RAICHUR UNIVERSITY, RAICHUR

Krishna Tunga Campus, Yeragera-584133, Raichur

DEPARTMENT OF STUDIES IN CHEMISTRY

MASTER OF SCIENCE

Choice Based Credit System

With effect from 2023-2024

RAICHUR UNIVERSITY, RAICHUR

Krishna Tunga Campus, Yeragera-584133, Raichur

Department of Studies in Chemistry

Programme: Master of Science (M.Sc.) in Chemistry

Programme Overview:

Duration: 2 Years (4 semesters)

Master of Science (M.Sc.) in Chemistry programme provides fundamental and applied knowledge in Chemistry with hands-on training through laboratory practicals and foster career in teaching, research or industry.

Program Educational Objectives (PEOs):

- Post graduates will demonstrate capability to understand, analyse, develop, and execute the chemical solutions for the current societal requirements through experimental and experiential learning.
- Post Graduates exhibit professionalism and organizational goals with commitment to ethics, team work and respect for everyone.
- Students will be motivated for continuous learning and career development.
- Students impart educational skills and the knowledge in Chemistry in academia, research and industries .

Program Outcomes (POs):

- Discipline knowledge: Capable to apply knowledge of Chemistry and research to understand and solve the societal requirements.
- Solving of problems: Identify, analyse, interpret and develop solutions for problems related to Chemistry in Society.
- Design and execute chemical systems for different applications
- Apply hands-on training and research knowledge to conduct investigations, interpretation and formulation of solution.
- Application of advanced methodologies in synthesis and analytical techniques for finding solution in various domains.
- Acquire the information on the environmental issues and apply the knowledge to monitor and provide solutions to overcome.
- Able to work individually as well as in teams by institutionalizing the ethical values.
- Motivate for continuous learning and acquire updates in the field.

RAICHUR UNIVERSITY, RAICHUR

Distribution of Courses/Papers in Postgraduate Programme I to IV Semester as per Choice Based Credit System (CBCS) for Chemistry

M.Sc. I-SEMESTER

Semester No.	Paper Code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of SEE (Hrs)
			IA	SEE	Total	L	T	P		
FIRST	HCT11	Essentials of Inorganic Chemistry	20	80	100	4	-	-	4	3
	HCT12	Concepts in Organic Chemistry	20	80	100	4	-	-	4	3
	HCT13	Fundamentals of Physical Chemistry	20	80	100	4	-	-	4	3
	SCT11	Principles of Analytical Chemistry	20	80	100	4	-	-	4	3
	SCT12	Applied Analytical Chemistry	20	80	100	4	-	-	4	3
	SCT13	Environmental Chemistry	20	80	100	4	-	-	4	3
	HCP11	Inorganic Chemistry Practicals-I	10	40	50	-	-	4	2	4
	HCP12	Organic Chemistry Practicals – I	10	40	50	-	-	4	2	4
	HCP13	Physical Chemistry Practicals-I	10	40	50	-		4	2	4
Total Marks for I Semester					**550**				**22**	

M.Sc. II SEMESTER

Semester No.	Category	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of SEE (Hrs)
			IA	SEE	Total	L	T	P		
SECOND	HCT21	Advanced Inorganic Chemistry	20	80	100	4	-	-	4	3
	HCT22	Reactions in Organic Chemistry	20	80	100	4	-	-	4	3
	HCT23	Applied Analytical Methods	20	80	100	4	-	-	4	3
	SCT21	Applied Physical Chemistry	20	80	100	4	-	-	4	3
	SCT22	Selected Topics in Physical Chemistry	20	80	100	4	-	-	4	3
	SCT23	Biophysical Chemistry	20	80	100	4	-	-	4	3
	OET21	Chemistry for Daily life	10	40	50	2	-	-	2	2
	OET22	Agro and Environmental Chemistry	10	40	50	2	-	-	2	2
	HCP21	Inorganic Chemistry Practicals – II	10	40	50	-	-	4	2	4
	HCP22	Organic Chemistry Practicals – II	10	40	50	-	-	4	2	4
	SCP21	Physical Chemistry Practicals-II	10	40	50	-	-	4	2	4
Total Marks for II Semester					**600**				**24**	

