, Interaction between spin and a magnetic field, Larmor Precession, Relaxation times, Bloch equations, The Chemical shift, The Coupling constant, Nuclei other than hydrogen exhibiting NMR, Continuous wave N.M.R and Fourier Transform N.M.R spectroscopy, N.M.R in Medicine. The position of ESR absorptions – Hyperfine structure of E.S.R absorptions, Double resonance in E.S.R, The fine structure of E.S.R spectra, Principle of Nuclear Quadrupole Resonance, Quadrupole Hamiltonian Nuclear Quadrupole energy levels for axial and non-axial symmetry, NQR in the study of chemical bonding, Halogen, Minerals and Nitrogen, Principles of Mossbauer Spectroscopy, The isomer shift, quadrupole splitting, Magnetic hyperfine Interaction, Principle of Mass spectrometry, ion production, fragmentation, ion analysis.

Reference Books

1. Fundamentals of Molecular Spectroscopy by C. N. Banwell and E.M. McCash, 5th Edn. Tata McGraw-Hill Pub. Company Ltd. 2013
2. Molecular Structure and Spectroscopy; G.Aruldas, Prentice,Hall of India Pvt. Ltd., New Delhi, 2008
3. Molecular structure and symmetry; R L Carter; Wiley India Pvt. Ltd., 2012
4. Introduction to Spectroscopy; Pavia, Lapman and Kriz; Thomson Learning Inc. 2001
5. A Basic Guide to NMR; James N. Shoolery; 3rd edn, Varian Associates, 2008
6. Fundamentals of contemporary Mass Spectrometry; Chhabil Dass; John Wiley & Sons, Inc, 2007
7. A complete introduction to NMR spectroscopy; R.S.Macomber, Wiley Inter-science pub; NewYork,1998
8. Understanding NMR Spectroscopy; J. Keeler, Wiley Interscience, 2002.
9. Interpretation of organic spectra ; Yong,Cheng Ning, John Wiley & Sons (Asia) Pvt. Ltd., 2011

15PH3014 SOLID STATE PHYSICS

Credit: 3:0:0

Course Objective:

- To get knowledge on band theory of solids
- To understand theoretical aspects of dielectric, magnetic and optical properties of solids
- To gain knowledge on the principle of super conductivity

Course Outcome:

- To apply the theory of solids to explain the properties of materials

Course Description

Elastic vibration, Mono and Linear diatomic lattice, optic and acoustic modes, infrared absorption, localized vibration, quantization of lattice vibration, Phonon momentum, Energy bands in solids, Nearly free electron model, Bloch's theorem, Kronig and Penny model, Tight bound approximation, Brillouin zone, Fermi surface, density of states, Dielectric constant and polarisability, Local field, different types of polarization, Langevin function, Classius-Mosotti relation, Ionic and Electronic Polarisability, Ferroelectricity, Dipole theory, Quantum theory of Paramagnetism, Ferromagnetism, Weiss theory, Temperature dependence of magnetism, Exchange interaction, Ferromagnetic domains surfaces, Bloch Wall, Antiferromagnetism, Molecular field theory, Neel temperature, Ferrimagnetism, Point defects in crystals, Colour centres, Photoconductivity, Trap capture, recombination centres, Luminescence, Excitation and emission, Decay mechanism, Electroluminescence, Zero resistance, Behavior in magnetic field, Meissner effect, thermodynamics of superconducting materials, London equation, B.C.S. theory (qualitative), Tunneling A.C. and D.C. Josephson effect, Type I and II superconductors, High T_c superconductors

Reference Books

1. Elementary Solid State Physics, M. Ali Omar, Pearson Education, 2004
2. Introductory solid state Physics, H.P.Myers, Second edition, Taylor and Francis, 2009
3. Advanced Solid State Physics, P.Philips, Cambridge University Press, 2012
4. Solid State Physics, Neil W. Ashcroft, N. David Mermin, Cengage Learning, 2011
5. Solid State Physics, R.J.Sing, Pearson, 2012.
6. Introduction to Solid State Physics, Kittel, John Wiley, 8th edition, 2004
7. Solid State Physics, S.O. Pillai New Age Publications, 2002

15PH3015 PHYSICS OF NANOMATERIALS

Credits 3:0:0

Course Objective:

- To understand the theoretical concepts of nanomaterials
- To gain knowledge on preparation and characterization techniques
- To get knowledge on few nanodevices

Course Outcome:

- Students apply the knowledge to prepare and characterize novel nanomaterials

Course Description:

Introduction to Quantum well, wire and dots, Density of states, Schrodinger wave equation of 1, 2 and 3D structures, super lattice, Quantum confinement, Thin film deposition, patterning and etching. Colloidal dispersions, Self-assembly, Growth modes, Ostwald ripening, Metallic nanowires and quantum conductance, Carbon nanotubes and its properties, electrical properties of Quantum dots and wells, Quantum Hall effect. hardness, Nano indentation, Absorption spectra, Excitons, Coupled wells and Superlattices, Quantum confined Stark effect, nanodevices, Single-electron transistors, Esaki and quantum mechanical tunneling diodes, Magnetic Nanodevices, Magnetoresistance, Spintronics, MEMS and NEMS.

Reference Books

1. Introduction to Nanotechnology, Charles P.Poole, Jr. and Frank J.Owens, Wiley, 2003
2. Silicon VLSI Technologies, J.D.Plummer, M.D.Deal and P.B. Griffin, Prentice Hall, 2000
3. Introduction to Solid State Physics, C.Kittel, a chapter about Nanotechnology, Wiley, 2004

15PH3016 ADVANCED STATISTICAL MECHANICS

Credits 3:0:0

Course Objectives

- To learn about different ensembles and their applications
- To know the basic principles of statistical mechanics
- To gain expertise in Monte Carlo methods

Course Outcomes

- Acquiring skills on the basic principles of statistical mechanics
- Apply principles of statistical mechanics to Molecular dynamics
- Apply the Bose-Einstein distribution for understanding the formation of Bose-Einstein condensation

Course Description

Phase space volume, microcanonical ensemble, introduction to molecular dynamics, Harmonic oscillator and oscillator baths; integrating equations of motion: finite difference methods; the canonical ensemble; application of canonical ensemble to molecular dynamics; grand canonical ensemble; grand canonical phase space and partition function; Application of grand canonical ensemble to ideal gas; Monte Carlo method; the central limit theorem; Wang-Landau sampling; free energy perturbation theory; adiabatic dynamics; metadynamics; quantum ensembles and the density matrix; Fermi-Dirac and Bose-Einstein statistics; Bose-Einstein condensation; the Feynman path integral technique; Ising model

Reference books

1. Statistical Mechanics: theory and molecular simulation, Mark Tuckerman, Oxford University Press, New York, 2010
2. Statistical Mechanics, R K Pathria, Elsevier, 2001
3. Fundamentals of Statistical and Thermal Physics, F. Reif, Waveland Press, Inc. 2009
4. Statistical Mechanics, K. Haung, John Wiley and Sons, 1987
5. Introductory Statistical Mechanics, R.B. Mariana, Oxford Science publications, 2007
6. An introductory course of Statistical Mechanics, P.B. Pal, Narosa, 2009
7. Elementary Statistical Physics, C. Kittel, Dover Publications, 2004

15PH3017 PHOTONICS

Credits 3:0:0

Course Objectives:

- To learn various processes involving in the development of laser.
- To understand the various applications using lasers
- To know the working and fabrication of optical fibers

Course Outcome:

- Students can understand the fabrication and application of various lasers and optical fiber.

Course Description:

The paraxial wave equation, Gaussian beams, the ABCD law for Gaussian beams, Diffraction theory of laser resonators; Theory of Lasers, principle and working of different lasers. Theory of Q-switching and mode locking process; Introduction to nonlinear optics, nonlinear polarization and wave equation, second harmonic generation, phase matching, three-wave mixing, parametric amplifications, nonlinear susceptibilities, nonlinear materials; Propagation of light through isotropic medium, anisotropic medium, theory of electro-optic, magneto-optic and acousto-optic effects and devices, integrated optical devices and techniques; Overview of optical fibers. Ray optics representation. Multipath dispersion materials Combined effect of material and multipath dispersion, Modal birefringence, Attenuation in optical fibers

Reference Books

1. Lasers and nonlinear Optics: B. B. Laud, New Age International (P) Ltd. (2007)
2. Laser Electronics: J. T. Verdeyen, Prentice, Hall Inc. (1995).
3. Laser Fundamentals: W. T. Silfvast, Cambridge University Press, (2003)
4. Optics and Photonics: An Introduction, John & Wiley Sons, Inc. 2007--- F. Graham Smith, Terry A. King, Dan Wilkins
5. Optical solitons: From Fibers to Photonic Crystals, G.P. Agrawal and Y. Kivshar, Elsevier Academic Press, 2003
6. Applications of Nonlinear Fiber Optics, G.P. Agrawal, Elsevier Academic Press, 2008
7. Photonics: Optical Electronics in Modern Communications, The Oxford Series in Electrical and Computer Engineering, 2007---Amnon Yariv and Pochi Yeh

15PH3018 THIN FILM TECHNOLOGY

Credits 3:0:0

Course Objective:

- To gain knowledge on vacuum systems, Thin film coating techniques
- To understand the growth process of thin film
- To study on characterization techniques and thin film applications

Course Outcome:

- To apply the knowledge of thin film coating techniques to prepare thin films by various methods
- To do characterization studies on thin films and fabricate thin film devices

Course Description

Basic vacuum concepts, pumping systems, monitoring equipment, vacuum and non-vacuum thin film deposition techniques, Substrate materials and its properties, Substrate cleaning, buffer layer, metallization, growth process, Adsorption, surface diffusion, nucleation, surface energy, texturing, structure development, interfaces, stress, adhesion, epitaxy, growth monitoring, composition control, lattice mismatch, surface morphology, Structural and optical characterizations, dc electrical conductivity as a function of temperature, Hall effect, types of charge carriers, charge carrier density, Material selection, Design and Fabrication of Thin film resistor, capacitor, diode and transistor, Thin film solar cells, Thin film mask blanks for VLSI, Thin films sensors, magnetic thin films for MEMS and NEMS application.

Reference Books

1. Thin Film Technology Handbook by Aicha Elshabini, Aicha Elshabini, Riad, Fred D. Barlow, McGraw, Hill Professional, 1998
2. Thin film Technology, K.L.Chopra, Tata McGraw, Hill, 1985
3. An Introduction to Physics and Technology of Thin Films by Alfred Wagendristel, Yu Ming Wang, World Scientific, 1994
4. Handbook of Thin, film Deposition Processes and Techniques: Principles, Method, equipment and Applications By Krishna Seshan William Andrew Inc., 2002
5. Handbook of thin film technology, L.I.Maissel and R.Glang, McGraw Hill Book Company, New York (1983).
6. Thin, film deposition: principles and practice by Donald L. Smith, McGraw, Hill Professional, 1995

15PH3019 PRINCIPLES OF RENEWABLE ENERGY

Credits 3:0:0

Course Objective:

- To give an overview of the energy problem faced by the current generation
- To highlight the limitations of conventional energy sources that affect the climate
- To underline the importance of renewable energy sources
- To give a thorough knowledge about various renewable energy technology and to give a glimpse of cutting edge research technology that is happening place in the field of renewable energy sources.

Course Outcome:

- The students will understand the problems of conventional energy sources. They will realize the importance of renewable energy sources and try to find solutions to non,conventional energy sources by research.

