M.Sc. Analytical Chemistry Programme under Outcome Based Education (OBE) System

SYLLABUS

DEPARTMENT OF CHEMISTRY
(DST-FIST Sponsored Department)
NATIONAL COLLEGE (Autonomous)

(Nationally Accredited at 'A^+' Level by NAAC with CGPA of 3.61 on 4.00 Scale)

(College with Potential for Excellence)

Tiruchirappalli 620 001

Post Graduate and Research Department of Chemistry Vision Statement

The Chemistry Department is dedicated

- To develop a centre of excellence for teaching and research at parity with national and international standards.
- To prepare the students of chemistry in that they are self-reliant, highly informative and a better candidate in the demanding and ever-changing world.
- To prepare the knowledgeable graduates for careers in academia, industry and government.

Mission Statement

- To develop a wholesome and efficient student who will cause transformation in society through a study of chemistry.
- To extend the best student support services by making them comprehensive and by evolving a curriculum relevant to the student community and society at large.
- To encourage students to face CSIR-NET, GATE, SET and other competitive examinations.
- To invite scientists from National/International laboratories for lectures of global standards.
- To provide high-quality education through an effective teaching – learning process for their pursuing high-quality teaching, learning, research and service.
- To provide an educational environment where students can realize their full potential in Chemistry and attain quality education to face the challenges of the future.

GOALS

- To improve student's basic knowledge of Chemistry and develop analytical skills of scientific inquiry to design and carry out scientific investigations and evaluate scientific evidence to conclude.
- To make the students think analytically, critically and creatively to solve problems, judge arguments, and make decisions in scientific and other contexts so that students can start a career in chemical industries.
- To give the training to develop inquiring minds and curiosity about science.

Scope and objective of the M.Sc. analytical degree program

- To understand the main ideas and concepts of Chemistry and apply scientific information to solve problems in any situation so that they get a strong foundation in Chemistry.
- Discuss and evaluate scientific information from different sources (internet, newspaper articles, television, scientific texts and publications) and assess its credibility.
- Enable the students in the fields to design the scientific inquiry skills to design and carry out scientific investigations by applying the principles of Organic, Inorganic, Physical Chemistry, Instrumental methods of Analysis and Analytical Chemistry.
- Draw conclusions supported by scientific explanations and a reasoned interpretation of the analysis of the data.
- Describe and discuss ways in which science is applied and used to solve local and global problems.
- Discuss how science and its applications interact with social, economic, political, environmental, cultural and ethical factors.

Programme Outcomes (POs):

- Graduates are prepared to be creators of new knowledge leading to innovation and entrepreneurship employable in various sectors such as Private, Government, and Research organizations.
- Graduates are trained to evolve new technologies in their discipline.
- Graduates are groomed to engage in the lifelong learning process by exploring their knowledge independently.
- Graduates are framed to design and conduct experiments /demos/create models to analyze and interpret data.
- Graduates ought to have the ability to effectively communicating the findings of physical sciences; incorporating with existing knowledge.

Programme Specific Outcomes (PSOs):

- Human and social values and responsibilities in the context of learning Chemistry.
- Communicative skills and the creative scientific mind towards learning Chemistry.
- Positive approach towards environment and ecology from the chemistry perspective.

- Critical thinking and the analytical mind, students develop for the in-depth knowledge in advanced-level chemistry
- The relevance of extension of chemistry in the social context for solving social issues
- Employability Skills shall enable the students to find jobs in Core Chemistry and other related fields
- Entrepreneurial skills shall empower the students to start their own industries / business in core chemistry fields
- Analytical or experimental Skills make the students capable of doing higher-level research works in the emerging fields of chemistry.

Employment opportunity

- Employability skills shall enable the students to find jobs in core chemistry and other related fields.
- In pharma industry, oil refineries, metal refineries, food industries QC, QA, R&D and production.
- Entrepreneurial skills shall empower the students to start their own industries / business in core chemistry fields.

NATIONAL COLLEGE (AUTONOMOUS), TIRUCHIRAPPALLI-620 001.
NATIONALLY ACCREDITED AT 'A+' LEVEL BY NAAC
M.Sc., ANALYTICAL CHEMISTRY COURSE STRUCTURE UNDER O.B.E.S
(APPLICABLE TO THE CANDIDATES ADMITTED FROM THE ACADEMIC YEAR (2020-2021)

SEM	PART	COURSE	COURSE TITLE	INSTUCTION HOURS /WEEK	CREDIT	EXAM HRS	MARKS			TOTAL
							CIA	EXTERNAL		
								W	O	
I		CORE COURSE-CC 1 (P20ACH1)	INORGANIC CHEMISTRY-I	5	5	3	25	75	-	100
		CORE COURSE-CC 2 (P20ACH2)	ORGANIC CHEMISTRY-I	5	5	3	25	75	-	100
		CORE COURSE-CC 3 (P20ACH3)	BASICS OF ANALYTICAL CHEMISTRY	5	5	3	25	75	-	100
		CORE COURSE-CC 4P (P20ACH4P)	INORGANIC CHEMISTRY PRACTICAL–I	6	3					
		CORE COURSE-CC 5P (P20ACH5P)	ORGANIC CHEMISTRY PRACTICAL-I	6	3					
			TOTAL	**27**	**15**				**-**	**300**
II		CORE COURSE-CC 6 (P20ACH6)	INORGANIC CHEMISTRY-II	5	5	3	25	75	-	100
		CORE COURSE-CC 7 (P20ACH7)	PHYSICAL CHEMISTRY-I	5	6	3	25	75	-	100
		CORE COURSE-CC 4P (P20ACH4P)	INORGNIC CHEMISTRY PRACTICAL-I	6	3	6	25	75	-	100
		CORE COURSE-CC 5P (P20ACH5P)	ORGNIC CHEMISTRY PRACTICAL-I	6	3	6	25	75	-	100
		CORE COURSE-CC 8P (P20ACH8P)	INORGANIC CHEMISTRY PRACTICAL–II	6	3	6	25	75	-	100
		CORE COURSE-CC 9P (P20ACH9P)	ORGANIC CHEMISTRY PRACTICAL-II	6	3	6	25	75	-	100
		ELECTIVE COURSE-I (P20ACH10E)	GREEN AND ENVIRONMENTAL CHEMISTRY	5	5	3	25	75	-	100
		ELECTIVE COURSE –II(P20ACH11E)	QUALITY ASSURANCE AND BIOCHEMICAL ANALYSIS	5	6	3	25	75	-	100
			TOTAL	**44**	**33**				**-**	**800**
III		CORE COURSE-CC 10 (P20ACH12)	PHYSICAL CHEMISTRY –II	5	5	3	25	75	-	100
		CORE COURSE-CC 11 (P20ACH13)	ORGANIC CHEMISTRY-II	5	5	3	25	75	-	100
		CORE COURSE-CC 12P (P20ACH14P)	ANALYTICAL CHEMISTRY PRACTICAL-I	6	3	6	25	75	-	100
		CORE COURSE-CC 13P (P20ACH15P)	PHYSICAL CHEMISTRY PRACTICAL	6	3	6	25	75	-	100
		ELECTIVE COURSE – III (P20ACH16E)	RETROSYNTHETIC ANALYSIS, PHOTOCHEMISTRY AND ORGANIC SPECTROSCOPY	5	5	3	25	75	-	100
			TOTAL	**27**	**22**				**-**	**500**
IV		CORE COURSE –CC14 (P20ACH17)	CHEMISTRY OF MATERIALS	5	5	3	25	75	-	100
		CORE COURSE-CC15 (P20ACH18)	ADVANCED ANALYTICAL TECHNIQUES	5	6	6	25	75	-	100
		CORE COURSE- CC 16 (P20ACH19P)	ANALYTICAL CHEMISTRY PRACTICAL –II	6	3	6	25	75	-	100
		PROJECT P20ACHP20	PROJECT- ANALYTICAL CHEMISTRY	6	6	3	25	75		100
			TOTAL	**22**	**20**					**400**
			GRAND TOTAL	**120**	**90**					**2000**

INORGANIC CHEMISTRY I – P20ACH1

Semester: I **Core Course: I**

Instruction Hours/Week: 5 **Credits: 5**

Objectives:

1. To know the structure of ionic compounds and mechanism of solid-state reactions.
2. To get the knowledge of crystal systems by X-ray diffraction methods.
3. To understand the concepts of theory and application in inorganic photochemistry and to acquire the knowledge in supramolecular chemistry of inorganic compounds.
4. To study the chemistry and structure of Boron, Sulphur and Nitrogen chain Compounds.

UNIT I: Ionic Bonding and Solid-State Reaction (18 hours)

Structure of crystal lattice – The perovskite and spinel structures- radius ratio rule-Lattice energy - Born-Lande equation - Kapustinskii's equation – Thermodynamics of complex formation- High-T_c superconductors - solid-state reactions- types and example - tarnish reaction, decomposition reaction, solid-solid reaction - factors influencing reactivity and structure effect - Irradiation - the photographic process.

UNIT II: Crystalline State (18 hours)

Crystal systems and lattice types - Bravais lattices - Crystal Symmetry - point groups and space groups (No detailed study) - Miller indices - reciprocal lattice concept - close packed structures - BCC, FCC, HCP-voids-coordination number crystal binding - molecular, covalent, metallic and hydrogen bonded crystals. X-ray diffraction by crystals - function of crystals - transmission grating and reflection grating - Bragg's equation (No derivation) - diffraction methods - rotating crystal, oscillation and Weisen Berg methods - indexing and determination of lattice types - unit cell dimensions of cubic crystals - structure factor - Fourier synthesis.

UNIT III: Inorganic Photochemistry (18 hours)

Electronic transitions in metal complexes - metal centered and charge transfer transitions - various photophysical and photochemical processes of coordination compounds – unimolecular charge- transfer photochemistry of cobalt (III) complexes - mechanism of CTTM photo reduction. Ligand field photochemistry of Cr (III) complexes - Adamson's rule – conventional flash photolysis and single

photon counting- photo-physics and photochemistry of Ru-polypyridine complexes - emission and redox properties - photochemistry of organometallic compounds - metal-carbonyl compounds - compounds with metal-metal bonding - Reinecke's salt - chemical actinometer.

UNIT IV: Supramolecular Chemistry (18 hours)

Concepts and languages of supramolecular chemistry - hydrogen bonds - C-H…X interactions - halogen bonds - π-π - interactions - non-bonded interactions. M.O.F. (Metallo Organic Frameworks) - organometallic systems - combination of different interactions to design molecular rods, triangles ladders, networks etc. - design of nanoporous solids – supramolecular metallo catalysis – co- catalysts - catalysis of synthetic reactions - biomolecular and abiotic catalysts - role of supramolecular chemistry in the development of nanoscience and technology - supramolecular devices - supramolecular photochemistry.