M.Sc. III-SEMESTER

Semester No.	Category	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of SEE (Hrs)
			IA	SEE	Total	L	T	P		
THIRD	HCT31	Applied Inorganic Chemistry	20	80	100	4	-	-	4	3
	HCT32	Theoretical and Solid State Chemistry	20	80	100	4	-	-	4	3
	HCT33	Spectroscopy	20	80	100	4	-	-	4	3
	SCT31	Heterocyclic and Synthetic Organic Chemistry	20	80	100	4	-	-	4	3
	SCT32	Medicinal Chemistry	20	80	100	4	-	-	4	3
	SCT33	Agro, Health and Medicinal Care Chemicals	20	80	100	4	-	-	4	3
	OET31	Instrumental Analytical Techniques	10	40	50	2	-	-	2	2
	OET32	Bioanalytical Techniques	10	40	50	2	-	-	2	2
	HCP31	Inorganic Chemistry Practicals-III	10	40	50	-	-	4	2	4
	HCP32	Physical Chemistry Practicals-III	10	40	50	-	-	4	2	4
	SCP31	Organic Chemistry Practicals – III	10	40	50	-	-	4	2	4
Total Marks for III Semester					**600**				**24**	

M.Sc. IV-SEMESTER

Semester No.	Category	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of SEE (Hrs)
			IA	SEE	Total	L	T	P		
FOURTH	HCT41	Natural Products	20	80	100	4	-	-	4	3
	HCT42	Spectroscopy and Chromatography	20	80	100	4	-	-	4	3
	HCT43	Advanced Concepts in Physical Chemistry	20	80	100	4	-	-	4	3
	SCT41	Selected Topics in Inorganic Chemistry	20	80	100	4	-	-	4	3
	SCT42	Inorganic industrial materials	20	80	100	4	-	-	4	3
	SCT43	Energy and Industrial Inorganic Chemistry	20	80	100	4	-	-	4	3
	HCP41	Spectral data interpretation	10	40	50	-	-	4	2	4
	HCRP42	Research project/Internship	20	80	100	-	-	8	4	4
Total Marks for II Semester					**550**				**22**	

(I-IV semester)- Total Marks: 2500 and Total credits: 100

HCT – Hard core theory, SCT – Soft core theory, HCP – Hardcore practical, OET – Open Elective theory, OEP- Open elective practical, HCRP-Hard Core Research Project, IA – Internal Assessment, SEE – Semester End Examination, L – Lecture, T – Tutorial, P – Practical.

Note: In each semester, HCT, HCP and SCP papers are compulsory whereas students have to opt one soft core paper out of three soft core papers provided. Further, students can conduct either project work in the lab or internship either in industries or institutes. OET papers are for non-Chemistry students. Chemistry students have to take OET papers offered by other departments

M.SC. CHEMISTRY FIRST SEMESTER

Course Title: ESSENTIALS OF INORGANIC CHEMISTRY	**Course Code: HCT11**
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course Objectives:

1.	To refresh the chemistry knowledge learnt in UG programs and to introduce advanced concepts on related topics**.**
2.	Acquisition of skills in Inorganic Chemistry.
3.	To impart essential theoretical knowledge on atomic structure, periodic properties and chemical bonding.
4.	To develop the ability to correlate the chemical and physical properties of elements and their compounds with their positions in the periodic table.
5.	Understand the theories in Inorganic Chemistry

Unit	Description	Hours
1	**Review of periodic properties and theories of Bonding:** Review of periodic properties- Atomic size, ionization potential, and electron affinity and electro negativity. Ionic Bond: Radius ratio rules, types and structures of simple ionic compounds, lattice energy, Born-Lande equation, Kapustinskii equation, Size effects, polarizing power and polarizability of ions, Fajan's rules, solubility of ionic solids and hydration energy. Covalent Bond and Metallic Bond: VSEPR theory shapes of molecules-ClF_3, ICl_4^-, TeF_5-, I_3-, $TeCl_6^{2-}$, XeF_6, $SbCl^{3-}$, IF_7, XeF_8^{2-}, TaF_8^{3-}Concepts of hybridization, Energetics of hybridization, Bent rules and energetics of hybridization, partial ionic character, covalent-coordinate and multicentre bonding, M.O theory- LCAO approach, σ, δ and π molecular orbits. M.O treatment of homo nuclear and hetero nuclear diatomic molecules, Bond order in delocalized π- bonding systems, Ex: CO_3^{2-} NO_3^- and SO_3. Metallic bonding – electron sea model, VBT. Hydrogen Bonding	15hrs
2	**Structures and Energetics of Ionic Crystals and Covalent Bonds:** Ionic Bond: Properties of ionic compounds, crystal lattices, closed packed structures, coordination number of an ion, radius ratio rule, structures of crystal lattices- NaCl, CsCl, ZnS and rutile. Lattice energy: Born Lande equation, Born-Haber cycle, uses of Born-Haber type of calculations. Covalent character in ionic bonds, Fajan's rules, hydration	15hrs