Course description

Classification of Energy Sources, Advantages and Limitations of Renewable Energy sources, Solar radiation at the Earth's Surface, Solar Radiation Measurements, Solar Energy Collectors, Flat plate Collectors, Concentrating Collector, Solar Energy Storage, Solar Water Heating, Solar Pumping, Solar Furnace, Solar Cooking, Wind Energy, Basic Components Of a WECS (Wind Energy Conversion System), Classification of WECS, Wind Energy Collectors and Storage, Photosynthesis Process, Bio Fuels, Bio-mass Conversion Technologies, Wet processes and Dry Processes, Classification of Bio-gas plants, Bio-gas from plant Wastes, Energy From The Oceans, Tidal Wave Energy conversion, Ocean Thermal Energy Conversion, Chemical Energy Sources, Fuel Cells and Batteries, Hydrogen Energy, Thermionic and Thermoelectric Generators.

Reference Books

1. Non,Conventional Energy Sources, G.D. Rai, Standard Publishers Distributors, ISBN 9788186308295 (2004)
2. Non,Conventional Energy Sources, B.H.Khan, Tata McGraw Hill (2006) ISBN, 07, 060654,4
3. Renewable Energy, Godfrey Boyle, Oxford University Press in association with the Open University, (2004), ISBN 9780199261789
4. Renewable energy: sources for fuels and electricity, Thomas B. Johansson, Laurie Burnham, Island Press, (1993), ISBN 9781559631389
5. Renewable energy: sustainable energy concepts for the future, Roland Wengenmayr, Thomas Bührke, Wiley,VCH, (2008), ISBN 9783527408047
6. Renewable Energy: Sources and Methods, Anne Maczulak, Infobase Publishing, (2009), ISBN 9780816072033

15PH3020 PHYSICS OF NANOSCALE SYSTEMS

Credits: 3:0:0

Course Objective:

- To learn the various modern technologies used in nano devices and sensors.
- To know about the Semiconductor, bio and Photonics based sensors and its electronic properties of such nanostructure devices.
- To understand the effect of the reduced dimensionality on the electronic charge transport.

Course Outcome:

- To apply the operating principle of various nanodevices and its single atom manipulation

Course Description

Electronic level modification of 0D, 1D, 2D -Esaki and resonant tunneling diodes, Mott-wannier excitons - molecular electronics, molecular switching, Schottky devices, Mesoscopic Devices, Metal Insulator Semiconductor devices, MOSFET characteristics - NanoFET - Single Electron Transistors, Resonant Tunneling Devices, Carbon Nanotube based logic gates, optical devices. Connection with quantum dots, quantum wires, and quantum wells. biosensor, micro fluids, Sensors for aerospace and defense: Accelerometer, Pressure Sensor, Night Vision System, Nano tweezers, nano-cutting tools, Integration of sensor with actuators and electronic circuitry as diagnostic tool, Biosensors- generation, characteristics and applications, conducting Polymer based sensor, DNA Biosensors, optical sensors and Biochips, Magnetoresistance, Spintronics, MEMS and NEMS -Fabrication, Modeling Applications MEMS and NEMS, Packaging and characterization of sensors, Method of packaging at zero level, dye level and first level Sensors. Photonic Nanodevices-Semiconductor quantum dots, Photonic crystals, Metamaterials.

Reference Books

1. Sensors: Micro & Nanosensors, Sensor Market trends (Part 1&2) by H. Meixner.2008
2. Between Technology & Science: Exploring an emerging field knowledge flows & networking on the nanoscale by Martin S. Meyer.2007
4. Nanoscience & Technology: Novel structure and phenomea by Ping Sheng, Talyor and Francis,2003
3. Nano Engineering in Science & Technology : An introduction to the world of nano Design by Michael Rieth,2003
4. Enabling Technology for MEMS and nano devices -Balles, Brand, Fedder, Hierold,John Wiley and sons, 2004
5. Optimal Synthesis Methods for MEMS- G. K. Ananthasuresh,Klower Academic publisher,2003

15PH3021 RADIATION TREATMENT AND PLANNING

Credits: 3:0:0

Course Objective:

- To gain knowledge on radiotherapy machines
- To understand the interaction of photon beam on matter
- To learn about the clinical treatment planning
- To gain knowledge on electron beam therapy and advanced radiotherapy treatment methods

Course Outcome:

- To demonstrate overall knowledge on radiotherapy treatment planning

Course Description

Radiotherapy Machines, X-rays and Gamma rays, Linear accelerator, Accelerating wave guide, Microwave power transmission, Auxiliary system, Electronic beam transport, LINAC treatment head, Production of photon and electron beams from linac, Beam collimation, Cobalt-60 versus LINAC, Radiation therapy simulators, Physical Aspects Of External Photon Beams, Photon beam sources, Inverse square law, Surface dose, Skin sparing effect, Percentage depth dose, various ratios, Total scatter factor, Isodose distribution in water phantom, Isodose charts and factors effecting, Correction of irregular counters, Missing tissue compensation, Correction of tissue inhomogeneity, Clarkson's method, Dose calculation, clinical Treatment Planning In Photon Beams And Recent Advances, Treatment planning, Volume definition, ICRU 50, ICRU 62 concepts, Dose specification, Patient data acquisition, Simulation, Conventional simulation, Isodose curves, Wedge filters, Bolus, Compensating filters, Field separation Physical Aspects Of Electron Beam Therapy, Production of electron beams, Interaction of electron with matter, Range concept, Electron shielding, Dose prescription and thumb rule, Field inhomogeneity, Photon contamination, Virtual SSD, Oblique incidence, Advanced Radiotherapy Treatment Methods, Treatment planning system, Imaging in radiotherapy, CT simulation, Basics of 3-D conformal therapy, 3-D Conformal Radiotherapy, Introduction to Intensity Modulated Radiotherapy and Image Guided Radiotherapy, Stereotactic Radiosurgery and Stereotactic Radiotherapy, Tomotherapy, Particle beam therapy.

Reference Books

1. Review of Radiation Oncology Physics - A Hand book for Teachers and Students, EB. Podgorsak, International Atomic Energy Agency, 2005
2. Radiation therapy Physics, WR. Hendee and GS. Ibbott, J. Wiley, 2004
3. The Physics of Radiation Therapy, FM. Khan, Wolters Kluwer, 2003
4. Treatment Planning in Radiation Oncology, FM. Khan and RA. Potish, Williams & Wilkins, 1998
5. Introduction to Radiological Physics and Radiation Dosimetry, FH. Attix, Wiley, 1986

15PH3022 MEDICAL RADIATION DOSIMETRY

Credit 3:0:0

Course Objective:

- To learn the basic concepts of radiation
- To understand the interaction of radiation with matter
- To understand Kema, dose activity
- To gain knowledge on dosimetry systems

Course Outcome:

- To demonstrate knowledge on radiation and Dosimetry systems

Course Description

Basic Radiation Physics, Atoms and nuclei, Fundamental particles, Atomic and nuclear structure, Mass defect and binding energy, Radiation, Classification of radiation, Electromagnetic spectrum, Radioactivity, Alpha, beta and gamma rays, Methods of decay, Isotopes, Radiation sources. Interaction Of Radiation With Matter, Types of indirectly ionizing radiation, Photon beam attenuation, Types of photon interactions, Types of electron interactions, Types on neutron interactions, Photo electric effect, Coherent scattering, Compton effect, Pair production, Photo nuclear disintegration, Effect following radiation interaction, Radiation Quantities And Units, Radiometric, interaction, protection and dosimetric quantities, Particle and energy fluence, Linear and mass attenuation coefficient, Stopping power, Linear energy transfer, Absorbed dose, Exposure, Activity, Equivalent dose, Effective dose, Electronic or charged particle equilibrium, Bragg gray cavity theory, Radiation Detection, Properties of dosimeters, Methods of radiation detection, Ionization chamber dosimetry system, Proportional counters, Geiger Muller counters, Semi conductor detector, Solid and liquid scintillation counters, Film dosimetry, Thermoluminescent dosimetry, Calorimetry, Chemicaldosimetry, Calibration of Photon and Electron Beams, Ionization chambers, Electro meter and power supply, Phantoms, Chamber signal corrections for influence quantities, Calibration of mega voltage photon beams

Reference Books

1. Radiation Detection and Measurement, Glenn F. Knoll, John Wiley & Sons, 2010.
2. Review of Radiation Oncology - A Hand book for Teachers and Students by EB. Podgorsak, International Atomic Energy Agency, 2005
3. Radiation therapy Physics by WR. Hendee and GS. Ibbott, J. Wiley, 2004
4. Physics of Radiation Therapy by FM. Khan, Wolters Kluwer, 2003
5. Treatment Planning in Radiation Oncology by FM. Khan and RA. Potish, Williams & Wilkins, 1998
6. Introduction to Radiological Physics and Radiation Dosimetry by FH. Attix, Wiley, 1986

15PH3023 RESEARCH METHODOLOGY

Credits: 3:0:0

Course Objective

- To gain knowledge on various research tools available for carrying out research
- To gain understanding on numerical and statistical methods to solve research problems
- To solve simple statistical and numerical problems using C++ programming

Course Outcome

- To apply various techniques for practical problems
- To apply numerical and statistical problem solving skills and computer programming
- skills to solve research problems

Course Description

X ray studies, Microscopic and spectroscopic methods, Correlation, comparison of two sets of data, comparison of several sets of data, Chi squared analysis of data, characteristics of probability distribution, some common probability distributions, Measurement of errors and measurement process, sampling and parameter estimation, propagation of errors, curve fitting, group averages, equations involving three constants, principle of least squares, fitting a straight line, parabola and exponentials curve method of moments, Solution of differential equations, simple iterative method, Newton Raphson method, Numerical by integration, Simpson rule, Gaussian quadrature, solution of simultaneous equation, Gauss Jordan elimination method, Eigenvalue and eigenvectors by matrix diagonalization (Jacobian method), Application of numerical and statistical methods using C++ programming; Solving quadratic equations, solution of equation by Newton Raphson method, matrix diagonalization (Jacobian method), Integration by Simpson's rule, Fitting of a straight line using principle of least square

Reference Books

1. B.K.Sharma, Spectroscopy Goel publishing house, 2007
2. Computer applications in Physics, Suresh Chandra, Narosa publishing hours (2003)
3. Numerical methods for Mathematics, Science and Engineering, John H. Mathews Prentice Hall, India (2000)

15PH3024 MATERIAL CHARACTERIZATION

Credits: 3:0:0

Course Objective

- To know about the Microscopic and Spectroscopic methods
- To understand the analysis of materials using electron microscopy and optical methods
- To learn the instrumentations of Thermal, Electrical, Mechanical and Magnetic methods of characterization.

Course Outcome

- To understand various methods available for characterizing the materials.

Course Description

Optical Microscopy, Optical Microscopy Techniques, Bright & dark field optical microscopy, phase contrast microscopy, Differential interference contrast microscopy, Fluorescence Microscopy, Scanning probe microscopy (STM, AFM), Scanning new field optical microscopy X-Ray Diffraction methods, Rotating crystal, Powder method, Debye, Scherrer camera, Structure factor calculations, EBSD & ED, Principles and Instrumentation for UV, Vis, IR, FTIR Spectroscopy, Raman Spectroscopy, NMR, XPS, AES and SIMS, proton induced X-Ray Emission spectroscopy (PIME), Rutherford Back Scattering (RBS) analysis, application. SEM, EDAX, EPMA, TEM, STEM working principle and Instrumentation, sample preparation, data collection, processing and analysis, Photoluminescence, light matter interaction, instrumentation, Electroluminescence, instrumentation, Applications, Thermogravimetric analysis (TGA), instrumentation, determination of weight loss and decomposition products, differential thermal analysis (DTA), cooling curves, differential scanning calorimetry (DSC), instrumentation, specific heat capacity measurements, determination of thermomechanical parameters, Chromatography, Liquid & Gas Chromatography. Two probe and four probe methods, van der Pauw method, Hall probe and measurement, scattering mechanism, C,V characteristics, Schottky barrier capacitance, impurity concentration, Mechanical and Magnetic Analysis, Vickers Hardness test, Vibrating Sample Magnetometer, Working principle of VSM, Instrumentation.