UNIT V: Cyclic Inorganic Compounds (18 hours)

Chemistry of boron - carboranes – metallo-carboranes - importance of icosahedral frame work of boron atoms in boron chemistry - closo, nido and arachnostructure - structural study by Wade's rule. S-N cations and anions. Chains- catenation-heterocatenation - polythiazyl compounds (S_4N_4, S_2N_2 and $(SN)_x$)-homocyclic inorganic systems- reactions of Cp_2TiS_5.

Course Outcomes:

With the knowledge of the contents given in the paper, "crystal systems, photochemistry and supramolecular chemistry of inorganic compounds" a student should be able to enter into the field of crystallography and photochemistry.

Text Books:

1. M. C. Day and J. Selbin,"*Theoretical Inorganic Chemistry*", 2nd Ed., **1985**. Affiliated East- West Press Pvt. Ltd, New Delhi.
2. J. E. Huheey, E. A. Keiter and R. L. Keiter, "*Inorganic Chemistry –Principles of Structure and Reactivity*", Harper Collins College Publishers, 4th Ed., **1993**.
3. F. A. Cotton and G. Wilkinson, "*Advanced Inorganic Chemistry*" 5th Ed., Wiley- Interscience Publication, New York, **1988**.
4. L. V. Azaroff, "*Introduction to Solids*", Mc-Graw Hill, **2009**.
5. N. B. Hannay, "*Solid State Chemistry*", Printice Hall, New Delhi, **1976**.
6. F. C. Philips, "*An Introduction to Crystallography*", Longmans, 3rd Ed., **1963**.

7. K. F. Purcel and J. C. Kotz, "*Inorganic Chemistry*", W. G. Saunder's Company, Philadelphia, **1982**.
8. D. F. Shriver, P.W. Atkins and C.H. Langford, "*Inorganic Chemistry*", ELBS.6th Ed., **1990**.
9. J. Ferraudi, "*Elements of Inorganic Photochemistry*", Wiley, New York, **1988**.
10. W. Adamson and P. D. Fleischauer, "*Concepts of Inorganic Photochemistry*", Wiley, New York, **1975**.
11. J. L. Atwood and J. W. Steed, "*Supramolecular Chemistry: A concise Introduction*", John Wiley & Sons, **2000**.
12. J. M. Lehn, "*Supramolecular Chemistry: Concepts and Perspectives*", Wiley-. VCH, **1995**.

Reference Books:

1. W.E. Jolly, "*Modern Inorganic Chemistry*", McGraw Hill International Ed., New York, **1994**.
2. Gary Wulfsberg, "*Inorganic Chemistry*", University Science Books, **2000**.
3. B.Douglas, D.H.Me Daniel and J.J. Alexander, "*Concepts and Models of Inorganic Chemistry*", John Wiley and Sons, New Delhi, **2001**.

ORGANIC CHEMISTRY I – P20ACH2

Semester: I **Core Course: 2**

Instruction Hours/Week: 5 **Credit: 5**

Objectives:

1. To appreciate the concept of substitution, addition and elimination reactions and their reaction mechanisms
2. To learn the concepts of various methods of determination of reaction mechanism and to comprehend the various factors that operate in organic reactions
3. To appreciate the stereo chemical aspects of a reaction and conformational analysis of organic molecules
4. To learn and understand the path, feasibility and mechanism of a reaction. To understand the techniques involved in the determination of mechanism of reactions and to propose methods to determine the mechanism of reaction

UNIT I: Nucleophilic Substitution Reaction (18 hours)

Aliphatic Nucleophilic Substitution, Aromatic Nucleophilic Substitution and Aliphatic Electrophilic Substitution S_N1, S_N2, S_Ni mechanisms - stereochemical factors - effect of substrate structure, leaving group, attacking nucleophile and solvent - neighbouring group participation - substitution at allylic and vinylic carbons - ambident nucleophiles. S_N1, S_NAr, Benzyne mechanisms - orientation effect of substrate structure, leaving group, attacking nucleophile. S_E1, S_E2, S_Ei, mechanisms - stark enamine reaction - decarboxylation of aliphatic acids - halogenation of aldehydes and ketones.

UNIT II: Aromatic Electrophilic Substitution and Aromaticity (18 hours)

Arenium ion mechanism - orientation and reactivity energy profile diagrams - the ipso attack - ortho/para ratio - substitution in thiophene - pyridine. Concept of aromaticity - Huckel's rule - effect of aromaticity on bond length, ring current - non-benzenoid aromatic compounds – aromatic character in three, five, seven and eight membered rings - anti aromaticity - system with 4, 8, 10 π electrons - annulene - sydnones - alternant and non-alternant hydrocarbons.

UNIT III: Reactive Intermediates and Optical Rotatory Dispersion(18 hours)

Reactive Intermediates: Classical and non-classical carbocations, carbanions-free radicals, carbenes, nitrenes, arynes and singlet oxygen- general methods of generation, detection, geometry, stability and reactivity of these intermediates.

Introduction to theory and terminology - circular birefringence – circular dichroism - cotton effect and ORD curves - comparison between ORD and CD and their inter relationship - axial haloketone rule and octant rule - applications to determine the absolute configuration of monocyclic ketones and steroids.

UNIT IV: Organic Stereochemistry -I-Optical Isomerism (18 hours)

Optical isomerism - Optical activity and Chirality - elements of symmetry - Stereochemistry of overcrowded molecules (hexahelicene, ansa compounds, cyclophanes and trans cycloalkenes - Newmann, Sawhorse and Fischer projections - representation and interconversion - Absolute configuration – R & S notations for special molecules (allenes, spirans, biphenyls) R-S nomenclature of cyclic chiral compounds - molecules with more than one chiral center. Asymmetric synthesis - Optical purity - determination of enantiomeric excess by NMR - definition of terms like prochirality, enantiotopic and diastereotopic atoms, groups and faces - stereoselective and stereospecific reactions.

UNIT V: Geometrical isomerism and Dynamic Stereochemistry (18 hours)

Geometrical isomerism: E, Z - determination of configuration of geometrical isomers (cyclisation, converting into compounds of known configuration, dipole moment, converting into less symmetric compounds – spectroscopic methods) configuration of cyclic and bicyclic ring systems - cis-trans nomenclature of three, four and six membered substituted cyclic systems - decalins. **Dynamic Stereochemistry:** Quantitative correlation between conformation and reactivity - Winstein-Eliel equation - Curtin Hammet principle - saponification of an ester - esterification of an alcohol - chromic acid oxidation of cyclohexanols - neighbouring group participation - deamination of 2- amino cyclohexanol.

Course Outcomes:

1. Students learn the techniques of studying the mechanisms of reactions and to understand the nucleophilic substitution reactions shown by organic molecules.
2. Students get to know the mechanistic pathways of those nucleophilic substitution reactions.
3. Students understand the structural and stereochemical implications on nucleophilic substitution reactions.
4. Students learn the characteristic features of electrophilic substitutions and understand the different kinds of electrophilic mechanisms in both aromatic and aliphatic compounds.

5. Students understand the importance of stereochemical aspects of structure and properties
6. Students get to know the chemical reactions and the mechanisms *via* different intermediates
7. Students learn the techniques of studying the mechanisms of reactions

Text Books:

1. R. Panico, W. H. Powell, L. Jean. C. Richer, "*A guide to IUPAC Nomenclature of Organic Compounds*", **1993**, Jain Inter science.
2. S. C. Pal, "*Nomenclature of Organic Compounds*", **2008**, Narosa Publishing House.
3. D. Nasipuri, "*Stereochemistry of Organic Compounds-Principles and Applications*", 2nd Ed., New Age International **2005**.
4. P. S. Kalsi, "*Stereochemistry*", Wiley Eastern Ltd, **1990**.
5. E. L. Eliel and S. H. Wilen, "*Stereochemistry of Organic Compounds*", John Wiley, **2008**.
6. T. H. Lowry and K. S. Richardson, "*Mechanism and Theory in Organic Chemistry*", 2nd Ed., Harper and Row, **1981**.
7. O. P. Agarwal, "*Chemistry of Organic Natural Products*", Volume I & II, Goel Publishers, **2014**.
8. I. L. Finar, "*Organic Chemistry*", Volume-II, 5th Ed., **2006**.

Reference Books:

1. Structure and Mechanisms, F. Carey, R. Sundberg, "*Advanced Organic Chemistry. Part-A*". 4th Ed., Kluwer Publishers, **2000**.
2. Michael B. Smith, J. March, "*March's Advanced Organic Chemistry*", John Wiley & Sons, 6th Ed., **2007**.
3. J. Clayden, N. Greeves, P. Wothers, "*Organic Chemistry*", Oxford University Press, **2001**.
4. J. Mc. Murry, "*Organic Chemistry*", Brooks/Cole publisher, 5th Ed., **2000**.
5. M. B. Smith, "*Organic Synthesis*', Academic Press, Elsevier, 3rd Ed., **2010**.
6. E.L. Eliel, "*Stereochemistry of Carbon Compounds*", McGraw Hill Book Company, New York, **1975**.
7. Jerry March "Advanced Organic Chemistry (Reaction, Mechanisms and Structure)", - Willey, **2005**.
8. V.K. Ahluwalia and R.K. Parashar, "Organic Reaction Mechanism", Narosa- **2006.**

BASICS OF ANALYTICAL CHEMISTRY-P20ACH3

Semester: I **Core Course: 3**

Instruction Hours/Week: 5 **Credit: 5**

Objectives:

1. The intends of the course is to enlighten the students in the area of analytical chemistry
2. To study the separation techniques, optical methods of chemical analysis, electro analytical techniques and thermal methods of analysis
3. To evokes a sense of environmental concern in students

UNIT I: Introduction to Analytical chemistry (18 hours)

Classifications of analytical methods, factors influencing choice of analytical method, toxic chemicals sampling and handling hazards, material safety data sheets. Miniaturization of analytical methods and its significance in modern chemical analysis. Various types of Error - accuracy, Precision, significant figures - Standard deviation - Correlation and regression - Fitting of linear equations - Multiple linear regression analysis, control charts.