	energy and solubility of ionic solids. Covalent Bond: Valence bond theory, resonance, hybridization and energetics of hybridization. VSEPR theory: Deduction of molecular shapes. MOT of homo and heteronuclear molecules and MO treatment for the molecules involving delocalized π- bonding (CO_3^{2-}, NO_3^- and CO_2). Walsh diagrams and Bent's rule.	
3	**Coordination Chemistry:** Coordination numbers 2 to 10 and their geometries. Crystal field theory of coordination compounds: octahedral, square planar, tetrahedral, trigonal bipyramidal and square pyramidal fields, measurement of 10 Dq and factors affecting it, CFSE, Spectrochemical series and Jahn-Teller effect. Structural evidences for ligand field splitting: hydration, ligation and lattice energies. Evidences for covalency in M-L bonding. MO theory of coordination compounds: MO energy level diagrams for octahedral and tetrahedral complexes without and with pi-bonding. Electronic Spectra: Spectroscopic ground terms, Orgel diagrams for transition metal complexes (Td &Oh). **Magnetism: Types, spin moment, spin-orbit coupling.**	15hrs
4	**Stability of Complexes and Acid-Base theory:** Stability of Metal Complexes, Concepts of Acids and Bases and Non-aqueous Solvents: Stability of complexes: Step-wise and overall formation constants, factors affecting stability of metal complexes, determination of stability constants of metal complexes by spectrophotometric and polarographic methods. Concept of acids and bases: Theories of acids and bases, Bronsted and Lewis acids and bases, Lux-Flood theory, leveling effect of solvents, hardness and softness, HSAB concept and its applications. Non-aqueous solvents: Classification of solvents, properties of non-aqueous solvents. Reactions in non-aqueous media: Liquid ammonia, anhydrous sulphuric acid, anhydrous HF, liquid sulphur dioxide. Super acids.	15hrs

References:

1. Inorganic Chemistry-Principles of Structure and Reactivity, 4thEdn J. E. Huheey, E.A. Keiter, R. L. Keiter and O.K. Medhi. Pearson Education (2009).
2. Shriver & Atkins' Inorganic Chemistry, 5th Edn-P. Atkins, Tina Overton, J. Rourke, 00 Mark Weller and F.Armstrong.Oxford University Press (2010)
3. Inorganic Chemistry, 2nd Edn. Catherine E. Housecroft and A.G. Sharpe, Pearson Prentice Hall (2005)
4. Concise Inorganic Chemistry-J. D. Lee, 5th Edn, New Age International (1996).

5. Chemical Applications of Group Theory, 2nd Edn-F. A. Cotton, Wiley Eastern Ltd ( ).
6. Symmetry and Spectroscopy of Molecules-K. Veera Reddy, New Age International, (2011).
7. Group Theory in Chemistry-M. S. Gopinathanan and V. Ramakrishnan, Vishal Publishing Co. (2007)
8. Organometallic Chemistry-A unified Approach, R.C. Mehrotra and A. Singh, 2nd Edn. New Age International (2011).
9. F.A.Cotton and G.Wilkinson : Advanced Inorganic Chemistry, Wiley, 1991.
10. Basic Organometallic Chemistry – B D Gupta and A J Elias, Universities Press (2013)

Course outcomes:

1.	Identify the nature of bonding exists between various elements.
2.	Apply fundamental chemical theories in interpretation of complex systems
3.	Interpret and apply the properties of s, p, d and f block elements for different applications.
4.	Apply the theories of acid base in Chemical reactions
5.	Explain selected crystal structures and the parameters that affect the crystal structure of a compound

Course Title: CONCEPTS IN ORGANIC CHEMISTRY	**Course Code: HCT12**
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course Objectives:

1.	To understand basic and fundamental theoretical aspects of organic chemistry.
2.	To study the nature of bonding and aromaticity in organic compounds.
3.	Evaluate the molecular geometry, hybridization and polarity of organic molecules.
4.	To acquire the knowledge of substitution reactions occurring in organic molecules.
5.	To understand electron delocalization and its effect on stability and reactivity