Reference Books

1. Atomic Force Microscopy/ Scanning Tunneling Microscopy, S.H.Cohen & Marcia L.Lightbody (Editors), plenum press, Newyork, 1994.
2. Principles of Thermal analysis and calorimetry by P.J.Haines (Editor), Royal Society of chemistry (RSC), Cambridge, 2002.
3. B.D.Cullity, "Elements of X-Ray diffraction" (II Edition) Addison Wesley publishing Co., 1978.
4. Lawrence E.Murr, Electron and Ion Microscopy and Microanalysis principles and Applications, Mariel Dekker Inc., Newyork, 1991.

15PH3025 CRYSTAL GROWTH TECHNIQUES

Credits 3:0:0

Course Objective

- To study the basic knowledge about the nucleation mechanism involved in crystal growth
- To understand the broad areas of crystal growth methods such as melt, solution, vapour transport.
- To understand some of the advanced crystal growth systems such as CVD and PVD

Course Outcome:

- Students can understand the different techniques used for growing crystals

Course Description

Importance of crystal growth, classification of crystal growth methods, Theories of nucleation, Classical theory, Gibbs Thomson equation for vapor solution and melt energy of formation of a nucleus, Adsorption at the growth surface, Nucleation, Homogeneous and Heterogeneous nucleation, Growth surface. Solution, selection of solvents, solubility and super solubility, Saturation and super saturation, Meir's solubility diagram, Metastable zone width, measurement and its enhancement, Growth by (i) restricted evaporation of solvent, (ii) slow cooling of solution and (iii) temperature gradient methods, Growth in Gel media, Electrocrystallization. Flux Growth, principle, choice of flux, Growth kinetics, phase equilibrium and phase diagram, Growth techniques, solvent evaporation technique, slow cooling technique, transport in a temperature gradient technique, Accelerated crucible rotation technique, Top seeded solution Growth, Hydrothermal Growth. Melt growth, Heat and transfer, Growth techniques, conservative processes, Bridgman, Stockbarger method, pulling from the melt, Czochralski method (CZ), cooled seed Kyropoulos method, Non, conservative processes zone refining, vertical, horizontal floatzone methods, Skull melting Process, Vernueil method, flame fusion, plasma and arc image methods. Basic principle, physical vapour deposition (PVD), Evaporation and Sublimation processes, sputtering, chemical vapour Deposition (CVD), Advantages and disadvantages, chemical vapour transport, Fundamentals, Growth by chemical vapour transport (CVT) Reaction .

Reference books

1. Ichiro Sunagawa, Crystal Growth, Morphology and performance, Cambridge University press, (2005).
2. Mullin, J. N, 'Crystallization', Butterworths, London (2004)
3. Hand book of crystal growth, Volume 1, 2 & 3. Edited by D. T. J. Hurle North Holland, London (1993)

15PH3026 RADIATION PHYSICS

Credits: 3:0:0

Course Objectives:

- To review the basic physics principles of atomic and nuclear physics
- To study the basics of radiation physics and interaction of radiation with matter
- To know about the basic counting statistics, calibration and methods of measuring radiation
- To understand the sources of radiation in the environment and their applications

Course Outcome:

- The students will become familiar with the basics of radiation physics and their sources in the environment, their methods of detection and the application of different types of radiations.

Course Description:

Review Of Physical Principles, Mechanics, Units and dimensions, Energy Transfer, Elastic and inelastic collision, Electromagnetic waves, The wave mechanics atomic model, The nucleus, The neutron and the nuclear force, Isotopes, The atomic mass unit, Binding energy, Nuclear models, Nuclear stability, Radioactivity And Interaction Of Radiation With Matter, The units of radioactivity, Series decay, Alpha rays, Range-energy relationship, Energy transfer, Beta rays, Range energy relationship, Mechanism of energy loss, ionization and excitation, Gamma rays, Exponential absorption, Absorption mechanisms, Neutrons, Production, Methods Of Measuring Radiation, Gas filled detectors, Scintillation detection systems, Semiconductor detectors, Thermoluminescent detectors, High purity Germanium Detectors, Track devices, Spark counters and spark chambers, Miscellaneous detectors, Counting Statistics And Calibration Of Instruments, Uncertainty in the measuring process, Various types of distribution, Error Propagation, Accuracy of counting measurements, Significance of data from statistical view point, Calibration and standards, Source calibration, Neutron sources, X-ray machines, Radiation In The Environment And Their Applications, Types of radiation sources, Natural radiation sources, Artificial sources of radiation, Applications of radiations

Reference Books

1. Nicholas Tsoulfanidis, Sheldon Landsberger, Measurement and Detection of Radiation, Third Edition, CRC Press; 2010
2. Radiation Detection and Measurement, Glenn F. Knoll, John Wiley & Sons, 2010,
3. Radiation Physics for Medical Physicists, Ervin B. Podgorsak, Springer, New York (2010)
4. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed, Academic Press, Elsevier (2007)
5. Environmental Radioactivity From Natural, Industrial & Military Sources, Merril Eisenbud and and Thomas F. Gesell, Academic Press, (1997, Fourth Edition)
6. G.G.Eicholz and J.W.Poston, Principles of nuclear radiation detection, ANN Arbor Science, 1985

15PH3027 NANOFLUIDS

Credit: 3:0:0

Course Objective:

- To know the basics of nanofluids
- To learn the nanofluid synthesis methods
- To understand the basics of conductive and convective heat transfer
- To learn the application of nanofluids

Course Outcome:

- Students can understand the basics and industrial application of nanofluids

Course Description

Fundamentals of Cooling, Making Nanofluids, Materials for Nanoparticles and Nanofluids, Methods of Nanoparticle Manufacture, Mechanism and Models for enhanced thermal support, Structure based Mechanism and Models, Dynamics based Mechanism and Models, Synthesis of nanofluids, Synthesis of colloidal Gold nanoparticles, Turkevich method, Brust method, Microwave Assisted Synthesis, Solvothermal Synthesis, Magnetic Nanofluids, Inert Gas Condensation, Conduction Heat Transfer, Lumped, parameter method, One Dimension Transient Conduction, Guarded Hot Plate method, Transient Hot wire, Thermal conductivity of Oxide nanofluids, Hamilton Crosser Theory, Convective Heat Transfer, Newton's law of cooling, equations of fluid flow and heat transfer, Navier, Stokes equations, Experimental study of natural convection, Eulerian, Eulerian approach, Eulerian, Lagrangian approach, Fundamentals of Boiling, Nukiyama curve, Vehicle cooling, Transformer cooling, Biomedical applications.

Reference Books

1. Nanofluids: Science and Technology, Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep, John Wiley sons, 2007
2. Holman J.P., 'Heat Transfer', SI Metric Ed., Mc Graw Hill, ISE, 1972.
3. Heat and Mass Transfer, R.K. Rajput, S. Chand, 2008
4. Heat transfer Principles and applications, Binay K. Dutta, Prentice, Hall of India Pvt. Ltd, New Delhi, 2001

15PH3028 PHYSICS OF ADVANCED MATERIALS

Credit: 3:0:0

Course Objective:

At the completion of this course, students should be able to:

- Distinguish various classes of advanced materials which includes semiconducting and nano materials for technological applications,
- to learn new terms and information on variety of materials like metamaterials, biomaterials, photonic crystal fibers, coatings and thin films, composites etc.
- Understanding high temperature refractory material, to identify various classes of composite materials, their properties and applications.

Course Outcome

- Understand the advanced development in materials emphasizing the production /structure /property /function relation and application of a number of advanced materials for technological applications.

Course Description

Introduction, Overview Of Crystal Structures, Structure - Property Relations, Phase Transitions, Semiconducting Materials For Thin Films And Epitaxy, Renewable Energy Materials, Nanomaterials, Ceramic materials, Composite Materials Classes And Its Applications, Metamaterials And Its Applications, Photonic Crystal Fibers, Polymers and Biomaterials, Nonlinear Optical Materials, Dielectric Materials, Magnetic And Superconducting Materials, Plasmonics, Materials For Energy Storage Applications, Refractory Materials And Coatings For High Temperature Applications.

Reference Books:

1. The Handbook of Advanced Materials: Enabling New Designs, James K. Wessel, Wiley-Interscience; 1 edition (April 27, 2004)
2. M Ohtsu, K Kobayashi, T Kawazoe and T Yatsui, Principals of Nanophotonics (Optics and Optoelectronics), University of Tokyo, Japan (2003).
3. Buddy Ratner. Biomaterials Science. Second edition. Orlando, Academic Press, 2000
4. Bharath Bhushan, Springer Handbook of Nanotechnology, 3rd edition, Springer-Verlag (2009)
5. Analysis of polymers an introduction- T.R.Crompton. Smithers Rapra Technology Pvt Ltd, SY4 4NR,UK,2008
6. Handbook of Composites by G. Lubin, Van Nostrand, New York, 1982.
7. Francis de Winter, Solar Collectors, Energy Storage, and Materials (Solar Heat Technologies), MIT Press, USA (1991)
8. Physics and Applications of negative refractive index materials, S. A. Ramakrishna and T.M. Grzegorzczuk, CRC Press, 2009
9. Foundations of Photonic Crystal Fibres, World Scientific, Frédéric Zolla et al, 2005

15PH3029 SOLITONS IN OPTICAL FIBERS

Credit: 3:0:0

Course Objectives:

- To learn about the world of nonlinear Schrödinger equation and ordinary solitons
- To know the utility of dispersion managed solitons
- To study in detail the soliton interactions

Course Outcomes:

- Acquiring skills to find exact solutions for nonlinear Schrödinger equation
- Apply the knowledge of solitons for propagation through optical fibers
- Demonstrate the soliton concept through numerical simulations

Course Description

The nonlinear Schrödinger equation and ordinary solitons; Fiber dispersion and nonlinearity; derivation of nonlinear Schrödinger equation and fundamental consequences; Origin of soliton; Soliton transmission in dispersion tapered fibers; numerical solution of nonlinear Schrödinger equation using split-step Fourier algorithm; dispersion managed solitons; pulse behavior in maps having gain or loss; Erbium doped fiber amplifiers; Gordon-Haus effect; Gordon-Haus effect for dispersion managed solitons; measurement of timing jitter; soliton interactions; soliton-soliton collision in wavelength division multiplexing; applications of inverse scattering transform; wavelength division multiplexing with ordinary solitons; wavelength division multiplexing with ordinary dispersion managed solitons; polarization and its effects; hardware and measurement techniques for solitons.

Reference books

1. Solitons in Optical Fibers, L.F. Mollenauer and J.P. Gordon, Academic Press, San Diego, CA, 2006
2. Optical Solitons in Fibers, A. Hasegawa and M. Matsumoto, Springer-Verlag, Berlin, 2001
3. Optical solitons: From Fibers to Photonic Crystals, G.P. Agrawal and Y. Kivshar, Elsevier Academic Press, 2003
4. Applications of Nonlinear Fiber Optics, G.P. Agrawal, Elsevier Academic Press, 2008
5. Fiber-Optic Communication Systems, G.P. Agrawal, Wiley, 2010
6. Light Propagation in Gain media: Optical Amplifiers, G.P. Agrawal and M. Premaratne, Cambridge University Press, 2011
7. Nonlinear Fiber Optics, G.P. Agarwal, Elsevier Academic Press, 2013

15PH3030 GENERAL PHYSICS LAB I

Credits: 0:0:2

Course Objective:

- To get practical skill on basic optical, electrical and electronic experiments.
- To understand the advance experiments on properties of matter.