Unit-II: Separation Techniques (18 hours)

Solvent extraction, efficiency, selectivity, Nernst distribution law, distribution coefficient, derivation for the most efficient extraction, applications and numerical problems. Methods- batch and continuous extraction of liquids, continuous solid-liquid extraction (Soxhlet extraction of phytochemicals).

Chromatography–classification, mechanisms-adsorption, partition, ion exchange, gel permeation and affinity chromatography. Performance retention parameters, theoretical plate, efficiency, resolution, peak broadening- Van Deemter equation. Principles of course, 2D and preparative thin layer chromatography, Gas chromatography-detectors, temperature programming, high performance liquid chromatography, HPLC - theory, instrumentation and techniques. Normal phase and reversed phase liquid chromatography, Cation and anion exchange chromatography for metals and organic molecules.

Unit-III: Optical methods of chemical analysis (18 hours)

Pre-learning topics: Beer-Lambert's law and derivation. Interaction of electromagnetic radiation with matter, Beer-Lambert's law, derivation, verification, deviations, molar extinction coefficient, choice of solvent, Sandell sensitivity, Ringbom's plot, photometric titrations, Single beam and double beam UV-Vis spectrophotometer, Atomic absorption spectroscopy- instrumentation and

application in quantitative and qualitative analysis, Numerical problems. Principle, instrumentation and applications of fluorimetry, turbidimetry and nephelometry.

Unit-IV: Electro analytical methods (18 hours)

Potentiometry- electrode systems, potentiometric titrations- acid- base, precipitation and redox titrations. Polarography and Voltammetry- Diffusion currents, half-wave potentials, characteristics of the DME, Amperometric titrations, applications of polarography and amperometric titrations. Electrogravimetry, Coulometry, Coulometry at constant potential, coulometric titrations, applications. Conductometric titrations- ionic conductances, acid-base titrations.

UNIT V: Thermo analytical Methods and Fluorescence Spectroscopy (18 hours)

Comparison of Thermogravimetric analysis (TGA) and Differential Thermal analysis (DTA) - Differential Scanning Calorimetry (DSC). Principle and instrumentation - Thermometric titrations. Basic aspects of synchronous fluorescence spectroscopy and instrumentation - Instrumentation on fluorescence ratio imaging.

Course Outcome

In this introductory course the students will acquire knowledge of the basic concepts of analytical chemistry.

Text Books and Reference Books:

1. G.D. Christian, Analytical chemistry, 6th Ed., John – Wiley and Sons Inc, **2004**.
2. Douglas A. Skoog and F. James Holler, Timothy A. Nieman, Principles of instrumental analysis, **1998**.
3. H.H. Willard, L.L. Merrit, J.A. Dean and F.A. Settle, Instrumental methods of analysis, CBS Publishers: 7th Ed., **1986**.
4. A.J. Bard and I.R. Faulkner, Electrochemical methods, 2nd ed., Wiley: New York, **2000**.
5. Wilson Keith and John Walker, Principles and techniques of Biochemistry and Molecular biology, 6th Ed., Cambridge, **2005**.
6. Skoog, West, Holler and Crouch. Fundamentals of analytical chemistry, 8th Ed., Thomson Asia Pvt. Ltd, **2004.**

Essential Reading / Recommended Reading

1. F. W. Fifield and D. Kealey, Principles and practice of Analytical Chemistry, 5th Ed., **1991**.
2. S. M. Khopkar, Basic concepts of analytical chemistry, 3rd Ed., New age international, **2009.**
3. Robert A. Meyers, Encyclopedia of Analytical Chemistry: Applications,Theory, and Instrumentation, 15 volume Set, Wiley, **2011**.
4. Robinsen, Undergraduate instrumental analysis 6th Ed., Taylor and francies, **2004**.
5. Analytical Chemistry "Gary D Christian; Purnendu K Dasgupta; Kevin Schug, John Wiley Publisher" **2014.**
5. Vogel's text book of quantitative chemical analysis "G. H. Jeffery J. Bassett J. Mendham R C. Denney, 5th Ed., The School of Chemistry, Thames Polytechnic, London, **1989.**

INORGANIC CHEMISTRY PRACTICAL–I P20ACH4P

Semester: I **Core Course: 4**

Instruction Hours/Week: 6 **Credit: 3**

Objectives:

1. To learn and identify the inorganic cation in a mixture.
2. To know the colourimetric techniques for estimation of ions.

- Semi-micro qualitative analysis of a mixture containing two common and two rare cations.
- Estimation of Copper, Ferric, Nickel, Chromium and Manganese using photoelectric colorimeter.

Course Outcomes:

1. Students will be able to identify and estimate the amount of inorganic ions present in a sample.
2. Students learn the instrumentation technique of Photocolorimeter.

References:

1. Vogel, "*Quantitative Inorganic Analysis*", ELBS, 3rd Ed., **1971**.
2. V. V. Ramanujam, "*Inorganic Semimicro Qualitative Analysis*", The National Publishing Company, Madras, **1974**.

ORGANIC CHEMISTRY PRACTICAL – I – P20ACH5P

Semester: I **Core Course: 5**

Instruction Hours/Week: 6 **Credits: 3**

Objectives:

1. To learn the separation techniques of binary organic mixtures and characterize them.
2. To study some single stage preparation of organic compound.

Qualitative Analysis of an Organic Mixture Containing Two Components

Pilot separation, analysis and derivatization.

Preparation of Organic Compounds (Single Stage)

(a) Methyl-m-nitrobenzene from methyl benzoate (nitration)
(b) Glucose penta acetate from glucose (acetylation)
(c) Resacetophenonone from resorcinol (acetylation)
(d) Phenyl-azo-2-naphthol from aniline (diazotization)
(e) 2-Naphthylmethylether from 2- Naphthol (methylation)
(f) Dibenzalacetone from benzaldehyde

Course Outcomes:

1. Students learn the separation of binary organic mixtures
2. Students understand the green chemistry concepts
3. Students learn the skills of doing micro level analysis
4. Students get to know the methods of qualitative analysis of organic compounds
5. Students understand the single stage preparation of organic compounds
6. Students learn about the derivative of the organic functional groups

Text Books:

1. Dey and Sitaraman, "*Laboratory Manual of Organic Chemistry*", Allied Publishers, **1992**.
2. N. S. Gnanaprakasam, G. Ramamurthy, "*Organic Chemistry Lab Manual*", S. Viswanathan Printers and Publishers Pvt. Ltd., **2015**.

References:

1. Furniss, S. B.; Hannaford, A. J.; Smith, P. W. G.; Tatchell, A. R. "*Vogel's Text Book of Practical Organic Chemistry*", 5th Ed., Longman Scientific & technical, England, **1989**.

INORGANIC CHEMISTRY-II- P20ACH6

Semester: II **Core Course: 6**

Instructions Hours per Week: 5 **Credits: 5**

Objectives:

1. To understand the principles and reaction mechanisms of coordination chemistry
2. To learn the biological role and mechanism of bioinorganic complexes
3. To study the various types of organometallic reactions and role of organometallic catalysts

UNIT I: Coordination Chemistry Principles (18 hours)

Nomenclature of mono and polynuclear coordination compounds - valence bond theory - formation of octahedral complexes on the basis of VBT - limitations of VBT - crystal field theory (CFT) - shapes of d-orbitals in octahedral symmetry - CFSE - strong field and weak field splitting - calculation of CFSE - splitting in tetrahedral symmetry - only weak field - tetragonal symmetry - differences between tetrahedral and tetragonal symmetry - Jahn-Teller distortions - splitting pattern in various symmetries - factors affecting the magnitude of splitting (10 Dq) - Spectrochemical series - Jorgenson's relation - evidences for CFT - magnetism and colour of transition metal ions - LFT. MO theory – octahedral and tetrahedral complexes - $\pi-$ bonding and MO theory - ligands having filled and empty - $\pi-$ bonds - effect of 10 Dq - evidences for - $\pi-$ bonding from X-ray crystallography, IR and photoelectron spectroscopy - Nephelauxetic effect.

UNIT II: Coordination Chemistry and Reaction Mechanism (18 hours)

Stability of coordination compounds - detection of complex formation in solution - stability constants - step-wise and overall formation constants - pH metric, and photometric methods of determination of formation constants - factors affecting stability - statistical and chelate effects - forced configuration.

Kinetics and mechanism of reactions - labile and inert complexes - ligand displacement reactions - hydrolysis and anation reactions in octahedral and square planar complexes-trans effect - theory and applications - electron transfer reactions - complementary and non-complementary types - inner sphere and outer sphere processes-isomerisation and racemisation - reactions of coordinated ligands - template effects - synthesis of macrocyclic ligands.

UNIT III: Bioinorganic Chemistry (18 hours)

Biological role of metal ions – Gold compounds and Rhematoid arthritis- anti cancer drugs- characterization of K^+, Na^+, Ca^{2+} and Mg^{2+} complexes of alkali and alkaline earth metal ions with macrocycles - ion channels - ion pumps. Oxygen transport (Hb and Mb) and storage - carbonic anhydrase -carboxypeptidases - iron-sulphur proteins and non-heme iron cytochromes of electron transport chain - cytochrome P-450 enzymes.

UNIT IV: Organometallic Reactions (18 hours)

Ligand association and dissociation reactions-oxidative addition and reductive elimination reactions. Hapticity - ligand classification - synthesis and structure - uses of typical organometallics in organic synthesis - such as metal alloys and organomercuric compounds in medicine. Metal carbenes - carbynes - metal clusters complexes of - acceptor ligands - carbonyls - 18 electron rule - applications and limitations - isolobal concept - applications to structure - carbonyl hydrides - nitrosyl complexes - bridging and terminal nitrosyls - bent and linear nitrosyls - dinitrogen complexes - dioxygen complexes – molecular orbitals of metallocenes.

UNIT V: Reaction and Catalysis by Organometallic Compounds (18 hours)

Catalysis by organometallic compounds - hydrogenation of olefins hydroformylation of olefins – oxidation of olefins to aldehydes and ketones - polymerization of alkenes- Tolman catalytic loops- cyclo-oligomerisation of acetylene - Fischer- Tropsch synthesis - epoxidation – metathesis - carbonylation of methanol.

Course Outcomes:

By learning the basic principles of coordination chemistry and the reaction mechanism in organometallics, a student can improve his knowledge to predict the mechanism in coordination and organometallic reactions.

References:

1. J. E. Huheey, E. A. Keiter and R. L. Keiter, "*Inorganic Chemistry – Principles of Structure and Reactivity*", Harper Collins College Publishers, 4th Ed., **1993**.
2. F. A. Kettle, "*Physical Inorganic Chemistry - A Coordination Approach*", Spectrum Academic Publishers, Oxford University Press, **1996**.
3. P. Powell, "*Principles of Organometallic Chemistry*", 2nd Ed., Chapman and Hall, London,**1988**.