Unit	Description	Hours
1	**Basic Aspects of Organic Structures and Properties:** **Concept of hybridization**: sp, sp^2, sp^3 hybridization with examples, modified hybrid orbitals. **Electron delocalization and Resonance:** Delocalized electron in conjugated systems, resonance hybrid, resonance energy, stability of allylic and benzylic cations and radicals, effect of delocalized electrons on pK_a. **Aromaticity:** Concept of aromaticity, Huckel's rule, aromaticity of benzene, dienes, cyclopentadienyl anion, tropylium cation, cyclopropenyl cation, annulenes, azulene, heterocyclic compounds. Aromatic dications and dianions. Concept of homoaromatic, nonaromatic and antiaromatic compounds. **Aromatic Electrophilic Substitutions**: General mechanism in aromatic electrophilic substitution reaction, Nitration, Sulphonation, Halogenation, Friedel-Crafts alkylation and acylation, Diazo-coupling, Vilsmeir Hack reaction, Gatterman Koch reaction and their applications in organic synthesis. Energy profile diagrams. Orientation and reactivity. Effect of substituent's on aromatic ring system.	15hrs
2	**Intermediates and Substitution Reactions:** **Reactive intermediates:** Gnereation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes, nitrenes, arynes, ylides (phosphorous and sulphur ylides) and enamines with representative examples. **Methods of determining reaction mechanisms**: Kinetic method, identification of products, detection of intermediates, study of catalysts, isotopic labeling, cross-over experiments and stereochemical evidences with suitable examples. **Aliphatic Nucleophilic Substitution**: The SN^1 SN^2, SN^i and SET	15hrs

	mechanisms. Classical and nonclassical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements. Reactivity effects of substrate structure, attaching nucleophile, leaving group and reaction medium. **Electrophilic Substitution**: SE1 and SE2 Mechanism and stereochemistry, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.	
3	**Addition And Elimination Reactions:** **Addition Reactions:** Addition to carbon-carbon and carbon-hetero atom multiple bonds. Addition involving electrophiles, nucleophiles and free radicals, concerted addition. Mechanism, orientation and stereochemistry of addition reactions. Addition of hydrogen halides to alkenes. Addition of HCN, bisulphate, Grignard reagent, hydride, amino compounds, alcohols and thioalcohols to C=O. Acid catalyzed hydration and related addition reactions. **Elimination Reactions:** E_1, E_2 and E_{1CB} reactions, regioselectivity in β-elimination reactions (orientation of π-bonds), and stereochemistry requirement in β-elimination reactions. Saytzeff and Hoffmann rules, elimination vs substitution, E_1, E_2 and E_{1CB} comparative study, 1,1-elimination (α-elimination) - dehalogenation of vicinal dihalides, elimination reactions without involving hydrogen like dehalogenations and related reactions decarboxylative eliminations. Pyrolytic eliminations; Chugaev and Cope eliminations.	15hrs
4	**Stereochemistry:** **Stereoisomerism:** Introduction, molecular structure – projection formulas (Fischer, Newmann, Sawhorse and Flying wedge), interconversion of projection formulas. Molecular symmetry and symmetry elements. Chirality and steroisomerism. Enatiomers, diastereomers, epimers, anomers (definition and examples). Racemic mixture, Racemisation involving - carbonanion, carbocation as intermediates, Walden inversion, rotation about carbon-carbon single bond. Resolution (racemic modification) – mechanical separation, preferential crystallization, biochemical, chemical and chromatographic method. D,L-configuration threo, erythro – configuration. R,S-nomenclature for isomers with more than one chirality centre. **Optical isomerism**: Conditions for optical isomerism: Elements of symmetry-plane of symmetry centre of symmetry, alternating axis of symmetry (rotation-reflection symmetry). **Optical isomerism due to**	15hrs

	molecular dissymmetry: Eg. allenes, spiranes, biphenyls, alkylidine and cycloalkanes. **Geometrical isomerism**: Due to C=C, C=N and N=N bonds, *E*, *Z* conventions, determination of configuration by physical and chemical methods. Geometrical isomerism in cyclic systems.	