Course Outcome:

- To apply the knowledge on basic Physics experiments to solve practical problems.

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15PH3031 GENERAL PHYSICS LAB II

Credits: 0:0:2

Course Objective:

- To get practical skill on experiments related to properties of matter and heat.
- To understand the architecture of microprocessors and methodology of programming.

Course Outcome:

- To apply the practical skill in heat and properties of matter to various applications.
- Student will be able to write simple program using microprocessor for practical applications.

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15PH3032 ADVANCED PHYSICS LAB I

Credits: 0:0:4

Course Objective:

- To get practical skills on advance experiments on optics, electricity and magnetism.

Course Outcome:

- Student will be able to apply the knowledge on advance Physics experiments to solve Research problems.

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15PH3033 ADVANCED PHYSICS LAB II

Credits 0:0:4

Course Objective:

- To get practical skill on various deposition techniques to prepare thin films and grow Crystals having nanostructures
- To get practical training on some basic characterization techniques of nanostructure thin films and crystals

Course Outcome:

- To apply the practical knowledge to fabricate novel nano devices to solve research Problems

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15PH3034 MATERIALS CHARACTERIZATION LAB

Credit: 0:0:2

Course Objective:

- To train the students to operate advanced equipments and to understand the basic concepts of Nanotechnology
- To equip the students with practical knowledge about Nano Materials

Course outcome:

- To demonstrate the practical skill on measurements and instrumentation techniques of some Nano physics experiments.

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15PH3035 COMPUTATIONAL PHYSICS LAB

Credits: 0:0:2

Course Objective:

- To gain programming skills to solve simple problems using C++ Programming.
- To solve simple statistical and numerical problems using C++ programming.

Course Outcome:

- To apply the programming skills to solve practical problems.
- To apply numerical and statistical problem solving skills and computer programming skills to solve research problems.

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15PH3036 SIMULATIONS IN STATISTICAL PHYSICS LAB

Credit: 0:0:2

Course Objective:

- To understand the molecular simulation for various materials structures

Course Outcome:

- Student will get knowledge in simulation software and expertise in molecular simulations

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15PH3037 HEAT AND OPTICS LAB

Credit: 0:0:2

Course Objective:

- To train the students on Optics and Heat experiments to understand the basic concepts.
- To equip the students with practical knowledge in Optics and heat experiments

Course outcome:

- Demonstrate the practical skill on measurements and instrumentation techniques of some physics experiments.

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15PH3038 PROPERTIES OF MATTER LAB

Credit: 0:0:2

Course Objective:

- To train the students on Properties of matter and waves to understand the basic concepts.
- To equip the students with practical knowledge in properties of matter and waves experiments

Course outcome:

- Demonstrate the practical skill on measurements and instrumentation techniques of some physics experiments.

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15PH3039 SIMULATIONS OF NANOSCALE SYSTEMS

Credit: 3:0:0

Course Objectives:

- To introduce the molecular simulation techniques, with special focus on molecular dynamics and Monte Carlo.
- To develop their own codes and utilize the learned methods towards solving a problem of their interest in Nanotechnology Applications.

Course Outcome:

- To solve the Nanoscience and the technology problems using the molecular stimulation

Introduction to Molecular Simulations-Computer Experiments and Modelling, Examples of molecular simulations, Monte Carlo-Molecular Dynamics- Newton's equation of motion. Degrees of Freedom, Constraints, Lennard Jones Potentials, Short and Long Range Potentials, Force Fields, Bonded and Non-Bonded Interactions Ensembles- Micro canonical Ensemble (NVE), Canonical ensemble (NVT), Isothermal-Isobaric Ensemble, Grand canonical ensemble, Observables-Temperature, Pressure, Thermostats, Barostats-Andersen- Berendsen, Nose-Hoover implementations. Ensembles- Microcanonical Ensemble (NVE), Canonical ensemble (NVT), Isothermal-Isobaric Ensemble, Grand canonical ensemble, Observables-Temperature, Pressure, Thermostats, Barostats-Andersen- Berendsen, Nose-Hoover implementations. Monte Carlo (MC) formulation, MC, structural characterization, MC, applications, Random Number generation- Lattice-Crystal structure, Simple MC Open Source Simulations tools. Molecular dynamics (MD) formulation, MD dynamic information, MD applications, Euler-Verlet algorithms, Analysis trajectories, Correlations functions, Autocorrelations function (ACF), Structure Correlations Function (SCF). MD- Open Source Simulations tools.

Reference Books

1. D. Frenkel, B. Smit, Understanding Molecular Simulation: From Algorithms to Applications, Academic Press, 2002.
2. J. M. Haile, Molecular Dynamics Simulation: Elementary Methods.
3. M.P.Allen, D.J. Tildesley, Computer Simulation of Liquids, Clarendon Press, Oxford, 1987
4. D.J. Evans, G.P. Morriss Statistical Mechanics of Nonequilibrium Liquids, Second Edition, Cambridge University Press.
5. D.C. Rapaport, The Art of Molecular Dynamics Simulations, 2nd Edition, Cambridge University Press, 2004

15PH3040 ASTROPHYSICS

Credits: 3:0:0

Course Objective:

- To provide with a fundamental understanding about the stars and their properties
- To provide knowledge of the instruments used to explore the cosmos
- To give an overview of the giant scale structure of the universe such as galaxy and clusters of galaxies
- To know about the origin and fate of the universe

Course outcome:

- Able to demonstrate the mechanisms of different telescopes.
- Able to apply the knowledge of astrophysics in identifying stars and galaxies

Course Description:

Introduction to Solar systems and various models, laws of planetary motions, the formation of stars and planets, properties of stars, spectral classification of stars, Hertzsprung Russell diagram, distant measurements of stars, life cycle of stars, neutron stars, black holes and supernovae, theory of telescope and detectors, new generation optical telescopes, The Milkyway, galaxy, interstellar medium, stellar population, different types of galaxies, the cosmological distant scale, The Universe, Cosmological models, the standard Big bang theory, big bounce theory, life in the universe.

Reference Books

1. Michael Zeilik, Stephen . A.Gregory, Introductory Astronomy and Astrophysics, Fourth Edition, Saunders College Pub., Michigan, U.S.A, 1998 ISBN 9780030062285
2. A. B. Bhattacharya, S. Joardar, R. Bhattacharya, Astronomy and Astrophysics, Jones and Barlett Publishers, U.S.A., (2010) ISBN 978-1-934015-05-6
3. Martin V. Zombeck, Book of astronomy and Astrophysics, Cambridge University Press, U.K. (2007) ISBN 978-0-521-78242-5
4. Thanu Padmanabhan, Theoretical Astrophysics (Vol. I, II, II): Cambridge University Press, U.S.A., (2002) ISBN 0 521 56242 2
5. Wolfgang Kundt, Astrophysics: A new approach, Second edition, Springer, 2006
6. Introduction to AstroPhysics The Stars, Jean Dufay, Dover publications, 2012
AstroPhysics for Physicists, Chaudhuri, University Press, 2010

LIST OF SUBJECTS

Subject Code	Subject Name	Credits
14PH1001	Applied Physics	3:0:0
14PH1002	Applied Physics Lab	0:0:2
14PH2001	Physics for Computer Science and Engineering	3:0:0
14PH2002	Physics for Civil and Mechanical Engineering Sciences	3:0:0
14PH2003	Physics for Electrical Engineering Sciences	3:0:0
14PH2004	Physics for Biotechnology	3:0:0
14PH2005	Physics for Media	3:0:0
14PH2006	Mechanics and Properties of Matter	3:0:0
14PH2007	Heat and Thermodynamics	3:0:0
14PH2008	Electricity and Magnetism	3:0:0
14PH2009	Optics	3:0:0
14PH2010	Vacuum and Thin film Technology	3:0:0
14PH2011	Semiconductor Physics	3:0:0
14PH2012	Spectroscopy	3:0:0
14PH2013	Electromagnetic Theory	3:0:0
14PH2014	Solar cells and its applications	3:0:0
14PH2015	Principles of medical diagnostic techniques	3:0:0
14PH2016	Thin film technology for Engineers	3:0:0
14PH2017	Astro Physics	3:0:0
14PH2018	Renewable Energy sources	3:0:0
14PH2019	Condensed Matter Physics	3:0:0
14PH2020	Nuclear Energy for Sustainable development	3:0:0
14PH2021	Lasers and Fiber Optics	3:0:0
14PH2022	Nanophysics Lab	0:0:2
14PH3001	Nanophotonics	3:0:0
14PH3002	Quantum Mechanics	3:0:0
14PH3003	Solid State Physics	3:0:0
14PH3004	Laser Technology	3:0:0
14PH3005	Thin film Lab	0:0:2
14PH3006	Thermodynamics and Quantum Mechanics for Nanoscale Systems	3:0:0

14PH1001 APPLIED PHYSICS

Credits 3:0:0

Course Objective:

- To impart knowledge on the basic concepts of quantum mechanics and its applications
- To understand the working principle of various lasers and its application in fibre optics
- To study the principles of acoustics and applications of ultrasonic waves
- To get more knowledge on engineering materials and its applications

Course Outcome:

- To apply physics principles of latest technology to solve practical problems in engineering.

Course Description:

De-broglie hypothesis, Heisenberg uncertainty principle, Experimental verification of matter waves, Schrodinger's wave equations and its application, Scanning Electron Microscope (SEM), Principle of Laser, Nd :YAG, He:Ne, CO₂ and Semiconductor lasers , Holography, Propagation of light in optical fibres, Classification of Optical fibres , Fibre optic communication system, Fibre endoscope, Acoustics, Absorption coefficient, Reverberation time, Sabine's formula, Acoustics of buildings, Production of Ultrasonic waves, Acoustic grating , Pulse Echo Testing,

Magnetic materials, types, properties, Hysteresis, Magnetic recording and reading. Superconductors, types , properties, Maglev.

Reference Books

1. V. Rajendran – Engineering Physics, McGraw –Hill Publishing company Ltd, Publication, 2011.
2. John W.Jewett, Jr., Raymond A.Serway - Physics for Scientists and Engineers with Modern Physics, Cenage Learning India Private Ltd, 2008
3. M.N. Avadhanulu, P.G. Kshirshagar – A Text Book of Engineering Physics- S.Chand & Co. Ltd, 2008
4. Hitendra K Malik, A K Singh – Engineering Physics, McGraw –Hill Publishing company Ltd,2008
5. G.Aruldas - Engineering Physics, PHI Learning Pvt. Ltd , 2010
6. A.Marikani, Engineering Physics, PHI learning Private Limited, 2009

14PH1002 APPLIED PHYSICS LAB

Credits 0:0:2

Course Objective:

- To train engineering students on basis of measurements and the instruments
- To give practical training on basic Physics experiments which are useful to engineers
- To equip the students with practical knowledge in electronics, optics, and heat experiments

Course Outcome:

- To demonstrate the practical skill on measurements and instrumentation techniques of some Physics experiments.

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD and notify it at the beginning of each semester.