4. K. F. Purcel and J. C. Kotz, "*Inorganic Chemistry*", W. G. Saunder's Company, Philadelphia.
5. W. U. Malik, G. P. Tuli and R. D. Madan, "*Selected Topics in Inorganic Chemistry*", 6th Ed., **2001**, S. Chand & Company Ltd., New Delhi.
6. Gurdeep Raj, "*Advanced Inorganic Chemistry*", Vol. II, 8th Ed., **2002**, Goel Publishing House, Meerut.
7. W. Kaim and B. Schewederski, "*Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life*", John-Wiley and sons, New York, **2013**.

Reference Books:

1. G. L. Miessler and D.A. Tarr, "*Inorganic Chemistry*", Pearson, Prentice Publishers, Delhi, **2009**.
2. Cotton F A and Wilkinson G, "*Inorganic Chemistry A Comprehensive Text*", Inter science Publishers, New York, 5th Ed., **1988**.
3. Purcell K F and Kotz J C, "*Inorganic Chemistry*", W B Saunders Company, Philadelphia, **1977**.
4. B. Douglas, D.H. McDaniel and Concepts and Models of J.J. Alexander, "*Inorganic Chemistry*", John Wiley and Sons, New Delhi, **2001**.

PHYSICAL CHEMISTRY I – P20ACH7

Semester: II **Core Course: 7**

Instructions Hours per Week: 5 **Credits: 6**

Objectives:

1. To learn to apply quantum mechanics to simple chemical systems.
2. To learn in detail rotational, vibrational and electronic spectra of molecules.
3. To understand the thermodynamic properties of real gases and to apply phase rule to three component systems.
4. To understand the advanced concepts involved in kinetics.
5. To study reactions in photochemistry and radiation chemistry.

UNIT I: Quantum Chemistry-I (18 hours)

Inadequacy of classical mechanics - Black body radiation, Planck's concept - Wave -particle dualism - Uncertainty Principle - Inadequacy of old quantum theory. Schrodinger equation – Postulatory basis of quantum mechanics - Operator algebra: operator, linear and Hermitian, Eigen functions and eigen values, angular momentum operator, commutation relations. Application of wave mechanics to simple systems - particle in a box, one- and three-dimensional - distortion of the box and Jahn-Teller effect - quantum numbers - Orthogonalisation and normalization.

UNIT II: Molecular Spectroscopy – I (18 hours)

Einstein coefficient of absorption and transition probabilities - basis of selection rules - Representation of spectra - the width and intensity of spectral transitions oscillator strength. Electronic spectra - electronic spectra of molecules - Born Oppenheimer approximation - vibrational coarse structure - Franck-Condon principle - dissociation energy - Fortrat diagram - Pre-dissociation - various types of transitions - solvent effect on spectra. Infra-red spectra - vibrational spectra - selection rules - harmonic and anharmonic oscillators - vibration and rotation spectra of diatomic molecules - vibration spectra of polyatomic molecules - normal vibration and normal coordinates - Influence of rotation on the spectra of polyatomic molecules - parallel and perpendicular bands - FTIR.

UNIT III: Classical Thermodynamics (18 hours)

Thermodynamic properties of real gases - Fugacity - definition - methods of determination of fugacity - variation of fugacity with temperature and pressure - activity and activity coefficient - definition - Standard states for gases, liquids, solids and component of solutions - determination of activity and activity

coefficient from freezing point - EMF and solubility measurements. Phase rule - Application of phase rule to the three component systems - systems of three liquids - solid-liquid system (Eutectic systems - two salts and water).

UNIT IV: Chemical Kinetics (18 hours)

Theories of reaction rate - Absolute reaction rate theory (ARRT) - significance of reaction coordinate - Potential energy surfaces - Kinetic isotopic effect - Principle of microscopic reversibility - Steady-state approximation. explosions and hydrogen – oxygen reactions. Factors influencing reaction rates in solution - application of ARRT to solution kinetics - effect of solvent and ionic strength, influence of pressure on rates in solution - significance of volume of activation. Acid-base catalysis - Hammett's acidity function - Bronsted relation.

UNIT V: Techniques in Chemical Kinetics, Photochemistry and Radiation Chemistry (18 hours)

Fast reaction techniques: Flow methods: Stopped flow technique – Relaxation methods - Flash photolysis - Shock tube method - molecular beam method. **Photochemistry:** Photo physical process in electronically excited molecules – Jablonski diagram – Stern-Volmer equation - Chemical Actinometers - Lasers and their applications. **Radiation chemistry:** Sources of high energy radiation - radiolysis of water – solvated electrons - Scavenging techniques - Applications of radiation chemistry.

Course Outcomes:

The students will be able to

1. Apply quantum mechanics to simple chemical systems.
2. Interpret rotational, vibrational and electronic spectra of molecules.
3. Understand the thermodynamic properties of real gases and to apply phase rule to three component systems.
4. Understand the advanced concepts involved in kinetics and apply the same in the laboratory.
5. Acquire knowledge on photochemistry and radiation chemistry.

Text Books:

1. A. K. Chandra, "*Introductory Quantum Chemistry"*, 4th Ed., Tata McGraw Hill Ed., **1994**.
2. R. K. Prasad, *Quantum Chemistry*, 2nd Ed., New Age International Publishers **2000**.
3. N. Levine, *Quantum Chemistry*, 4th Ed., Prentice Hall of India Pvt. Ltd., **1994**.

4. D. A. McQuarrie, *Quantum Chemistry,* University Science Books **1998**.
5. S. Glasstone, Introduction to Theoretical Chemistry, Affiliated East-West Press
6. G. N. Barrow, Introduction to Molecular Spectroscopy, International McGraw Hill Ed., **1993.**
7. P. Straughan and S. Walker, Spectroscopy, Vol. I to III, Chapman Hall, London **1976**.
8. C.N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy' Tata- McGraw- Hill Education, 4th Ed., **1994**.
9. S. Glasstone, Thermodynamics for Chemists, East-west Affiliated Pvt., Ltd, New Delhi **1969.**
10. R. P. Rastogi and R. R. Misra, An Introduction to Chemical Thermodynamics Vikas Publishing House Pvt Ltd., **1992.**
11. Klotz and P. M. Rosenberg, Chemical Thermodynamics: Basics Theory and Methods, 3rd ed.,W. A. Benjamin, NY **1974**.
12. K.J. Laidler, Chemical Kinetics, 2nd Ed., Tata McGraw Hill, **1975.**
13. A. Frost and R. G. Pearson, Kinetics and Mechanisms, John Wiley & Sons **1953**.
14. J. C. Kuriacose and J. Rajaram, Kinetics and Mechanisms Transformations, Macmillan & Co., **1993**.
15. P. W. Atkins, Advanced Physical Chemistry, 7th Ed., Clarendon **2002.**
16. K. K. Rohatgi and Mukerjee, Fundamentals of Photo Chemistry, Wiley Eastern Ltd **1986**.
17. G. Hughes, Radiation Chemistry, Oxford University Press **1973.**

Reference Books:

1. Peter Atkins and Julio de Paula, "*Atkin's Physical Chemistry*", Oxford Publishers, **2014**.

INORGANIC CHEMISTRY PRACTICAL-II P20ACH8P

Semester: II **Core Course: 8**

Instructions Hours per Week: 6 **Credits: 3**

Objectives:

1. To learn the separation of ions in a mixture.
2. To learn the volumetric estimation of some inorganic cations.
3. To learn the gravimetric techniques.
4. To know the preparation of coordination complexes.

Titrimetry (V) and Gravimetry (G)

A mixture of solution(s) should be given for estimation Cu (V) and Ni (G)

Cu (V) and Zn (G)
Fe (V) and Zn (G)
Fe (V) and Ni (G)
Zn (V) and Cu (G)

Preparation of the following compounds

a) Tetramminecopper (II) sulphate.
b) Potassium trioxalatochromate (III).
c) Potassiumtrioxalatoaluminate (III).
d) Trithioureacopper (I) chloride.
e) Trithioureacopper (I) sulphate.

Preparation of coordination complexes and their characterization by magnetic susceptibility measurements and Infrared, UV /Vis spectroscopic techniques.

Course Outcomes:

1. Students learn the estimation of ions by separating them in a mixture.
2. Students get skill in preparation of coordination compounds.

Text Book:

1. Inorganic Semi-Micro Qualitative Analysis, V.V. Ramanujam, The National Publishing House, Chennai, **1990**.

Reference Books

1. W.G. Palmer, "*Experimental Inorganic Chemistry*", Cambridge University Press, Cambridge, **1965**.
2. V.I. Posypaiko and N.A. Vasiua, "*Analytical Chemistry in Metallurgy*",Mir Publisher, Moscow, **1984**.
3. G.H. Jaffery, J. Bassett, J. Mendhan and R.C. Deeny, "*Vogel's Textbook of quantitative Chemical analysis*", ELBS, **1997**.

ORGANIC CHEMISTRY PRACTICAL II – P20ACH9P

Semester: II **Core Course: 9**

Instruction Hours/Week: 6 **Credit: 3**

Objectives:

1. To learn quantitative analysis in organic chemistry and get hands on experience on the double stage preparation of organiccompounds.
2. To learn the interpretation of UV and IR spectra of organic compounds.

Quantitative analysis of Organic Compounds

Estimation of phenol, aniline, ketone, glucose

Preparation of Organic Compounds (Double Stage)

a) *p*-bromo acetanilide from aniline (acetylation and bromination).
b) acetyl salicylic acid from methyl salicylate (hydrolysis and acetylation)
c) 1,3,5-tribromobenzene from aniline (bromination, diazotization and hydrolyzation).
d) p-nitroaniline from acetanilide (nitrogen and hydrolysis).
e) benzylic acid from benzoin (rearrangement).
f) benzanilide from benzophenone (rearrangement).
g) *p*-bromoaniline from acetanilide (bromination and hydrolysis).
h) *m*-nitroaniline from nitrobenzene.
i) 1,2,4-triacetoxy benzene from hydroquinone (oxidation and acylation)

- Separation of organic compounds using thin layer and column chromatographic techniques.
- Characterization of organic compounds using infrared and *UV-Vis* spectroscopic techniques.

Course Outcomes:

1. Students understand the quantitative analysis in organic chemistry.
2. Students know the estimation of organic compounds.
3. Students understand the double stage organic preparations.
4. Students get to know the chromatographic techniques.