References::

1. Organic Chemistry, J. Clayden, S. Warren, N. Greeves, P. Wothers, 1st Edition, Oxford University Press, UK, 2001.
2. Organic Chemistry – Solution Mannual, S. Warren, Oxford University Press, UK, 2009.
3. Advanced Organic Chemistry, Part-A: Structure and Mechanisms, 5th Edition, Francis A. Carey, Richard J. Sundberg, Springer, New York, 2007.
4. Principles of Organic Synthesis, R.O.C. Norman, J.M. Coxon, 3rd Edition (First Indian Reprint), Nelson Thrones, UK, 2003.
5. Advance Organic Chemistry – Reactions, mechanisms and structure, Jerry March, 4th Edition, Wiley India Pvt. Ltd., New Delhi, 2008.
6. Organic Reaction Mechanisms, V.K. Ahluwalia, R.K. Parashar, 3rd Edition, Narosa Publishing House, New Delhi, 2009.
7. Pathway to Organic Chemistry – Structure and Mechanism, P. Bhattacharjee, Arunabha Sen Books and Allied Pvt. Ltd., Kolkta, India, 2012.
8. Organic Chemistry, Paula Yurkanis Bruice, 3rd Edition, Pearson Education, Sai Printo Pack Pvt. Ltd., New Delhi, India, 2007.
9. Organic Chemistry (As per UGC Syllabus), S.M. Mukherji, S.P Singh, R.P. Kapoor, R. Dass, Vol. I, New Age International Pvt. Ltd., New Delhi, 2010.
10. Stereochemistry of Organic Compounds – Principles and applications, D. Nasipuri, Revised 2nd Edition, New Age International Pvt. Ltd., New Delhi, 2009.
11. Organic Reactions and their Mechanisms, P.S. Kalsi, 2nd Edition, New Age International Pvt. Ltd., New Delhi, 2007.
12. Organic Chemistry, Solomons, Fryhle, 8th Edition (Wiley Student Edition), Brijbasi Art Press Ltd., Noida, India 2004.
13. Organic Chemistry, G. Marc Loudon, 4th Edition, Oxford University Press, UK, 2000.
14. Organic Chemistry, R.T. Morrison, R.N. Boyd, 6th Edition, Pearson Education (Singapore Pvt. Ltd.), Delhi, Indian, 2005.
15. Organic Chemistry, L.G. Wade, JR., 5th Edition, Pearson Education (Singapore Pvt. Ltd.), Delhi, Indian, 2004.
16. Organic Chemistry, M.A. Fox, J.K. Whitesell, 2nd Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts, London, 1997.
17. Organic Chemistry, M. Jones, Jr., 2nd Edition, W.W. Norton and Company, New York, 2000.
18. Organic Chemistry, Francis A. Carey, 5th Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
19. Modern Methods of Organic Synthesis, W. Carruthers, 3rd Edition, Cambridge University Press, UK, 2004.

course outcomes:

1.	Acquire the basic and fundamental aspects of organic chemistry reactions.
2.	Interpret the molecular geometry, hybridization and polarity of organic molecules
3.	Recognize the existence of stereoisomerism and conformational analysis
4.	Capable to predict the mechanism of substitution reactions
5.	Apply the knowledge in nomenclature, identification of organic compounds

Course Title: FUNDAMENTALS OF PHYSICAL CHEMISTRY	Course Code: HCT13
Teaching Hours/Week (L-T-P): 4- 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To understand physical phenomenas like Chemical thermodynamics and Chemical kinetics.
2.	To study the nature of kinetics of reactions and electrochemical reactions.
3.	Evaluate the basics and applications chemical thermodynamics.
4.	To acquire the knowledge of catalysis and electrochemistry in solution state.
5.	To understand basics of corrosion, corrosion control and its applications,

Unit	Description	Hours
1	**Quantum Chemistry:** A brief review of black body radiation, Photoelectric effect, Compton effect, de-Broglie's hypothesis, Heisenberg's uncertainty principle., Concept of operator - Addition, Subtraction, Multiplication of operators, Commutative, Linear, Del, Hermitian operators and their properties , Hamiltonian operators, Eigenvalue and Eigen function. Postulates of quantum mechanics Schrödinger wave equation - wave function and its interpretation, Pauli Exclusion Principle, elementary application to a particle in one dimensional box, particle in a ring and hydrogen atom. One dimensional harmonic oscillator. Conditions for orthogonality and normalization of wave functions, Kroneckers delta.	15hrs
2	**Electro and Supramolecular Chemistry:**Activity and Activity co-efficient, mean activity co-efficient, Debye-Huckle limiting law (qualitative aspect only) and assumptions. Ionic strength, thickness of ionic atmosphere. Concept of acids and bases, buffer action and capacity. Buffer solutions. Handerson Hassalback equation (quantitative) and its application in preparation of buffer. Importance of buffer in biological system. **Supramolecular Chemistry** Definition of supramolecular chemistry. Nature of binding interactions in supramolecularstructures ion-ion, ion-dipole, dipole-dipole, H-bonding, van der Waals interactionsroleof H-bonding and other weak interactionsSelf-assembly molecules:,	15hrs