14PH2001 PHYSICS FOR COMPUTER ENGINEERING SCIENCES

Credits : 3:0:0

Course Objective:

- To know about the Basic laws of Physics
- To learn about the principles of solid state devices
- To learn about the principle of laser

Course Outcome:

- Better understanding of theory of electronic devices
- Able to select materials for different applications
- Able to understand the classification of lasers and its efficiency
- Able to demonstrate lasers in industrial applications

Course Description:

Semiconductors fundamentals, Thermistors and piezo resistors, phosphorescence and fluorescence; Gunn effect and Thermoelectric effect, Radiative transitions ,LEDs, LCDs, semiconductor laser and its characteristics, Photoconductors, photodiodes, avalanche photodiode, phototransistor, Integrated circuit technology, Basic monolithic integrated circuits, epitaxial growth, masking and etching , Diffusion of impurities, Monolithic diodes, integrated resistors, integrated capacitors and inductors, monolithic circuit layout, additional isolation methods, large scale integration (LSI), medium scale integration (MSI) and small scale integration (SSI),The metal semiconductor contact, Basic Operational Amplifier characteristics, Basic Applications of operational amplifier, Sinusoidal, square, Triangular and ramp wave generators, Solution of differential equation, Analog computation, Magnetic and Digital memory devices, Principles and Applications, Magnetic recording heads.

Reference Books:

1. Jacob Millman, Christos C Halkias, Satyabrata , Millman's Electronics Devices & Circuits, Tata McGraw-Hill Publishing Company Pvt. Ltd. 2008
2. Millman. J. and Halkias C.C, Integrated Electronics, McGraw Hill, 2004
3. Allen Mottershead, Electronic Devices and Circuits, Prentice Hall of India, 2009
4. Malvino and Leach, Digital Principles and Applications, Tata McGraw Hill, Co. 2008.
5. V.K.Metha, Rohit Metha, Principles of Electronics, 2006
6. A.Marikani, Engineering Physics, PHI learning Private Limited, 2009

14PH2002 PHYSICS FOR CIVIL AND MECHANICAL ENGINEERING SCIENCES**Credits : 3:0:0****Course Objective:**

- To know about the Basic laws of Physics
- To learn about the properties of matter in different conditions
- To understand the propagation of waves and thermodynamics

Course Outcome:

- Better understanding of mechanics and properties of matter of materials
- Able to select materials for different applications
- Demonstrate the properties of materials through working models

Course Description

Theory of Projectiles, Laws of impact, impulse, Coefficient of restitution Elastic and inelastic collision, direct and oblique impact, velocity and kinetic energy on impact, Laws of kinetic energy, relative masses of colliding bodies, Theory of elasticity and experimental methods, Moment of inertia and its applications, Theory and applications of bending of beams, Torsional pendulum, cantilever, Flow of liquids, Coefficient of viscosity, Critical velocity, poiseuille's equation of flow of liquids, stokes method, surface tension, definition, angle of contact, rise of liquid in capillary tube, Oscillatory motion, Wave motion in one dimension. Wave equation and travelling wave solutions. Wave velocity, group velocity and dispersion. Shallow water waves. Earth quakes and Seismographs, Wave equation in three dimensions, spherical waves. Fundamental postulates of statistical mechanics and their basic laws, Universal law in statistical mechanics, application to one dimensional harmonic operator.

Reference Books:

1. Murugesan. R., Properties of Matter , S. Chand & Co Pvt. Ltd., New Delhi. 2007.
2. Gulati H.R., Fundamentals of General Properties of Matter, R. Chand & Co., New Delhi, 1982.
3. Subrahmanyam N. & Brij Lal, Waves & Oscillations, Vikas Publishing House Pvt. Ltd., New Delhi, 1994..
4. P.K. Chakrabarthy, Mechanics and General Properties of Matter, Books & Allied (P) Ltd., 2001.
5. D. Halliday, R.Resnick and J.Walker, Fundamentals of Physics, 6th Edition, Wiley, NY, 2001.
6. Gour R.K. and Gupta S.L. – "Engineering Physics". Dhanpat Rai Publications, New Delhi, 2002.

14PH2003 PHYSICS FOR ELECTRICAL ENGINEERING SCIENCES**Credits : 3:0:0****Course Objective:**

- To know about the Basic laws of Physics
- To learn about the principles of Electricity and magnetism

Course Outcome:

- Better understanding of theory of electricity and magnetism
- Able to select materials for different applications

- Demonstrate the properties of materials through working models

Course Description :

Electrostatic potential and field due to discrete and continuous charge distributions. Dipole and quadrupole moments. Energy density in an electric field. Dielectric polarization. Conductors and capacitors. Electric displacement vector, dielectric Susceptibility, Biot-Savart's law and Ampere's law in magnetostatics. Magnetic induction due to configurations of current-carrying conductors. Magnetization and surface currents. Energy density in a magnetic field. Magnetic permeability and susceptibility. Force on a charged particle in electric and magnetic fields. Time-varying fields. Faraday's law of electromagnetic induction. Self and mutual inductance. Resonance and oscillations in electrical circuits. Displacement current. Maxwell's equations in free space and in linear media. Scalar and vector potentials, gauges. Plane electromagnetic waves. Electromagnetic energy density, Poynting vector. Wave guides.

Reference Books

1. Raymond A. Serway and Robert J. Beichner's Physics: for Scientists and Engineers, 5th edition. 2000
2. D. Halliday, R. Resnick and J. Walker, Fundamentals of Physics, 6th Edition, by Wiley, NY, 2001
3. H. Young, A. Freedman, University Physics, Addison-Wesley, 2000
4. Brij Lal, N. Subramanyam, Electricity and Magnetism, S. Chand & Co., 2005.
5. Randall D. Knight, Physics for Scientists and Engineers A Strategic Approach, Volume 4: Pearson/ Addison Wesley, 2004.
6. A. Marikani, Engineering Physics, PHI learning Private Limited, 2009

14PH2004 PHYSICS FOR BIOTECHNOLOGY

Credits : 3:0:0

Course Objective:

- To impart knowledge on crystal structure and lattice
- To learn the Physics principles in medical imaging techniques
- To learn the principles of fiber endoscopy and laser assisted surgery.

Course outcome:

- Able to gain knowledge about the crystal structures and radiotherapy.
- Able to apply the techniques in treatments of tumours and medical imaging

Course Description:

Lattice, Basis, and crystal systems, Bravais lattices, Crystal planes and Miller indices, Medical imaging techniques, Magnetic Resonance Imaging, Nuclear Magnetic Resonance image analysis, Ultrasound Theory, Echo sound and echo cardiograph, Theory of nuclear medicine and radiotherapy, Targeted delivery techniques, dosimetry and radiation safety measures, Optical microscope and electron microscope, fiber optic endoscopy, Laser medical applications, treatment of tumours, treatment of retina.

Reference Books

1. Mukherjee, K. L., Medical Laboratory Technology-A procedure manual for routine diagnostic tests Volume 1, 2, 3, Tata McGraw Hill Publishing Company Ltd.
2. Godkar, P. B., Textbook of Medical Laboratory Technology, 2 Edition, Bhalani Publishing House, 2006
3. John Bernard Henry, (2001), Clinical Diagnosis and Management by Laboratory Methods, 20th Edition, Saunders.
4. M. A. Flower (Editor), Webb's Physics of Medical Imaging. CRC Press, Taylor & Francis Group, 2012. ISBN: 978-0-7503-0573-0
5. William R. Hendee, E. Russell Ritenour, Medical Imaging Physics, John Wiley & Sons, 2003
6. A. Marikani, Engineering Physics, PHI learning Private Limited, 2009

14PH2005 PHYSICS FOR MEDIA

Credits : 3:0:0

Course Objective:

- To gain knowledge on lens system and photometry
- To understand the concept colour theory and aberrations
- To gain knowledge on sound waves and its properties
- To understand the basic concepts of signal processing

Course Outcome:

- Demonstrate the knowledge on sound, light and signals

Course Description:

Basic lens system, Measurement of light, Photometry and colour theory, mixing of colours, Rayleigh's criterion of resolution, resolving power of grating, prism and telescope, microscope
Theory of Aberrations and types, Sound waves, Theory of vibration and experimental verification, Reflection of sound in open and closed organ pipe, principle of resonators, characteristics of musical sound, measurement of reverberation .acoustics of building and their remedies, sound engineering.

Reference Books:

1. N.Subrahmanyam and Brij lal, A Text book of Optics, S.Chand & Co.ltd., New Delhi, 22nd edition, 2000
2. R.K. Gaur and S.L. Gupta, Engineering Physics, Dhanpat Rai Publications, 2006
3. SN Sen Wiley, Acousics Waves and oscillations, Eastern Limited, 1990
4. Lonnie C Lumens, Fundamentals of digital signal processing, John Wiley and sons,1987
5. Avadhanulu, M.N., Kshirsagar, P.G., A Text Book of Engineering Physics, S.Chand & Co. Ltd., New Delhi, 6th edition, 2003.
6. Li Tan, Jean Jiang Fundamentals of: Analog and Digital Signal Processing Author House, 2007
7. R. G. Lyones, Understanding digital signal processing, Addison Wesley 1997

14PH2006 MECHANICS & PROPERTIES OF MATTER

Credits: 3:0:0

Course Objective:

- To know about the Basic laws of Physics
- To learn about the properties of matter in different conditions
- To understand elasticity and moment of inertia

Course Outcome:

- Better understanding of mechanics and properties of matter of materials
- Able to select materials for different applications
- Demonstrate the properties of materials through working models

Course Description:

Kepler's law, Newton's law, Experimental methods and applications, Earth quakes and Seismographs, Theory of Projectiles, Laws of impact, impulse, Coefficient of restitution Elastic and inelastic collision, , direct and oblique impact, velocity and kinetic energy on impact, Laws of kinetic energy, relative masses of colliding bodies, Theory of elasticity and experimental methods, Moment of inertia and its applications, Theory and applications of bending of beams, Torsional pendulum, cantilever, Flow of liquids, Coefficient of viscosity, Critical velocity, poiseuille's equation of flow of liquids, stokes method ,surface tension, definition, angle of contact, rise of liquid in capillary tube.

Reference Books:

1. Murugesan. R., Properties of Matter , S. Chand & Co Pvt. Ltd., New Delhi. 2007.

2. Gulati H.R., Fundamentals of General Properties of Matter, R. Chand & Co., New Delhi, 1982.
3. Subrahmanyam N. & Brij Lal, Waves & Oscillations, Vikas Publishing House Pvt. Ltd., New Delhi, 1994..
4. P.K. Chakrabarthy, Mechanics and General Properties of Matter, Books & Allied (P) Ltd., 2001.
5. D. Halliday, R.Resnick and J.Walker, Fundamentals of Physics, 6th Edition, Wiley, NY, 2001.
6. D. Halliday, R.Resnick and K.S. Krane, Physics, 4th Edition, VoIs. I, II & II Extended Wiley, NY, 1994.
7. Mathur D.S., Elements of Properties of Matter, Shyamlal Charitable Trust, New Delhi, 2008.
8. Brij Lal & Subramaniam. N, Properties of Matter, S.Chand & Co., New Delhi, 2005.

14PH2007 HEAT AND THERMODYNAMICS

Credits: 3:0:0

Course Objective:

- To learn about the different laws in thermodynamics
- To know the basic principles of statistical mechanics
- To learn the application of thermodynamics of a wide variety of physical systems

Course Outcome:

- Acquiring skills on the basic principles of thermodynamics & statistical mechanics
- Apply the principles of thermodynamics for real time systems
- Demonstrate the thermodynamic principles through experimental models

Course Description:

Laws of Thermodynamics, Entropy, change in entropy in adiabatic and reversible cycles Statistical basis of thermodynamics, probability and frequency, permutation and combination, macrostate and microstate, Fundamental postulates of statistical mechanics and their basic laws, Universal law in statistical mechanics, application to one dimensional harmonic oscillator, statistical ensemble, Basic theories of Phase transitions in statistical mechanics, Quantum statistics.