Text Books:

1. Dey and Sitaraman, "*Laboratory Manual of Organic Chemistry*", Allied Publishers, **1992**.
2. N. S. Gnanaprakasam, G. Ramamurthy, "*Organic Chemistry LabManual*", S. Viswanathan Printers and Publishers Pvt. Ltd., **2015**.

References:

1. Furniss, S. B.; Hannaford, A. J.; *et al*., "*Vogel's Text Book of Practical Organic Chemistry*", 5th Ed., Longman Scientific & technical, England, **1989**.

GREEN AND ENVIRONMENTAL CHEMISTRY – P20ACH10E

Semester: II **Elective Course: I**

Instruction Hours/Week: 5 **Credit: 5**

Objectives:

1. To learn the need and goals of green chemistry.
2. To make the students to plan the synthesis of organic compoundsin a greener approach.
3. To learn about the possible sources of agricultural pesticides its mode of transport and accumulation and its impacts on human health.
4. To improve their knowledge of basic information of radio- active decay and permissiable radiation dose.

UNIT I: Introduction to Green Chemistry (18 hours)

Green chemistry - Introduction - need for green chemistry - goals of green chemistry- Anastas' twelve principles of green chemistry - Designing a green synthesis (tools) - choice of starting materials, solvents, catalysts, reagents, processes with suitable examples.

UNIT II: Microwave, Ultrasound Assisted Organic Synthesis and Biocatalysts (18 hours)

Microwave activation - advantages of microwave exposure – Microwave assisted reactions, condensation reactions - oxidation, reduction reactions, multicomponent reactions. **Sonochemistry** - use of ultrasound in organic synthesis (alternate source of energy) - saponification - substitution, addition, oxidation reactions, reductions. Biocatalysts in green synthesis - use of biocatalysts in green chemistry - advantages - biochemical (microbial) oxidation and reduction reactions - Bakers yeast mediated bio-transformation biocatalyst mediated Baeyer-Villiger reaction.

UNIT III: Ionic liquids - Phase Transfer Catalyst and Green Synthesis (18 hours)

Ionic liquids - synthesis, physical properties of ionic liquids - applications in alkylation, epoxidation, Friedal-Crafts reaction - Diels-Alder reactions Knoevengal condensations and Wittig reactions. **PTC** - Definition - advantages, types of PTC reactions - synthesis of PTC, applications of PTC in organic synthesis Michael reaction - alkylation of aldehydes and ketones. Wittig, generation of dihalocarbene, elimination reaction.

UNIT IV: Toxicity of pesticides and insecticides (18 hours)

Pesticides - General aspects of classification in terms of chemical nature and generation wise. Mode of action of insecticides - General aspects. Bioaccumulation and bio- magnification of pesticides - Fate of insecticides in environment and environmental hazards - Major disasters with pesticides and herbicides - Toxicity of DDT, gammexene and malathion - comparison of organochlorine, organophosphate and carbamate insecticides - Detoxification of pesticides and allied chemicals - Safer pesticides - IPM - Environmental hazards arising from fertilizers - Minimization of environmental problems caused by fertilizers.

UNIT V: Radioactive Pollution (18 hours)

Nature of radioactive emission - units - Radiation from natural sources and Man-made activities - Effects of radiation on human health -Permissible radiation dose - Comparative risk analysis of fossil fuel based power generation versus nuclear power generation - Radioactive fallout -Nuclear winter: atmospheric turbidity and effects - Radioactive pollution in land, atmosphere and water - Nuclear waste disposal: Nature, general principles and strategies - Causes and prevention of nuclear reactor accidents.

Course Outcomes:

The student gained knowledge about

1. Twelve principles of green chemistry, eco-friendly synthesis using microwave, biocatalyst. PTC, ionic liquid and SCC.
2. Increase the use of environmentally friendly practices in reducing agricultural pollution.
3. The nuclear waste disposal prevention of nuclear reactor accidents, radioactive fall-out.

References:

1. Paul T. Anastas and John C. Warner, "Green Chemistry", Oxford University Press, Indian Ed., **2008**.
2. V. K. Ahluwalia and M. Kidwai, "New Trends in Chemistry", Anamaya Publishers, 2nd Ed., **2007**.
3. V. Kumar, "An Introduction to Green Chemistry", Vishal Publishers, 1st Ed., **2007.**
4. V. K. Ahluwalia and R. S. Varma, "Green Solvents", for organic synthesis Narosa Publishing, 1st Ed., **2009.**
5. V. K. Ahluwalia and Renu Aggarwal, "Organic Synthetic Special Techniques", Narosa, 2nd Ed., **2009.**
6. V. K. Ahluwalia, "Green Chemistry - Environmentally Benign Reactions", Ane books, India, **2006.**

7. Rashmi Sanghi and N. M. Srivastava, "Environment Friendly Alternatives", Narosa Publishing House, **2003.**
8. D. K. Asthana and Meera Asthana, "Environment - Problems and Solutions", S. Chand & Co Ltd.
9. Benny Joseph, "Environmental Studies", Tata McGraw Hill publishing Company Ltd, New Delhi.1st Ed., **2009.**
10. Erach Bharucha, "Text book of Environmental Studies", University press 2nd Ed., **2013.**

Reference Books:

1. Green Chemistry-An Introductory Text; Mike Lancater; RSC publishers, **2011**.
2. Green Chemistry – Designing Chemistry for the Environment – edited by Paul T. Anastas & Tracy C. Williamson. 2nd Ed., **1998**.

QUALITY ASSURANCE AND BIOCHEMICAL ANALYSIS-P20ACH11E

Semester: II **Elective paper: II**

Instruction Hours/Week:5 **Credits 6**

Objectives:

1. To learn the environmental and biochemical analysis.
2. To check the extend of air, water and soil pollution by different analytical methods.
3. To know the food and drug analysis.
4. To study the biochemically important Photochemical and pericyclicreactions.
5. To analyse chiral compounds.

Unit I: Quality Assurance and Quality Control (18 hours)

Definition - Quality control and Quality assurance, concept and philosophy of TQM, GMP, ICH and ISO 9000. Standardization concept for products. Introduction to various pharmacopeia, Overview of ICH Guidelines: QSEM, with special emphasis on Q-series guidelines, Validation of Analytical Procedures, Good Manufacturing Practice (GMP) Guide for Active Pharmaceutical Ingredients, Good Laboratory Practice (GLP).

Unit II: Document maintenance in pharmaceutical Industry (18 hours)

Batch Formula Record, Master Formula Record, Quality audit reports and documents, quality reports, distribution records, complaints and evaluation of complaints, Handling of return good, recalling and waste disposal. In process quality control and finished products quality control for following formulation in pharma industry: tablets, capsules, ointments, suppositories, creams, modified release products (controlled release, sustained release products, etc.,) parenterals, ophthalmic and surgical.

Unit III: Food Analysis (18 hours)

Estimation of moisture, ash, crude protein, fat, crude fibre, carbohydrate, calcium, potassium, sodium and phosphate in foods; Analysis of common adulterants in foods; milk and milk products alcohol test, fermentation test, dye reduction tests (methylene blue and resazurin), test to distinguish between butter and margarine, phosphatase test for pasteurization, estimation of added water; Beverages - caffeine and chicory in coffee, methanol in alcoholic drinks; Estimation of saccharin, coal tar dyes, aflatoxins in foods.

Unit IV: Analysis of Drugs and Poisons (18 hours)

Classification of drugs; Characterization of common drugs; Analgesics - aspirin, paracetamol, Expectorants - Benadryl, Vitamins- A and C Sedatives - diazepam, barbiturates, Antibiotics - penicillin, chloramphenicol, ampicillin, Cardiovascular sorbitrate, methyldopa. Drugs of abuse: Analysis of narcotics (nicotine, morphine, heroin). Estimation of drug residues in biological samples, General discussion of poisons with special reference to mode of action of snake venom, war gases, cyanide, carbon monoxide and opium, Estimation of cyanide, carbon monoxide and barbiturates.

Unit V: Clinical Chemistry and Lipid Analysis (18 hours)

Composition of blood: collection and preservation of samples; Clinical analysis; serum electrolytes, blood glucose, blood urea nitrogen, uric acid, albumin, globulins and blood gas analysis. Enzyme analysis: Assay of acid and alkaline phosphatases, isoenzymes of lactate dehydrogenase, aldolase, metal deficiency and disease; Estimation of calcium, iron and copper. Lipid Analysis: General composition of edible oils; Qualitative tests for purity; Factors affecting physical characteristics of fats and oils; oil stability tests; smoke, flash and fire point of oils. Estimation of rancidity – carbonyl value and peroxide value, Tests for common adulterants like argemone oil, rice bran oil, castor oil, palmolein oil, white oil and petroleum fractions.

Course Outcome:

In this course students will acquire a deeper knowledge about environmental and biochemical analysis.

Text Books and Reference Books:

1. S. M. Khopkar, Environmental Pollution Analysis, 2nd Ed., New Age International Pvt. Ltd.,**2015.**
2. Asim K. Das, Environmental Chemistry with Green Chemistry, Books and Allied (p)Ltd., **2010.**
3. P. D. Vowels and D. W. Connel, Experiments in Environmental Chemistry, Pergamon, **1980.**
4. R.A. Day and A.L. Underwood, Quantitative Analysis, Prentice Hall, **1980.**
5. M. Shadaksharaswamy and N. S. Manay, Foods: Facts and Principles, Wiley Eastern Ltd., **1987.**
6. C. H. Eckles, W.B. Combs and H. Macy, Milk and Milk Products, Tata McGraw Hill, **1996.**
7. Wilson Gisvold and R. F. Dorge Ed, Textbook of Organic Medicinal and Pharmaceutical Chemistry, **1998.**

8. K. S. Narayan Reddy and Suguna Devi, The essentials of Forensic medicine and Toxicology, Hyderabad: **2002.**
9. Paula Y. Bruice, Organic Chemistry, 8th Ed., Pearson Education Limited, **2016.**
10. Jagdamba Singh and Jaya Singh, Photochemistry and Pericyclic Reactions, 4th Edn., New Age International Publishers,**2019.**
11. D. Nasipuri, Stereochemistry of organic compounds – Principle and Applications, 4th Ed., New Age International Publishers, **2012.**

Essential Reading / Recommended Reading

1. Wilson and Goulding, A Biologist's Guide to Principles and Techniques of Practical Biochemistry, **1981.**
2. D.J. Holme and H.Peck, Analytical Biochemistry, Longman Group, **1983.**
3. P. R. Hesse, A text book of Soil Chemical Analysis. CBS Publishers, **1994.**
4. C. K.Sharma, Analytical Chemistry, 4th Ed., Krishna Prakashan media Pvt Ltd., Meerut, India, **2012.**
5. J. M. Coxon and B. Halton, Organic Photochemistry, 2nd Ed., Cambridge University Press, **2011.**

PHYSICAL CHEMISTRY II – P20ACH12

Semester: III **Core Course: 10**

Instruction Hours/Week:5 **Credits 5**

Objectives:

1. To learn in detail the applications of group theory to chemistry.
2. To learn the advanced concepts in quantum chemistry.
3. To study the concepts involved in NMR and ESR spectroscopy
4. To understand electrode-electrolyte equilibrium.
5. To get knowledge about electro kinetic phenomena and corrosion.