	catenanes and rotaxanes (qualitatives)	
3	**Polymer Chemistry:** Basic definitions, classification of polymers, Monomer, Repeat units, Linear, Branched, Cross Linked, Straight, Copolymers. Degree of polymerization. Molecular weight-Average molecular weight concepts, Number Average, Weight Average, Viscosity Average molecular weights. Determination of molecular weights, Osmotic pressure method, viscosity method, light scattering (Debye and Zimm plots), Ultra centrifugation method, polydispersity, molecular weight distribution. Definition of glass transition and melting point and their relationships. Factors effecting Tg value, Applications of Polymers.	15hrs
4	**Chemical Kinetics and Thermodynamics:** A brief review of basic concepts and terminology in reaction kinetics. Methods of determining rate laws. Steady state approximation, Arrhenius equation. Collision state theory for bimolecular reaction rates, Transition state theory. Comparison between collision and transition state theories. Lindemann and RRKM theories of unimolecular reaction rates. Concepts and significance of energy of activation. **Dynamics in solution**: Ionic reactions, effect of ionic strength. Primary and secondary salt effects. Dynamics of Fast reactions, Relaxation methods, Flow methods (stopped flow and plugged flow), Flash photolysis methods. Reviews on laws of thermodynamics. Maxwell's relation. Fugacity and its variation withtemperature.	15hrs

References:

1. Molecular Quantum Chemistry P.W Atkins
2. Problems in Quantum Mechanics by G. L. Squires.
3. Introduction to Quantum Chemistry by A. K. Chandra, 4th Edn. TMHNew Delhi.
4. Valence by C. A. Coulson.
5. Physical Chemistry by P. W. Atkins, ELBS London 1990.
6. Quantum Chemistry by Ira N. Levine, Prentiss Hall of India, New Delhi, India.
7. Quantum Chemistry by R. K. Prasad.
8. Electrochemistry by S. Glasstone.
9. Modern Electrochemistry by S. Bockris and A K N Reddy, Vol. 1 and 2,Butterworth London, 2006.
10. Thermodynamics by L. M. Koltz and R. M. Rosenberg.
11. An introduction to Chemical Thermodynamics by R. P. Rastogi and S. S. Mishra,Vikas Publishing house Pvt limited, New Delhi.

12.Chemical Kinetics by K. J. Laidler, Pearson edition.
13.Polymer science by Gowrikar, New Age Pvt Limited publishers, Chennai.
14.Polymer chemistry by Flory.
15. Polymer chemistry by A. Tager.
16. Introduction to polymer chemistry Billmayer(Jr).
17. J.-M. Lehn; Supramolecular Chemistry-Concepts and Perspectives (Wiley-VCH,1995
18. P. D. Beer, P. A. Gale, D. K. Smith; Supramolecular Chemistry (Oxford UniversityPress, 1999

Course outcomes:

1.	Able to analyse Thermodynamic aspects as well as kinetics of reactions.
2.	Evaluate the kinetics of chemical reactions with step wise mechanisms
3.	Able to determine the thermodynamics parameters of ideal and non ideal solutions
4.	Integrate the knowledge of catalysis, multilayer adsorption and surface reactions
5.	Interpret the electrochemical behaviour in solution state and surface
6.	Analyse and solve the problems in corrosion process

Course Title: PRINCIPLES OF ANALYTICAL CHEMISTRY	**Course Code: SCT11**
Teaching Hours/Week (L-T-P): 4- 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To understand the concepts of classical methods of analysis like titirmetry, gravimetry.
2.	To gain knowledge of purity and separation techniques
3.	To acquire basics of electroanalytical techniques
4.	To inculcate the skills for chemical analysis and treatment of data