Reference Books:

1. B. K. Agarwal and M. Einsner, Statistical Mechanics, John Wiley & Sons, 1988
2. John M. Seddon, Julian D. Gale, Thermodynamics and statistical mechanics, 2001
3. Federick Reif, Fundamentals of Statistical and Thermal Physics, McGraw- Hill, 1985
4. Brijlal, N.Subrahmanyam, P.S.Hemne, Heat thermodynamics and statistical physics, S.Chand & Co. Ltd, 2007
5. M.C. Gupta, Statistical Thermodynamics, Wiley Eastern Ltd, 1990
6. J.B.Rajam and C.L.Arora, Heat and Thermodynamics, S. Chand & Co. Ltd, 1972

14PH2008 ELECTRICITY AND MAGNETISM

Credits: 3:0:0

Course Objective:

- To develop a basic understanding of electric and magnetic fields in free space using the integral forms of Maxwell's laws.
- To learn electrostatic properties of simple charge distributions using Coulomb's law, Gauss's law and electric potential.
- To understand the concepts of electric field, potential for stationary charges

Course Outcome:

- Able to demonstrate an understanding of the electric field and potential, and related concepts, for stationary charges.
- Demonstrate an understanding of the magnetic field for steady currents and moving charges.
- Apply the principles in developing Circuits for devices

Course Description:

Laws and fundamental theory of Charged Particles and Electric Fields, Electrostatic Fields and Gauss's Law, Electric Potential, Ohm's Law and Direct Current Circuits, Magnetostatics, Biot-savart's law, differential equation of magnetostatics and ampere's law, Magnetic moment, magnetic scalar potential, macroscopic magnetisation, Magnetic Forces and Fields, Theory of Magnetic Fields and Electromagnetic Induction, working principle of dynamo, theory of transformers and its types.

Reference Books :

1. Raymond A. Serway and Robert J. Beichner's Physics: for Scientists and Engineers, 5th Edition. 2000.
2. D. Halliday, R. Resnick and J. Walker, Fundamentals of Physics, 6th Edition, by Wiley, NY, 2001.
3. H. Young, A. Freedman, University Physics, Addison-Wesley, 2000.
4. Brij Lal, N. Subramanyam, Electricity and Magnetism, S. Chand & Co., 2005.
5. Randall D. Knight, Physics for Scientists and Engineers: A Strategic Approach, Volume 4: Pearson/Addison Wesley, 2004.

14PH2009 OPTICS

Credits: 3:0:0

Course Objective:

- To impart basic knowledge pertaining to optics
- To learn the theoretical aspects of light
- To study the properties of waves and working principles of the optical instruments

Course Outcome:

Able to

- understand the basic properties of light wave and the principle optical instruments
- apply the knowledge on optics on designing various optical instruments.
- Demonstrate the optics principles in developing an optical device

Course Description:

Basic principles of Geometrical Optics, Superposition of waves, Theory of polarization, Brewster's law, Double refraction, Elliptically and circularly polarized light, Quarter wave plates and Half wave plates, Theory of Interference, Young's experiment, Phase difference and path difference, Newton's rings, principle and working of Michelson Interferometer, Theory of diffraction, diffraction due to a narrow slit, Fraunhofer diffraction, resolving power of microscope and telescope, Applications.

Reference books

1. M N Avadhanulu & P G Kshirsagar, A Text book of Engineering Physics, 8th edition, 2006
2. N. Subrahmanyam and Brijlal, Textbook of optics, chand publications, 1985
3. Eugene Hecht and A. R. Ganesan, Optics: Dorling Kindersely (India), 2008
4. A. K. Ghatak, Optics: Tata McGraw Hill, (2008)
5. Charles A. Bennett, Principles of Physical Optics, Wiley, 2008

14PH2010 VACUUM AND THIN FILM TECHNOLOGY

Credits: 3:0:0

Course Objective:

- To introduce students to the theory and use of high vacuum systems as well as thin film deposition process
- To study the physical behavior of gases and the technology of vacuum systems including system operation and design.
- To learn the Thin film deposition process, characterization techniques and applications

Course Outcome:

- Able to apply the knowledge of thin film coating techniques to prepare thin film devices.
- Able to understand the application of thin film technologies in fabricating optical coatings such as mirror, antireflective, and dielectric filter coatings
- Apply the characterization techniques in analyzing the material properties

Course Description:

The concept of vacuum, degrees of vacuum, Gas pressure, unit of measurements, Types of vacuum pumps, pumping mechanisms, direct pressure measurement, indirect pressure measurement, Thin film deposition mechanisms, Classification of thin film coating techniques and instrumentation, Thin film growth process, Evaporation, Deposition, Diffusion, Nucleation, Thin film characterization techniques. Structural, Optical, Electrical and morphology analysis of thin films. Application of thin films in electronic device fabrications.

Reference Books:

1. John F. O' Hanlon, An user's guide to Vacuum Technology, 3rd Edition., John Wiley & Sons Inc, 2003.
2. Austin Chambers, Chapman & Hall, Modern Vacuum Physics, CRC, Taylor and Francis, London, 2005, ISBN No: 0-8493-2438-6.
3. Krishna Seshan, Hand book of thin film deposition processes & technologies, Noyes publications/William Andrew publishing, 2nd Edition., 2002.
4. Milton Ohring, The materials Science of thin films, Academic Press, 1992, ISBN No: 0-12-524990-x.
5. L.B. Freund & S. Suresh, Thin film materials – stress, defect formation & surface evolution, Cambridge University Press, 2003, ISBN No: 0-521-822815.
6. K.L Chopra, Thin film Device Applications, Plenum Press, NY, 1983
7. L. N. Rozanov, Vacuum Technique, Taylor and Francis, London, 2002, ISBN No: 0-415-27351-x.
8. Donald L. Smith, Thin film deposition Principles & Practice, McGraw Hill, 1995, ISBN No: 0-07-058502-4.

14PH2011 SEMICONDUCTOR PHYSICS

Credits: 3:0:0

Course Objective:

- To introduce students to the theory of semiconductors and its characteristics.
- To study the physical behavior of semiconductors and the technology of integrated circuit fabrication.
- To learn the IC fabrication techniques for designing different electronic devices.

Course Outcome:

- Able to apply the knowledge of semiconductor physics to prepare electronic devices.
- Able to understand the application of semiconductor theory in fabricating integrated circuits.
- Apply the IC fabrication techniques for large scale applications

Course Description:

Electron arrangement in atoms, conduction in metals, semiconductors, energy band pictures, intrinsic and extrinsic semiconductors, semiconductor junction characteristics, forward and reverse bias, diode characteristics, Fermi energy, Hall effect, continuity equation, Fabrication of ICs, Basic monolithic integrated circuit technology, Epitaxial growth, photolithography, thin film resistors, transistors and capacitors, diodes, integrated field effect transistor, LSI, MSI and VLSI, MOS technology.

Reference Books:

1. Jacob Millman, Christos C Halkias, Millman's Electronics Devices and Circuits, Satyabrata , Tata McGraw-HillPublishing Company Pvt. Ltd. 2008
2. Millmaan. J. and Halkias C.C, Integrated Electronics, McGraw Hill, 2004
3. Allen Mottershead, Electronic Devices and Circuits, Prentice Hall of India, 2009
4. Malvino and Leach, Digital Principles and Applications, Tata McGraw Hill,Co. 2008.
5. V.K.Metha, Rohit Metha, Principles of Electronics, 2006

14PH2012 SPECTROSCOPY

Credits 3:0:0

Course Objective:

- To learn how these spectroscopic techniques are used in atomic and molecular structure determination
- To understand the principles and the theoretical framework of different Spectroscopic techniques
- To know the instrumental methods of different spectroscopic techniques

Course Outcome:

- Students can understand how spectroscopic studies in different regions of the spectrum probe different types of molecular transitions

Course Description:

Bragg's Law, X- ray diffraction , Zeeman, , Stark effect- Hyperfine structure -Photoelectron spectroscopy- UV-Visible spectrophotometer theory and instrumentation, analysis of absorption and transmission spectrum. Infra red spectroscopy, vibration spectrum of carbon monoxide, IR spectrophotometer, Instrumentation, FTIR and analysis of molecular interaction, Raman effect, polarization of light, Laser Ramam spectrophotometer, theory, instrumentation and applications.

Reference Books:

1. C. N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy, Tata McGraw-Hill Publishing Company Ltd. 4th Edition (2010)
2. J.M.Hollas, Modern Spectroscopy, John Wiley, (2004)
3. G. Aruldhas, Molecular Structure and Spectroscopy, Prentice - Hall of India Pvt. Ltd., New Delhi, (2008)
4. B. P Straughan and S.D Walker, Spectroscopy Vol I, II, III, Chapman and Hall, 1976
5. G. Herzberg Van Nostrand, Molecular Spectra and Molecular Structure, 1950
6. Harvey Elliot White, Introduction to Atomic Spectra, McGraw-Hill, 1934

14PH2013 ELECTROMAGNETIC THEORY

Credits 3:0:0

Course Objective:

- To learn the basics of electricity and magnetism and equations governing them.
- To acquire knowledge of fundamentals of magnetism
- To know the Maxwell's equations
- To learn about the electromagnetic waves.

Course outcome:

- Students apply the fundamental concept of electricity and magnetism in day to day life and solve problems in physics

Course Description:

Electric field, Gauss Law, Scalar potential , Poisson's equation, Green's Theorem, electrostatic potential energy and energy density, displacement vector, Biot and Savart law , Ampere's law, The magnetic vector and scalar potential, Macroscopic magnetization , Magnetic field, Electromagnetic induction – Faraday's law – Maxwell's equations , Displacement current, Vector and Scalar potentials , Gauge transformation, Lorentz gauge, Columb's gauge, Gauge invariance , Poynting's theorem, Radiation from an oscillating dipole , Radiation from a half wave antenna , Radiation damping , Thomson cross section , Lienard – Wiechert Potentials , The field of a uniformly moving point charge.

Reference Books

1. E. C. Jordan, K. G Balmain, Electromagnetic Waves and Radiating Systems, PHI Learning Pvt. Ltd., 2008

2. W. H. Hayt, J. A., Buck, Engineering Electromagnetics, Tata McGraw-Hill, 2011
3. J. D. Jackson, Classical Electrodynamics, John Wiley & Sons, 1998
4. John R. Reits, Fredrick J. Milford & Robert W. Christy. Foundations of Electro Magnetic Theory – Narosa Publishing House (1998)
5. B. B. Laud, Electromagnetics: New Age International 2nd Edition (2005)

14PH2014 SOLAR CELL AND ITS APPLICATIONS

Credits: 3:0:0

Course Objective:

- To impart knowledge of theory of photovoltaics
- To learn the history and development of solar cells
- To understand the Importance of carbon free energy sources

Course outcome:

- Able to learn mechanism of solar cells
- Able to understand the manufacturing process of thin film solar cell fabrication
- Able to apply thin film technique in solar cell fabrication.

Course description:

Solar cell fundamentals ,Classifications and manufacturing technologies, single- and multi-crystalline silicon, micromorph tandem cells, CdTe, CIGS, CPV, PVT), Next generation solar cells organics, biomimetic, organic/inorganic hybrid, and nanostructure-based solar cells. Solar cell performance, Efficiency of solar cells and solar simulator Grid connected supply, cost, and the major hurdles in the technological, economic, and political — towards widespread substitution of fossil fuels.