UNIT I: Group Theory (18 hours)

Elements of Group theory - Classes - group multiplication tables - properties of group, subgroup and isomorphism groups - symmetry elements and operations - point groups of molecules - Matrix representation of geometric transformation - Consequences of great orthogonality theorem and construction of character tables - reducible and irreducible representations and their relations - direct product – Applications of group theory for the determination of hybridization of atomic orbitals of non-linear AX_2. AX_3 and AX_4 molecules and linear molecules (CO_2) - Determination of symmetries of vibrational modes in non-linear (H_2O) and linear molecules (CO_2)- Rules for IR and Raman Activity.

UNIT II: Quantum Chemistry-II (18 hours)

Application of SWE to simple harmonic oscillator (Hermite polynomial, eigenfunctions, eigen values) - rigid rotator with free axis (SWE in polar coordinates, separation of angular functions and their solutions- selection rules for rotational and vibrational transitions - Bohr's correspondence principle -hydrogen atom and hydrogen like systems electron spin - Exactly solvable nature of systems - approximation methods - Variation method - application to hydrogen and helium atom - perturbation method to non – degenerate systems – Hartree Fock Self consistent field methods- Many electron atoms -wave function –one electron orbital – Pauli principle and Slater determinant.

UNIT III: Electrochemistry-I (18 hours)

Ionics: Debye-Huckel theory - radius of ionic atmosphere and its calculation – Debye-Huckel- Onsager equation and its modifications - asymmetry and electrophoretic effects – Debye Falkenhagen and Wien's effects - Activity of ions in solutions - Debye Huckel limiting Law. Electrode – electrolyte equilibrium: concentration cells - liquid junction potentials – Thermodynamic quantities from EMF data. Electrochemical energy - Storage system - Primary and secondary batteries –H_2-O_2 and Hydrocarbon - Oxygen fuel cells.

UNIT IV: Electrochemistry-II (18 hours)

Electro kinetic Phenomena: Theories of electrical double layer - Theory of multiple layers at electrode electrolyte interface - electro kinetic phenomena. Processes at electrodes - the rate of charge transfer - current density – Butler-Volmer equation - Taft equation. Electro chemical corrosion - construction and use of Pourbaix and Evans Cyclic voltammetry, advantages over polarography techniques diagram -prevention of corrosion - electro chemical oxidation and reduction.

UNIT V: Statistical Thermodynamics (18 hours)

Partition functions: Translational, rotational, vibrational, electronic – calculation of enthalpy, internal energy, entropy and other thermodynamic functions - application of partition functions to mono and diatomic molecules. Heat capacity of solids: Einstein and Debye's treatments - concept of negative Kelvin temperature. Non-equilibrium thermodynamics: Thermodynamics of irreversible process - enthalpy production and entropy flow in open system-Onsager theory - phenomenological relations - Onsager reciprocal relations - steady state conditions.

Course Outcomes:

The students will be able to

1. Apply group theory to chemistry.
2. Gain knowledge on advanced concepts in quantum chemistry.
3. Understand the theoretical background of NMR and ESR spectroscopy.
4. Apply electrochemical principles in practical experiments.
5. Acquire knowledge on electrical double layers and on corrosion prevention.

Text Books:

1. F. A. Cotton, Chemical Applications of Group Theory, 2nd Ed., Wiley Eastern **1971.**
2. A. K. Chandra, Introductory Quantum Chemistry, 4th Ed., Tata McGraw Hill, **1994**.
3. R. K. Prasad, Quantum Chemistry, 2nd Ed., New Age International Publishes **2000**.
4. D. A. Mcquarrie, Quantum Chemistry, University Science Books, **1983**.
5. J. P. Lowe, Quantum Chemistry, Academic Press, **1978.**
6. I. N. Levine, Quantum Chemistry, Allyn and Bacon, **1983.**
7. G. N. Barrow, Introduction to Molecular Spectroscopy, International Mc. Graw Hill Ed., **1993.**

8. A. P. Straughan and S. Walker, Spectroscopy, Vol. I to III, Chapman Hall, London **1976.**
9. C.N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy' Tata-McGraw- Hill Education,4th Ed., **1994.**
10. P. W. Atkins, Physical Chemistry, ELBS and Oxford University Press, Oxford, **1983.**
11. A. S. Glasstone, Introduction to Electrochemistry, Affiliated East-West Press, **1968.**

Reference Books:

1. Peter Atkins and Julio de Paula, "Atkin's Physical Chemistry", Oxford Publishers, **2014.**
2. Allen J. Bard and Larry R. Faulkner, "Electrochemical Methods Fundamentals and Applications", 2nd Ed., John Wiley and Sons, **2004.**

ORGANIC CHEMISTRY II – P20ACH13

Semester: III **Core course: 11**

Instruction Hours/Week: 5 **Credit: 5**

Objectives:

1. To appreciate the concept of substitution, addition and elimination reactions and their reaction mechanisms.
2. To understand the path, feasibility and mechanism of a reaction.
3. To understand the techniques involved in the determination of mechanism of reactions and applications of various molecular rearrangements.
4. To enable the student to understand and appreciate the importance of biomolecules.
5. To enable the student to understand and appreciate the importance of carbohydrates, antibiotics and steroids.

UNIT I: Addition Reactions and Addition to carbonyl group (18 hours)

Addition to carbon - carbon multiple bonds - electrophilic addition, nucleophilic and free radical additions - orientation and reactivity - Birch reduction - hydroxylation - hydroboration – epoxidation - Diels Alder reaction. Michael addition -ozonolysis, Clemmenson and Wolf-Kishner reductions. Mannich, Sobbe, Benzoin, Oppenauer oxidation - MPV reduction, Darzens Glycidic esters - Grignard reagents 1,2 and 1,4 addition - Gilman reagents - Wittig reaction.

UNIT II: Rearrangements and Elimination Reactions (18 hours)

Classification - mechanisms of the following rearrangements - Wagner, Meervein, Dienone-phenol, Wolff, Favorski, Steven, Sommelet Hauser, Demjenov, Von-Richer, Schmidt, Pummerer rearrangements. Mechanisms of E_1, E_2, E_1CB - stereochemistry of elimination -competition between elimination and substitution pyrolytic cis elimination - Chugaev reaction dehydration – dehydrohalogenation - Hofmann degradation - Cope elimination, Bredt's rule with examples. Saytzeff's rule and Hofmann rule.

UNIT III: Proteins, Nucleic Acids and Heterocyclic Compounds (18 hours)

Protein's classification – 1^o, 2^o, 3^o and quaternary structure of proteins - denaturation of proteins - biosynthesis of proteins. Nucleotides and Nucleosides - DNA - 1^o and 2^o structure- replication of DNA - RNA (*m*-RNA, *t*-RNA and *r*-RNA) genes - genetic code and informational theory - determination of base sequence of DNA - polymerase chain reactions. Synthesis and reactions of pyrazoles, oxazoles, thiazole, imidazole, pyridazine, pyrimidine, purines and pyrazines.

UNIT IV: Pericyclic Reactions (18 hours)

Characteristics - classification - molecular orbital symmetry - frontier orbitals ethylene,1,3-butadiene, 1,3,5-hexatriene and allyl systems - applications of frontier molecular orbital(FMO) and molecular orbital correlation diagram methods to eletrocyclic reactions (4n and 4n+2) system and cycloaddition reactions (2+2 and 4+2π electron system) - Woodward Hofmann rules - sigmatropic rearrangement (1,3 and 1,5 hydrogen shift) Cope and Claisen rearrangement (3,3 carbon shift) - chelotropic reactions.

UNIT V: Natural Products and Antibiotics (18 hours)

Steroids: Classification-structural elucidation of cholestrol (synthesis not required), structural elucidation and synthesis of Vitamin D, estrone, progestrone, ergosterol, androsterone and equilenin - Classification and functions of prostaglandins. **Antibiotics:** Chemotherapy - definition LD50 - Structural elucidation and synthesis of Penicillin, Streptomycin - Cephalosporin-C.

Course Outcomes:

1. Students learn the addition reactions in carbon-carbon unsaturated bonds and carbon-hetero atom multiple bonds.
2. Students have sufficient knowledge on the mechanisms of elimination reactions and their name reactions.
3. Students get to know the classifications, mechanisms and applications of various molecular rearrangements.
4. Students get to know the structure and importance of carbohydrates, antibiotics and steroids.

Text Books:

1. Jerry March, "*Advanced Organic Chemistry (Reactions, Mechanisms and Structure)",* - Wiley, **2005**.
2. Thomas H. Lowry and K. S. Richardson, "*Mechanism and Theory in Organic Chemistry*" Addisson-Wesley, **1988**.
3. V. K. Ahluwalia and R. K. Parashar*, "Organic Reaction Mechanism"*, Narosa, **2006**.
4. Raj K. Bansal, "*Heterocyclic Chemistry (Synthesis, Reactions and Mechanism)",* Wiley- Eastern Limited **1999**.
5. J. H. Weil, "*General Bio-chemistry"* - New Age International, **1997**.
6. M. Badger, "*Aromatic Character"*, Cambridge University Press, **1969**.
7. I. L. Finar, "*Organic Chemistry*", Volume-II, 5th Ed., **2006**.