Unit	Description	Hours
1	**Introduction to Analytical Chemistry** Definition and scope of Analytical Chemistry, Importance of Analytical Chemistry in various fields Types of analytical techniques: Classical vs. Instrumental. **Errors and Treatment of Analytical Data:** Classification of errors- determinate and indeterminate errors, minimization of errors. Limitations of analytical methods. **Random errors:** sources, distribution, and the normal curve. Accuracy and precision. **Statistical treatment of finite samples:** measures of central tendency and variability (mean, median, range, standard deviation, and variance). Student's t-test, confidence interval of mean, F-test, t-test, paired t-test, Q-test. Control charts. Propagation of errors, significant figures. Least square method of deriving calibration plots. Correlation and regression. Detection limits. **Sampling and sample handling principles:** sampling step, methods for solid, liquid, and gaseous samples. **Need for quality assurance:** Good laboratory practices (GLP), ISO guide 25, and significance of six sigma concepts.	15hrs
2	**Separation Techniques:** Introduction, Classification of separation techniques and chromatographic techniques. Theories, plate theory, rate theory, band broadening-eddy diffusion, longitudinal diffusion and resistance to mass transfer, column efficiency, Van Deemter's equation and its modern version, interrelationships, capacity factor, selectivity factor, column resolution, distribution constant **Solvent extraction:** General discussion, principles, factors affecting solvent extraction, quantitative treatment, extraction reagents, practical considerations, automation, and applications.	15hrs

	Paper and thin layer Chromatography: General principles and mechanism, classification of chromatographic methods-paper, thin layer, column and liquid chromatography. Selection of stationary and mobile phases, preparation of micro and macro plates, development, spray reagents, identification and detection, reproducibility of Rf values, qualitative, quantitative analysis and applications of TLC. **Ion Exchange methods**: Introduction, definitions, principles, cation exchangers, anion exchangers, regeneration, ion exchange columns, batch method, column method, and applications. **Column chromatography:** Principle, Criteria for the selection of adsorbents and mobile phase, characteristics of adsorbents, Preparation of column and applications	
3	**Titrimetric analysis:** **Acid base titrations:** Principle, role of solvent in acid-base titrations, effect of concentration. Titration curves for strong acid-strong base, weak acid – strong base, weak base –strong acid, polyprotic acids, poly equivalent bases, determination of equivalence point – theory of acid base indicators, and colour change range of indicators. Applications for nitrogen, nitrates and carbonates. **Oxidation –Reduction Titrations:** Redox process-balancing redox equations, titration curves. Redox indicators, detection of end point, visual indicators and potentiometric end point detection. Quantitative applications-adjusting the analyte's oxidation state, determination of chemical oxygen demand (COD) in natural and waste waters and other applications. Titrations of mercaptans and ascorbic acid with I_3^- and titration of organic compounds using periodate. **Precipitation Titration:** Principle, Formation constant, Indicators, Mohr's, Volhard and Fajan's method, Applications **Complexometric Titrations:** Introduction, a simple complexation titration, titration curves, types of EDTA titrations, titrations of mixtures, selectivity, masking and demasking agents, metal ion indicators, some practical considerations. **Organic Reagents in Inorganic Analysis:** Organic precipitants, general properties, reagents asprecipitants.	15hrs
4	**Electroanalytical Techniques** **Potentiometry:** Basic principles, types of electrodes (reference electrodes, glass electrodes, membrane electrodes), applications. **Conductometry:** Theory, measurements of conductivity, conductometric titrations, applications. **Coulometry:** Basic principles, constant current and control potential Coulometry, applications. **Voltammetry:** Polarography theory, dropping mercury electrode, quantitative applications, measurement of wave heights, pulse polarography, rapid scan polarography, stripping voltammetry, cyclic voltammetry.	15hrs

	Amperometry: Pricnciples, amperometric titrations with examples. Biamperometry. **Electrogravimetry:** Theory, completeness and nature of the deposit, instrumentation, electrolytic separation of metals and applications.	

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint. 2003 Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Instrumental Methods of Chemical Analysis, Chatwal and Anand, 5th Edn.
7. Chromatography, E. Heftman (ed). 5th Edition, Part A. and Part B. Elsevier Science Publishers, 1992.
8. Chromatography Today, C. F. Poole & S. K. Poole, Elsevier Science Publishers (1991).
9. Analytical Chemistry by Alka L. Guptha, A, Pragathi edition. Fourth edition.
10. Separation Methods by M. N. Sastri, Himalaya Publisher.
11. Modern Analytical Chemistry, Harvey, Harcourt Publishers.
12. An Introduction to Chromatography: Theory and Practical, V. KSrivastav and K. K. Srivastav.
13. Instrumental Methods of Chemical Analysis, Gurudeep R Chatwal, Sharma K Anand. Himalaya publishers.
14. Chromatography by B. K. Sharma, GOEL publishers.
15. Basic Concepts of Analytical chemistry, S. M. Khopakr, New Age International publications, 3rd edition.