Reference Books

1. Bube, R. H. *Photovoltaic Materials*. London, UK: Imperial College Press, 1998. ISBN: 9781860940651.
2. Green, M. A. *Solar Cells: Operating Principles, Technology and System Applications*. Upper Saddle River, NJ: Prentice Hall, 1981. ISBN: 9780138222703.
3. Wenham, S. R., M. A. Green, M. E. Watt, R. Corkish. *Applied Photovoltaics*. 2nd ed. New York, NY: Earthscan Publications Ltd., 2007. ISBN: 9781844074013.
4. Green, M. A. *Silicon Solar Cells: Advanced Principles and Practice*. Sydney, Australia: Centre for Photovoltaic Devices & Systems, 1995. ISBN: 9780733409943.
5. Aberle, A. G. *Crystalline Silicon Solar Cells - Advanced Surface Passivation & Analysis*. Sydney, Australia: University of New South Wales, 2004. ISBN: 9780733406454

14PH2015 PRINCIPLES OF MEDICAL DIAGNOSTIC TECHNIQUES

Credits: 3:0:0

Course Objective:

- To impart knowledge in Medical diagnostic techniques
- To learn the Physics principles in medical instrumentation
- To train the students to understand the principles of advanced equipments and the use of basic Medical diagnostic tools.

Course outcome:

- Able to Gain knowledge about the measurements and instrumentation techniques of some medical diagnostic techniques.
- Able to understand the Physics principles involved in diagnostic techniques and Instrumentation
- Able to apply the techniques in treatments like cancer and urology

Course Description:

Fundamentals and working principles of medical laboratory equipments, Medical imaging techniques, Medical Instrumentation analysis Magnetic Resonance Imaging, Theory of Digital signal Processing and its applications, Ultrasound, Theory Echo sound and echo cardiograph, X-ray Diffraction analysis and Instrumentation, Fundamental of Nuclear Radiation, Theory of nuclear medicine and radiotherapy, Targeted delivery techniques, dosimetry and radiation safety measures.

Reference Books

1. Mukherjee, K.L., Medical Laboratory Technology-A procedure manual for routine diagnostic tests Volume 1,2,3, Tata McGraw Hill Publishing Company Ltd.
2. Godkar, P. B. (2006), Textbook of Medical Laboratory Technology, 2nd Ed., Bhalani Publishing House.
3. John Bernard Henry, (2001), Clinical Diagnosis and Management by Laboratory Methods, 20th Ed., Saunders.
4. M. A. Flower (Editor), Webb's Physics of Medical Imaging. CRC Press, Taylor & Francis Group, 2012. ISBN: 978-0-7503-0573-0
5. William R. Hendee, E. Russell Ritenour, Medical Imaging Physics, John Wiley & Sons, 2003

14PH2016 THIN FILM TECHNOLOGY FOR ENGINEERS

Credits: 3:0:0

Course Objective:

- To gain knowledge on vacuum systems
- To learn about various coating techniques
- To learn about the various characterization techniques of thin films
- To gain knowledge on application of thin films

Course outcome:

- Able to apply the knowledge of thin film coating techniques to prepare thin film devices.
- Able to understand the application of thin film technologies in fabricating optical coatings such as mirror, antireflective, and dielectric filter coatings
- Apply the characterization techniques in analyzing the material properties

Course Description:

The concept of vacuum, degrees of vacuum, Gas pressure, unit of measurements, Types of vacuum pumps, pumping mechanisms, direct pressure measurement, indirect pressure measurement Thin film coating techniques, physical and chemical methods of thin film preparation, thin film growth process, growth monitoring and morphology, structural, optical and electrical studies on thin films and instrumentation, application of thin films in VLSI, Sensors, MEMS and NEMS.

Reference Books:

1. Alfred Wagendristel, Yuming, Yu-ming Wang, An Introduction to Physics and Technology of Thin Films, World Scientific, 1994
2. Krishna Seshan, Handbook of Thin-film Deposition Processes and Techniques: Principles, Methods Equipment and Applications, William Andrew Inc., 2002
3. L.I. Maissel and R. Glang, Handbook of thin film technology, McGraw Hill Book Company, New York, 1983.
4. Kasturi L. Chopra, R. E., Thin Film Phenomena, Krieger Pub. Co., 1979
5. Goswami, Thin Film Fundamentals, New Age International Ltd, 2003
6. Donald L. Smith, Thin-film deposition: principles and practice, McGraw-Hill Professional, 1995

14PH2017 ASTROPHYSICS

Credits: 3:0:0

Course Objective:

- To provide with a fundamental Understanding about the stars and their properties
- To give an overview of the giant scale structure of the universe such as galaxy and clusters of galaxies
- To know about the origin and fate of the universe

Course outcome:

- Able to have knowledge of the instruments used to explore the cosmos.
- Able to demonstrate the mechanisms of different telescopes.
- Able to apply the concepts of astrophysics in identifying new stars and comets.

Course Description:

Introduction to Solar systems and various models, Laws of planetary motions, the formation of stars and planets , the properties of stars, types and distant measurements, concept of black holes and supernovas, theory of telescope and detectors, new generation optical telescopes, The milkyway, galaxy, different types of galaxies, the cosmological distant scale, The Universe, Cosmological models, the standard Big bang theory, big bounce theory and the life in the universe.

Reference Books

1. Michael Zeilik, Stephen. A.Gregory, Introductory Astronomy and Astrophysics, Fourth Edition, Saunders College Pub., Michigan, U.S.A, 1998 ISBN 9780030062285
2. A. B. Bhattacharya, S. Joardar, R. Bhattacharya, Astronomy and Astrophysics, Jones and Barlett Publishers, U.S.A., (2010) ISBN 978-1-934015-05-6
3. Martin V. Zombeck, Book of astronomy and Astrophysics, Cambridge University Press, U.K. (2007) ISBN 978-0-521-78242-5
4. Thanu Padmanabhan, Theoretical Astrophysics (Vol. I, II, II): Cambridge University Press, U.S.A., (2002) ISBN 0 521 56242 2
5. Wolfgang Kundt, Astrophysics: A new approach, Second edition, Springer, 2006

14PH2018 RENEWABLE ENERGY SOURCES

Credits 3:0:0

Course Objective:

- To give an overview of the energy problem faced by the current generation
- To highlight the limitations of conventional energy sources that affect the climate
- To underline the importance of renewable energy sources
- To give a thorough knowledge about various renewable energy technology and to give a glimpse of cutting edge research technology that is happening place in the field of renewable energy sources.

Course Outcome :

- The students will understand the problems of conventional energy sources. They will
- realize the importance of renewable energy sources and try to find solutions to nonconventional
- energy sources by research.

Course Description:

Classification of Energy Sources, Fossil Fuels and Climate Change issues, Advantages and Limitations of Renewable Energy sources, Solar radiation at the Earth's Surface – Solar Radiation Measurements, Solar Cell, Solar Energy Collectors, Flat-plate Collectors, Concentrating Collector, Focusing Type, Solar Energy Storage, Applications of Solar Energy, Solar Water Heating, Solar Pumping, Solar Furnace, Solar Cooking , Wind Energy Technology, Aerodynamics , Wind Energy Conversion, Classification of WECS, Wind Energy Collectors, Wind Energy Storage, Applications of Wind Energy, Bio Fuels, Bio mass Resources, Classification of Bio-gas plants,

Materials Used For Bio-gas generation, Ocean Thermal Energy Conversion , Fuel Cells and Batteries , Hydrogen Energy , Micro Hydel Powers.

Reference Books

1. G.D. Rai, Non-Conventional Energy Sources, Standard Publishers Distributors, ISBN 9788186308295 (2004)
2. B.H.Khan, Non-Conventional Energy Sources, Tata McGraw Hill (2006) ISBN 0- 07- 060654-4
3. Godfrey Boyle, Renewable Energy, Oxford University Press in association with the Open University, (2004), ISBN 9780199261789
4. Thomas B. Johansson, Laurie Burnham, Renewable energy: sources for fuels and electricity, Island Press, (1993), ISBN 9781559631389
5. Thomas Bürke, Renewable energy: sustainable energy concepts for the future, Roland Wengenmayr, Wiley-VCH, (2008), ISBN 9783527408047
6. Anne Maczulak, Renewable Energy: Sources and Methods, Infobase Publishing, (2009), ISBN 9780816072033

14PH2019 CONDENSED MATTER PHYSICS

Credits: 3:0:0

Course Objective:

- To gain knowledge on band theory of solids
- To understand theoretical aspects of dielectric, magnetic and optical properties of solids
- To gain knowledge on the principle of super conductivity

Course Outcome:

- Able to comprehend the properties of solid through the basic crystal theories.
- Able to Demonstrate Magnetic properties of different materials
- Able to Apply the Properties of solid in developing new materials

Course Description

Theory of Lattice vibrations, elastic vibration, localized vibration, , Phonon- Phonon interaction, band theory of solids, Different types of polarization and its theory, dielectric properties, ferroelectric theory and properties, Theory of para, ferro and anti-ferro magnetism, point defects in crystals, color centers, electronic transitions in photoconductors, Thermo luminescence , electroluminescence, theory of superconductivity, Meissner effect, B.C.S theory, A.C and D.C Josephson's effect, Applications.

Reference Books

1. S.O. Pillai, Solid State Physics, New Age Publications, 2002
2. M. Ali Omar, Elementary Solid State Physics, Pearson Education, 2004
3. Kittel, Introduction to Solid State Physics, John Wiley, 8th edition, 2004
4. S.M.Sze, Physics of semiconductor devices, 2007
5. Chihiro Hamaguchi, Basic Semiconductor Physics, 2nd Edition 2001
6. Kwok Kwok Ng, Complete guide to semiconductor devices, 2nd Edition 2002
7. Philip Philips, Advanced Solid State Physics, Cambridge University Press, 2012

14PH2020 NUCLEAR ENERGY FOR SUSTAINABLE DEVELOPMENT

Credits 3:0:0

Course Objective:

- To give an overview of the energy problem faced by the current generation
- To highlight the limitations of conventional energy sources that affect the climate
- To underline the importance of renewable energy sources

- To give a thorough knowledge about various renewable energy technology and to give a glimpse of cutting edge research technology that is happening place in the field of renewable energy sources.

Course Outcome :

- The students will understand the problems of conventional energy sources. They will realize the importance of renewable energy sources and try to find solutions to nonconventional energy sources by research.

Course Description:

Nuclear basics, Atoms, electrons, nuclei, Fundamental forces, Nuclear characteristics, Static properties, Dynamic properties, Energy scenario in the world and in India, Growth trends and future prospects, Limitations of various energy resources, Environmental Impacts, Importance of nuclear energy in the current energy mix, Various types of nuclear reactors, Nuclear Fuel Cycle, Three stage Indian nuclear power programme, Growth, challenges and opportunities, The future of Indian nuclear power programme, Nuclear energy for sustainable growth.