Reference Books:

1. Structure and Mechanisms, F. Carey, R. Sundberg, "Advanced Organic Chemistry. Part-A". 4th Ed., Kluwer Publishers, **2000.**
2. Michael B. Smith, J. March, "March's Advanced Organic Chemistry", John Wiley & Sons, 6th Ed., **2007.**
3. J. Clayden, N. Greeves, P. Wothers, "Organic Chemistry", Oxford University Press, **2001.**
4. J. Mc. Murry, "Organic Chemistry", Brooks/Cole publisher, 5th Ed., **2000.**
5. M. B. Smith, "Organic Synthesis', Academic Press, Elsevier, 3rd Ed., **2010.**
6. M.G. Arora," Organic photochemistry and Pericyclic reaction, Anmol Publisher, **1998.**
7. Jagdamba Sing and Jaya Sing, "Photochemistry and Pericyclic reactions", New age International, **2005.**

ANALYTICAL CHEMISTRY PRACTICALS – I- (P20ACH14P)

Semester: III **Core Course: 12**

Instruction Hours/Week:6 **Credits 3**

Objectives

This practical paper on analytical chemistry intends to provide the students with the scientific skills required for the synthesis of various inorganic/organic compounds by different methods and their analysis by various analytical techniques.

Learning Outcome

In this practical course the students acquire practical skills related to analytical chemistry in synthesis of different inorganic/organic samples and their analysis.

Inorganic Preparations

1. Preparation of nano materials and their characterization by UV spectroscopy (band gap) and XRD (particle size) – 2 sessions. Eg ZnO.
2. Resolution of a racemic mixture by fractional crystallization.
3. Evaluation of efficiency of any synthetic method for a given organic preparation (one step preparation) by 2 or 3 different methods and comparison/evaluation of the methods with respect to the following parameters:

a) Ease of preparation, problems in handling chemicals, toxicity and flammability of chemicals.

b) Yield and cost effectiveness.

c) Product purity/quality.

d) Environmental costing (from the point of view of green chemistry).

4. Characterization of the organic compounds by: TLC, column liquid chromatography, fractional crystallization, UV, IR and NMR spectroscopic techniques.
5. Preparation of various hydroxides/oxides by different methods such as precipitation/ hydrothermal/high temperature (combustion)/sol-gel/Instrumental Methods of Analysis (Qualitative and Quantitative Methods).

GC Analysis

6. Qualitative identification of alcohols in a given mixture using gas chromatography.
7. Estimation of alcohols in a given mixture using gas chromatography.
8. Estimation of percentage esterification using gas chromatography.

Infra-Red Spectroscopy

9. Determination of the purity of the commercial benzoic acid using compressed discs.

Liquid Chromatography

10. Estimation of anions using ion chromatography

Thin Layer Chromatography

11. Identification of phenols using TLC.
12. Identification of amino acids using TLC.
13. Preparation of TLC plates, separation of analgesics, identification and estimation by UV spectrophotometer (2 sessions).

UV-Visible Spectrophotometry

14. Estimation of a mixture of caffeine and benzoic acid by UV spectrophotometer.
15. Identification of Fe in pharmaceutical preparation. (With sample preparation).

Text Books and Reference Books:

1. Vogel A.I. Quantitative Inorganic analysis. 2nd Ed., London: ELBS
2. Hesse P.R. A Text book of soil Chemical Analysis New Delhi: CBS, **2002**.

Essential Reading / Recommended Reading

1. Marr G. and B.W. Rockett, Practical Inorganic Chemistry, London: Van Nostrand Reinhold Co.

PHYSICAL CHEMISTRY PRACTICAL -P20ACH15P

Semester: III **Core Course: 13**

Instruction Hours/Week: 6 **Credit: 3**

Experiments:

1. Conductometry - Acid- alkali titrations.
2. Conductometry - Precipitation titrations.
3. Conductometry - Determination of dissociation constant of weak acids.
4. Conductometry - Solubility product of sparingly soluble silver salts.
5. Conductometry - Determination of degree of hydrolysis and hydrolysis constant of a substance.
6. pH - metric titrations - Acid -alkali titrations.
7. Potentiometric titrations - Precipitation titrations.
8. Potentiometric titrations - Redox titrations.
9. Kinetics - acid hydrolysis of Ester- Determination of energy of activation (Ea).
10. Kinetics - Saponification of Ester- Determination of Ea by conductometry.
11. Kinetics - Persulphate- Iodine reaction- Determination of order, effect of ionic strength on rate constant.
12. Determination of three compounds phase diagram by Transition Temperature method.
13. Study of phase diagram of two compounds forming a compound.
14. Determination of integral and differential heat of solutions by colorimetry.
15. Polymerization-Rate of polymerization of acrylamide.
16. Polarimetry–Inversion of cane sugar.

Text Books:

1. Senior Practical Physical Chemistry, D.D. Khosala, A. Khosala, V.C. Gard, R.Chand & Co., New Delhi, **1975.**
2. Practical Physical Chemistry B. Viswanathan and P.S. Raghavan, Viva Books Pvt. Ltd., New Delhi, **2008.**

Reference Books

1. Experimental Physical Chemistry Ed., by E. Daniels, International Student Ed., McGraw Hill,**1970.**
2. Experimental Physical Chemistry, G. Peter Mathews, Oxford Science Publications, **1985**.
3. J. B. Yadav, "Advanced Practical Physical chemistry", 20th Ed., GOEL publishing House, Krishna Pakashan Media Ltd., **2001**.
4. Findlay's "Practical Physical Chemistry" Revised and edited by B. P. Levitt 9th Ed., Longman, London, **1985.**
5. J. N. Gurthu and R. Kapoor, "Advanced Experimental chemistry", Vol. I. Chand & Co., Ltd, New Delhi, **1987.**

RETROSYNTHETIC ANALYSIS, PHOTOCHEMISTRY AND ORGANIC SPECTROSCOPY-P20ACH16E

Semester: III **Elective Course: III**

Instruction Hours/Week: 5 **Credit: 5**

Objectives:

1. To learn reagent less organic reactions and understand the principle behind thermal and photochemical organicreactions
2. To know the importance of addition reactions in organic compounds.
3. To understand the applicability of the spectroscopic techniques
4. To study the structure of the organic compounds from the study of spectra.

UNIT I: **Retro Synthetic analysis and Strategy (18 hours)**

Disconnection Approach and Synthetic Strategies: Introduction to retro synthetic analysis and disconnection approach - relay and convergent synthesis- linear synthesis- Introduction to synthons, synthetic equivalents - target molecule - Umpolung - designing synthesis by disconnection approach- Functional group interconversions: The importance of the order of events in organic synthesis - protecting group - principle, preparation and properties of alcohol and amine. C-C disconnections – Diels-Alder reaction and Robinson annulation – chemo-selectivity (guidelines).

UNIT II: Organic Photochemistry and Electron Spin Resonance Spectroscopy (18 hours)

Fundamental concepts - Jablonski diagrams – photosensitization-photochemical reactions - photo reduction - photo oxidation, photo rearrangements - di-π-methane rearrangement, photo reactions of ketones and enones – Norrish type I and II reactions - Paterno Buchi reaction - barton reactions - photochemistry of alkenes, dienes - photo addition reactions, photo chemistry aromatic compounds.

ESR: Basic principles - comparison between ESR and NMR spectroscopy - hyperfine splitting - calculation of unpaired electron density on an atom in a delocalized system (C_6H_6, p-xylene anion, naphthalene radical ion) - structure of methyl radical, p-benzoquinone radical anion.

UNIT III: ^{1}H NMR and^{13}C NMR Spectroscopy (18 hours)

^{1}H NMR spectroscopy - introduction - chemical shift, shielding, deshielding, chemical and magnetic non-equivalence of protons - spin-spin splitting - coupling constant - Dependencies of J-Couplings upon Dihedral Angles – Vicinal and Germinal coupling - Karplus equation - factors influencing chemical shift - first

and second order proton - simplification of complex. Spectra- double resonance techniques - contact shift reagents - chemical spin decoupling of exchangeable protons (OH, SH, COOH, NH, NH_2) - Nuclear Over Hauser Effect 2-D techniques (COSY, NOESY and ROSY). ^{13}C NMR- Basic principles FTIR, NMR relaxation - broad band decoupling - off resonance decoupling and calculation of chemical shift for simple aliphatic (olefin, alkynes, carbonyl carbon) and aromatic compounds - conformation and chemical shift correlation peak assignments. Importance of NOE phenomenon in ^{13} C spectroscopy.

UNIT IV: UV-Visible Spectroscopy and Mass Spectrometry (18 hours)

Basic principles of electronic transitions - applications of UV-visible spectroscopy - Woodward- Fiescher Scott rules - applications to conjugated dienes, trienes, polyenes - a-ß- unsaturated carbonyl compounds. Conjugated cyclic ketones and acetophenones - aromatic hydrocarbons and heterocyclic systems- differentiation of position isomers and cis-trans isomers. Mass spectroscopy: Introduction - ion production - factors affecting fragmentation, ion analysis - ion abundance - base peak, isotopic peak, meta stable peak, parent peak - fragmentation of organic compounds with respect to their structure determination of common functional groups - molecular ion peak - McLafferty rearrangements. Nitrogen rule – high resolution mass spectroscopy.

UNIT V: **Infrared Spectroscopy and Combined Spectroscopic Techniques (18 hours)**

Problems Molecular vibrations - stretching vibrations - symmetric and asymmetric - bending vibrations - rocking, scissoring, wagging and twisting - finger print region - characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds - alcohols, ethers, phenols and amines – detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, acids) - effect of hydrogen bonding (inter and intra molecular) and solvent effect on vibrational frequencies - overtones - fermi resonance. Calculation of double bond equivalents and its application in structural elucidation - problems involving combined UV, IR, NMR, CMR and mass spectra data.

Course Outcomes:

1. Students understand stereo chemical implications of pericyclic reaction in organic synthesis.
2. Students get to know the mechanistic pathways of DA, sigmatropic and electrocyclic reaction.

3. Students understand the structural and stereochemical implications on photochemical reactions.
4. Students learn the principles, techniques and applications of the ESR and NMR spectroscopy for the structural elucidations.
5. Students learn concepts and applications of UV-Vis spectroscopy.
6. Students get learnt the concept IR spectroscopy and are able to find out the IR stretching frequency of organic functional groups.

Text Books:

1. "Organic Photo Chemistry and Pericyclic reaction", M.G. Arora.
2. Organic Reactions and Orbital symmetry, T.L. Gilchrist and R.C. Storr. Cambridge, **1979.**
3. The Conservation of Orbital symmetry, R.B. Woodward and R. Hoffmann, Academic Press, **1970**.
4. Photochemistry and Pericyclic reactions. Jagdamba Singh and Jaya Singh New Age International, **2005.**
5. Organic Spectroscopy - Principles and Applications, Jag Mohan -Narosa, **2009.**
6. Elementary Organic Spectroscopy (Principles and Chemical Application). Y. R. Sharma, S. Chand, **2005**.
7. Organic Spectroscopy, William Kemp Macmillan, **2008**.
8. Spectroscopy of Organic Compounds - P.S. Kalsi - New Age International, **2012.**

Reference Books:

1. Structure and Mechanisms, F. Carey, R. Sundberg, "Advanced Organic Chemistry. Part-A". 4th Ed., Kluwer Publishers, **2000**.
2. Michael B. Smith, J. March, "March's Advanced Organic Chemistry", John Wiley & Sons, 6th Ed., **2007**.
3. J. Clayden, N. Greeves, P. Wothers, "Organic Chemistry", Oxford University Press, 2001.
4. J. Mc. Murry, "Organic Chemistry", Brooks/Cole publisher, 5th Ed., **2000.**
5. M. B. Smith, "Organic Synthesis', Academic Press, Elsevier, 3rd Ed., **2010.**

CHEMISTRY OF MATERIALS- P20ACH17

Semester: IV **Core Course: 14**

Instruction Hours/Week: 5 **Credit: 5**

Objectives

This paper on chemistry of materials intends to make the students get an idea on topics like inorganic materials, dimensionality in bonding, fibers and composites, amorphous materials, liquid crystals and conducting polymers. It enhances the creativity of students to tackle the needs of the community.

UNIT I: Basic Concepts and Synthesis of Nanomaterials (18 hours)

Introduction to nanoscale materials - atomic & molecular size. Scientific revolutions, Scope of nanoscience and technology, Quantum Dots. Nanostructures: Zero-, One-, Two- and Three- dimensional nano structures Chemical Routes for synthesis of nanomaterials: Sol-gel synthesis, Microwave heating synthesis and Sono chemical Synthesis. Physical Routes for synthesis of Nanomaterials: Bottom up-Ball Milling, Physical vapour deposition and Electrochemical approaches. Spin coating - Thin films – Epitaxy – Lithography. Applications of nanomaterials: Applications of nano-biotechnology in early medical diagnostics, in energy sector and ceramics industries. Organic nanomaterials: Rotoxanes and Catenanes.

UNIT II: Characterization Techniques and Methodologies (18 hours)

Techniques for characterization of nanoscale materials: Principles of Atomic Force Microscopy (AFM), Transmission Electron Microscopy (TEM) – Resolution and Scanning – Scanning Transition Electron Microscopy (STEM), Scanning Tunneling Microscopy (STM), Scanning Near field Optical Microscopy (SNOM). Nano carrier systems in biomedicine and drug delivery – Powder XRD – Particle Size analyser- Molecular modelling – Nano surveillance.

Unit III: Fibres and Composites Introduction (18 hours)

Inorganic polymers - Saffil alumina, zirconia. Classification of composites, micropscopic composites, Particle reinforced composites-large particle and dispersion strengthened composites. Fibre-glass reinforced composites continuous and discontinuous Fiber reinforced composites. Structural composites-laminates and sandwich panels. Polymer-matrix, metal-matrix, ceramic-matrix, carbon, hybrid composites and A1-B composites. Structural composites-laminates and sandwich panels.

Unit IV: Amorphous Materials (18 hours)

Crystalline versus amorphous solids. Glass formation, Structural effects in glass, Zachariasen's rules. Thermodynamics of glass formation-behaviour of liquids on cooling. Kinetics of crystallization and glass formation. Liquid immiscibility and phase separation in glass, structural theories of liquid immiscibility, mechanism of phase separation, Electrical conductivity of glass and the mixed alkali effect, Chalcogenide glasses, electrical properties, photocopying process, Glass ceramics, properties and application of glass ceramics.

Unit V: Liquid crystals and Crystallography (18 hours)

Mesomorphic behaviour, classification-thermotropic and lyotropic liquid crystals Calamitic, mesophases, nematic phase, smectic phase, chiral nematic phase and optical properties of liquid crystals. Crystal growing techniques.

Courses Outcome

In this paper they acquire a deeper knowledge about chemistry of materials.

Text Books and Reference Books:

1. M. Srivastava and C. Srinivasan, Science of engineering materials. Wiley Eastern Ltd, 3rd Ed., **2010.**
2. A.R. West, Solid-State Chemistry and its applications, John Wiley & Sons, 2nd students edition, **2014**.

Essential Reading / Recommended Reading

1. W.D. Callister, Material Science and Engineering. John Wiley and Sons Inc., 8th Ed., **2010**.

ADVANCED ANALYTICAL TECHNIQUES-P20ACH18

Semester: IV **Core Course: 15**

Instruction Hours/Week: 5 **Credit: 6**

Objectives

This course intends to make the students get an idea on advanced topics like optical spectroscopic methods, electrophoresis, kinetic methods of analysis and analysis of biomolecules. It helps the students to acquire knowledge, skills and attitudes to succeed in the competitive world.

Unit I: Optical spectroscopy methods (18 hours)

Atomic absorption spectroscopy: Basic principles and techniques, Flame AAS, non-Flame AAS, instrumentation, different types of nebulizers, electro thermal vaporizes, cold vapour AAS, radiation sources, HCL, EDL, detectors, photo-emissive cells, PMT, photodiodes, Interferences, spectral, chemical, matrix background, absorption correction methods, Zeeman effect, Smith- Hieftje methods, single beam and double beam instruments Atomic emission spectroscopy: Basic principles, ICP optical emission spectrometry, Microwave induced plasma systems in Atomic spectrometry. Atomic Fluorescence techniques: Basic principles and working of the instrument.

UNIT II: Basics of Molecular Modelling (18 hours)

Molecular modeling - Coordinate systems - Cartesian and internal coordinate systems - bond lengths, bond angles and torsion angles - distance matrix - stick models space filling models - potential energy surfaces – Molecular mechanics-application and parameterization - advantages and limitations of force fields.

Unit III: Techniques for biochemical analysis (18 hours)

Electrophoresis: Principles of electrophoresis, Instrumentation, Detection methods used in electrophoresis, classification of electrophoresis method- Zone electrophoresis, Isotachophoresis, Isoelectric focusing. Applications. Capillary electrophoresis: Theory, Instrumentation and applications, capillary electrochromatography. Mass spectrometry in structural biology, Enzyme and immune techniques- Enzyme based assay. ELISA, RIA, Fluorescent imaging, Fluorescent spectroscopy for biochemical analysis, Förster resonance energy transfer (FRET), Western blotting, Various types of Biosensors and chemosensors, Nanomaterials and nanotechnology used for biochemical analysis.

Unit IV: Kinetic methods of analysis (18 hours)

Kinetic techniques versus equilibrium techniques. Classifying chemical kinetic methods. Direct- computation fixed-time integral methods, Direct-computation variable time integral methods, Direct-computation rate methods, Curve – fitting methods. Making kinetic measurements-stopped flow analyser. Quantitative applications-Enzyme-catalyzed reactions, non-enzyme- catalyzed reactions, non-catalytic reactions. Characterization Applications- Determining V_{max} and K_m for enzyme catalysed reactions, elucidating the mechanisms for the inhibition of enzyme catalysis. Evaluation of chemical kinetic methods.

Unit V: Photoelectron and Laser Raman spectroscopy (18 hours)

Basic principles - UPES, XPES and AES - valence and core binding analysis, Koopman's theorem - ESCA and Auger spectroscopy to the study of surfaces. Laser Raman spectra: Rotational Raman spectra of linear molecules Vibrational Raman spectra – rotational fine structure - Fermi resonance.

Course Outcome

The students are expected to acquire knowledge about advanced analytical techniques.

Text Books and Reference Books:

1. G. D. Christian, Analytical Chemistry, 5th Ed., John-Wiley and Sons Inc.,**1994.**
2. D. A. Skoog, D. M.West and F. J. Holler, Fundamentals of Analytical Chemistry. 7th Ed., Saunders College Publishing. **1996.**
3. H. H. Willard, L, L. Merrit, J. A. Dean, and F. A. Settle, Instrumental methods of Analysis, C B S Publishers. **1996.**
4. G. W. Ewing, Instrumental Methods of Chemical Analysis, 5th Ed., McGraw- Hill, New York, **1988.**
5. D. Brune, R. Hellborg, H. J. Whitlow, O. Hunderi, Surface Characterization: A User's Sourcebook, WILEY-VCH, **2007**.
6. A. Manz, N. Pamme, D. Iossifidis, Bioanalytical Chemistry, Imperial College Press, **2004.**

Essential Reading / Recommended Reading

1. A. J. Bard, and I. R. Faulkner, Electrochemical Methods, 2nd Ed., Wiley, New York. **2000.**
2. Jeffery, Vogel's text book of Quantitative Chemical Analysis, 5th Ed., ELBS/ Longman, **1989.**
3. Skoog, West, Holler and Crouch, Fundamentals of Analytical Chemistry, 8th Ed., Thomas Asia Pvt. Ltd, **2004.**

ANALYTICAL CHEMISTRY PRACTICALS – II-P20ACH19P

Semester: IV **Core Course: 16**

Instruction Hours/Week:6 **Credits 3**

Objectives

This practical paper on analytical chemistry intends to provide the students scientific skills in quantitative techniques.

Learning Outcome

In this practical course the students acquire practical skills in analytical chemistry.

1. Estimation of Nitrogen or Nitro or Methoxy groups.
2. Separation of amino acids by Thin layer chromatography or Paper chromatography.
3. Separation of proteins by gel electrophoresis.
4. Estimation of rancidity in a sample of butter. (Iodine Value, Saponification Value).
5. Estimation of nicotine in tobacco by colorimetric.
6. Estimation of a common drug (paracetamol).
7. Analysis of water (estimation of suspended impurities, dissolved impurities, hardness (total and permanent), Alkalinity of water.
8. Extraction of caffeine from tea leaves, characterization by FTIR and estimation by colorimetry.
9. Estimation of protein in food samples.
10. Estimation of alkaline phosphate.
11. Estimation of a mixture of caffeine & benzoic acid by UV spectrophotometer.

Text Books and Reference Books:

1. Vowels P.D. and D.W. Connel, Experiments in Environmental chemistry Pergamon **1980.**
2. H.Varley and Anold Heinmann. Practical clinical biochemistry. **1978.**
3. David Plummer. An introduction to practical Biochemistry Tata Mc Graw Hill, **1979.**
4. J. Jayaraman Laboratory Manual in Biochemistry. Wiley Eastern, **1981.**

Essential Reading / Recommended Reading

1. Vogel's Textbook of Practical Organic Chemistry, Furniss, Pearson Education; 5th Ed., **2003.**