Reference Books

1. J. Suppes and Truman S. Storvick (Eds.), Sustainable Nuclear Power, Galen Elsevier Science (technical) (2006), ISBN: 978-0-12-370602-7
2. S N Ghoshal, Nuclear Physics, S.Chand Publishing (2013), ISBN 13 – 9788121904131
3. M V Ramana, The Power of Promise (Examining Nuclear Energy in India), Penguin Books Ltd (2012) ISBN: 9788184755596
4. Ian Hore-Lacy, Nuclear Energy in the 21st Century, Elsevier Science (2010), ISBN: 9780080497532
5. Raymond Murray, Keith E. Holbert, Raymond L. Murray, Nuclear Energy, Elsevier Science (2008), ISBN: 9780080919447

14PH2021 LASERS AND FIBER OPTICS

Credits: 3:0:0

Course Objective:

- To give a comprehensive overview of laser theory, laser engineering, types of laser and associated equipment, with an emphasis on practical system design.
- To learn techniques for characterisation, measurement and control of laser output.
- To illustrate the state of the art of laser technology via applications of lasers in industry and research

Course Outcome:

- Able to comprehend the laser principle and its applications.
- Able to understand the classification of lasers and its efficiency
- Able to demonstrate lasers in industrial applications

Course Description:

Power source for Continuous wave and pulsed lasers: Energy transfer in solid state laser systems, ion laser systems, molecular lasers, organic dyes and liquid dye lasers. Semiconductor lasers, Excimer lasers and metal vapour lasers, Optics for lasers, damage in optical components. Laser instrumentation and applications. Applications of Lasers in Medical field. Principle and theory of Holography, Construction and Reconstruction of Holograms, Theory and working principle of holographic interferometer. Classification of fibers, propagation of light through fiber, fiber losses, industrial applications of fibers, fibers in medical applications.

Reference Books:

1. Ready, J.F., Industrial Applications of Lasers, Academic Press, 2nd Edition, 2000.
2. Charschan, S.S., Van Nostrand, Lasers in Industry, 2001.
3. C.Breck Hitz, J.J.Ewing, Jeff Hecht, Introduction to laser technology, John Wiley & Sons, New Jersey, 2012
4. Colin Webb, Julian Jones, Handbook of Laser Technology & Applications, IOP publishing Limited, 2004
5. Lan Xinju, Laser Technology, Second Edition, CRC press, 2010.
6. K.Thyagarajan, D.Ajoy Ghatak, Lasers Fundamental and Applications, Second edition, Springer, New York, 2010

7. Anuradha D, Optical fibre laser: Principles and applications, New Age International, 2003.

14PH2022 NANO PHYSICS LAB

Credits: 0:0:2

Course Objective:

- To get practical skill on various deposition techniques to prepare thin films and grow Crystals having nanostructures
- To get practical training on some basic characterization techniques of nanostructure thin films and crystals
- To learn the process of preparing the nanomaterials through different techniques

Course Outcome:

- Able to understand and hands on training on different nanomaterial preparation techniques.
- Able to operate the sophisticated nanomaterial preparation equipments
- To apply the practical knowledge to fabricate novel nano devices to solve research problems

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14PH3001 NANOPHOTONICS

Credits: 3:0:0

Course Objective:

- To impart knowledge on the photonics in nanoscale structures
- To learn the properties of light in nano optics.
- To Study the Light –matter interactions

Course Outcome:

- Able to demonstrate the light interaction in different nanoscale systems.
- Can apply the concept in developing Nanooptical devices
- Able to demonstrate the Nonophotonics concepts in laser developments

Course Description

EM wave review, Review of Maxwell equations, Near fields and far fields, Concept of photons, and a brief review of other quantisation of energy, plasmons and phonons, Light generation by nanostructures, light propagation by nanostructures, Light-matter interaction, Surface effects, Surface EM wave, Surface polaritons, Size dependence Quantum wells, wires, and dots, Nanophotonics in microscopy, Nanophotonics in plasmonics, Dispersion engineering, Material dispersion, Waveguide dispersion (photonic crystals).

Reference Books :

1. P. N. Prasad, Nanophotonics, Wiley (2004).
2. M. Di Ventra et al., Introduction to Nanoscale Science and Technology, Springer (2004).
3. S. Kawata, Near-Field Optics and Surface Plasmon Polaritons, Springer (2001).
4. K. Sadoka, Optical Properties of Photonic Crystals, Springer-Verlag (2004)
5. John D. Joannopoulos, Steven G. Johnson, Joshua N. Winn & Robert D. Meade, Photonic Crystals: Molding the Flow of Light, Second Edition,
6. Lukas Novotny , “Principles of Nano-Optics” , Cambridge University Press, 2006
7. Mark L. Brongersma, Mark L. Brongersma, Pieter G. Kik, “Surface Plasmon Nanophotonics” Springer, 2010

14PH3002 QUANTUM MECHANICS

Credits: 3:0:0

Course Objective:

- To understand quantum theory and to learn about the formulation of quantum mechanics
- To learn about the solutions of Schrödinger equations in one dimensional problems
- To gain knowledge on the approximation methods used for solving stationary states problems

Course outcome:

- Able to execute the use of quantum theory to various problems in atomic Scale
- Able to Understand the behavior of micro systems with boundary conditions
- Able to apply the Quantum concepts in nano technology

Course Description:

Basic concepts of quantum theory, Matter waves- De Broglie wave theory–De Broglie wavelength of electrons. Experimental verification of matter waves- Davisson and Germer experiment, G.P.Thomson's experiment, Schrodinger wave equations, Applications of Schrodinger wave equations, Formulation of Quantum mechanics, Eigenvalues and Eigenfunctions, Dirac's Bra and Ket notations, Theory of angular momentum, Clebch – Gordon Co-efficients, Perturbation theories (Time dependant and time Independent) and its applications.

Reference Books

1. P.M. Mathews and Venkatesan, A text book of Quantum Mechanics –Tata McGraw-hill, 1st edition (2005)
2. K. Ghatak and Lokanathan, Basic Quantum Mechanics, Mc Millan, 2006
3. Gupta Kumar Sharma, Quantum mechanics, Jai Prakash Nath & Co -2007
4. G. Aruldas, Quantum mechanics, PH Learning Pvt. Lmt. – 2008
5. Jolly. D, Advanced Quantum Theory and Fields, Sarup & Sons, New Delhi, 2006
6. Leonard I. Schiff, Quantum Mechanics, McGraw Hill Book Company, 1968
7. Stephen Gasiorowicz, Quantum Mechanics, 3rd Edition, Pushp, Print Services, New Delhi, 2005

14PH3003 SOLID STATE PHYSICS

Credits: 3:0:0

Course Objective:

- To gain knowledge on band theory of solids
- To understand theoretical aspects of dielectric, magnetic and optical properties of solids
- To gain knowledge on the principle of super conductivity

Course Outcome:

- Able to comprehend the properties of solid through the basic crystal theories.
- Able to Demonstrate Magnetic properties of different materials
- Able to Apply the Properties of solid in developing new materials

Course Description

Theory of Lattice vibrations, elastic vibration, localized vibration, , Phonon- Phonon interaction, band theory of solids, Different types of polarization and its theory, dielectric properties, ferroelectric theory and properties, Theory of para, ferro and anti-ferro magnetism, point defects in crystals, color centers, electronic transitions in photoconductors, Thermo luminescence , electroluminescence, theory of superconductivity, Meissner effect, B.C.S theory, A.C and D.C Josephson's effect, Applications.

Reference Books

1. S.O. Pillai, Solid State Physics, New Age Publications, 2002
2. M. Ali Omar, Elementary Solid State Physics, Pearson Education, 2004
3. Kittel, Introduction to Solid State Physics, John Wiley, 8th edition, 2004
4. S.M.Sze, Physics of semiconductor devices, 2007

5. Chihiro Hamaguchi, Basic Semiconductor Physics, 2nd Edition 2001
6. Kwok Kwok Ng, Complete guide to semiconductor devices, 2nd Edition 2002
7. Philip Philips, Advanced Solid State Physics, Cambridge University Press, 2012

14PH3004 LASER TECHNOLOGY

Credits: 3:0:0

Course Objective:

- To give a comprehensive overview of laser theory, laser engineering, types of laser and associated equipment, with an emphasis on practical system design.
- To learn techniques for characterisation, measurement and control of laser output.
- To illustrate the state of the art of laser technology via applications of lasers in industry and research

Course Outcome:

- Able to comprehend the laser principle and its applications.
- Able to understand the classification of lasers and its efficiency
- Able to demonstrate lasers in industrial applications

Course Description:

Power source for Continuous wave and pulsed lasers: Energy transfer in solid state laser systems, ion laser systems, molecular lasers, organic dyes and liquid dye lasers. Semiconductor lasers, Excimer lasers and metal vapour lasers, Optics for lasers, damage in optical components. Laser instrumentation and applications. Applications of Lasers in Medical field .Principle and theory of Holography, Construction and Reconstruction of Holograms, Theory and working principle of holographic interferometer.

Reference Books:

1. Ready, J.F., Industrial Applications of Lasers, Academic Press, 2nd Edition, 2000.
2. Charschan, S.S., Van Nostrand, Lasers in Industry, 2001.
3. C.Breck Hitz, J.J.Ewing, Jeff Hecht, Introduction to laser technology, John wiley & Sons, New Jersey, 2012
4. Colin Webb, Julian Jones, Handbook of Laser Technology & Applications, IOP publishing Limited, 2004
5. Lan Xinju, Laser Technology, Second Edition, CRC press, 2010.
6. K.Thyagarajan, D.Ajoy Ghatak, Lasers Fundamental and Applications, Second edition, Springer , New York, 2010
7. Anuradha D, Optical fibre laser: Principles and applications, New Age International, 2003.

14PH3005 THIN FILM LAB

Credits: 0:0:2

Course Objective:

- To get practical skill on various deposition techniques to prepare thin films.
- To get practical training on some basic characterization techniques of nanostructure thin films
- To learn the process of preparing the nanomaterials through different techniques

Course Outcome:

- Able to prepare thin films for fabrication of devices like diodes, transistors and Solar cells.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14PH3006 THERMODYNAMICS AND QUANTUM MECHANICS FOR NANOSCALE SYSTEMS

Credits: 3:0:0

Course Objective:

- To learn and understand basic and advanced concepts of thermodynamics, statistical mechanics and quantum mechanics in the perspective nanoscale systems.

Course Outcome:

- The students should be able to understand the basic and advanced concepts to analyze the nanoscale systems

Course Description:

Laws of Thermodynamics , Thermodynamic potentials and the reciprocity relations , Maxwell's , Gibb's – Helmholtz relation, Thermodynamic equilibrium , Chemical potential, Statistical Description of Systems of Particles Statistical formulation of the state , Ensemble , Equation of motion and Liouville theorem, Statistical equilibrium ,Review of classical mechanics , de Broglie's hypothesis , Heisenberg uncertainty principle , Pauli exclusion principle , Schrödinger's equation, properties of the wave function , Application, Electrical and magnetic properties ,One dimensional systems, Metallic nanowires and quantum conductance , dependence on chirality , Quantum dots, Two dimensional systems , Quantum wells and modulation doping , Resonant tunnelling , Magnetic properties Transport in a magnetic field, Quantum Hall effect, Spin valves, Spin-tunnelling junctions , Domain pinning at constricted geometries , Magnetic vortices , Mechanical properties, Individual nanostructures , Bulk nanostructured materials, Ways of measuring, Optical properties, Two dimensional systems (quantum wells), Absorption spectra, Excitons , Coupled wells and superlattices, Quantum confined Stark effect.

Reference Books :

1. Federick Reif, Fundamentals of Statistical and Thermal Physics, Waveland press Inc, 2009
2. Bipin K. Agarwal and Melvin Eisner, Statistical Mechanics, New Age International (P) Ltd, 2005
3. M.C. Gupta, Statistical Thermodynamics, New Age International (P) Ltd, 2003
4. Charles P. Poole, Jr. and Frank J.Owens, Introduction to Nanotechnology, , Wiley, 2003
5. J.D. Plummer, M.D.Deal and P.B. Griffin, Silicon VLSI Technology, Prentice Hall, 2000
6. C.Kittel, Introduction to Solid State Physics, Wiley, 2004