Course outcomes:

1.	Apply basic analytical methods for chemical analysis
2.	Evaluate and treat the analytical data
3.	Apply the separation techniques in separation and purification
4.	Design and interpret the analytical data

Course Title: APLLIED ANALYTICAL CHEMISTRY	Course Code: SCT12
Teaching Hours/Week (L-T-P): 4- 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To understand the applications of analytical chemistry.
2.	To gain knowledge on environmental analysis, pharmaceutical analysis
3.	To inculcate the skills for chemical analysis

Unit	Description	Hours
1	**Environmental Analysis:** Analytical techniques for environmental monitoring,studies on air, water, and soil analysis, Regulatory aspects and compliance.Chemical and physical examination and measurement of quality of water, chemical substances affecting portability, odour, taste, temperature and electrical conductivity of water, suspended and dissolved solids, acidity and alkalinity of water, free carbon dioxide and chlorine. Chlorine demand. Analysis of calcium, magnesium, iron, manganese, silver and zinc in water. Determination of ammonia, nitrate cyanide, sulphate and fluoride. Determination of arsenic, beryllium, chromium, lead, selenium and mercury	15hrs
2	**Pharmaceutical Analysis:** Application of analytical chemistry in the pharmaceutical industry, Quality control and assurance, Drug formulation analysis **Clinical and Biochemical Analysis:** Composition of blood collection, and preparation of samples, clinical analysis – serum electrolytes, blood glucose, blood urea nitrogen , uric acid , albumin , globulin , barbiturates, acidic and alkaline phosphates, Immunoassay , principles of radioimmunoassay and applications . **Blood analysis**: trace elements in the body. Applications in clinical laboratories, Analysis of biomarkers and diagnostic substances, Biochemical analysis techniques.	15hrs
3	**Food and Beverage Analysis:** Detection and determination of sugars and starch. Methods for protein determination. Oils and fats and their analysis – iodine value, saponification value and acid value. Rancidity - detection and determination (peroxide number). Tests for common edible oils. Analysis of foods for minerals - phosphorus, sodium, potassium and calcium. General methods for the determination of moisture, crude fibre and ash contents of food. Analysis of milk for fat and added water. **Non-alcoholic beverages**: determination of chicory and caffeine in coffee;	15hrs

	caffeine and tannin in tea. Alcoholic beverages -methanol in alcoholic drinks and chloral hydrate in toddy. **Food additives**: chemical, preservatives - inorganic preservatives - sulphur dioxide and sulphites, their detection and determination. Organic preservatives - benzoic acid and benzoates, their detection and determination. Flavouring agents - detection and determination of vanilla and vanillin. Colouring matters in foods - classification, certified colours, detection of water soluble dyes, colour in citrus fruits, beet dye in tomato products, mineral colour. Pesticide residues in foods - determination of chlorinated organic pesticides.	
4	**Chemical analysis in Industries:** Parameters of analysis of the end products in the pharmaceutical industries, Different Experimental methods used in the analysis of following drugs: aspirin, nimesulide, metformin, andglimepiride. **Drug analysis:** Narcotics and dangerous drugs, classification of drugs, screening by gas and thin layer chromatography and spectrophotometric analysis. **Techniques for optimizing industrial processes:** Principles of quality control in manufacturing, Statistical tools for quality assurance. Application of analytical chemistry in ensuring product quality, Overview of sensors used in industrial processes, Automation and its role in analytical chemistry	15hrs

References:

1. Hage, P., &Carr, J. Analytical Chemistry: Principles and Techniques. (Latest edition).
2. Skoog, D. A., Holler, F. J., & Crouch, S. R. (Year). Principles of Instrumental Analysis. (Latest edition).
3. Schwarzenbach, R. P., Fenter, P. R. B., & Hofstetter, T. B. Environmental Analytical Chemistry. (Latest edition).
4. Baird, C., &Cann, M. Environmental Chemistry. (Latest edition).
5. Watson, D. G. (Year). Pharmaceutical Analysis: A Textbook for Pharmacy Students and Pharmaceutical Chemists. (Latest edition).
6. Nielsen, S. S. Food Analysis. (Latest edition).
7. Belitz, H.-D., Grosch, W., &Schieberle, P. (Year). Food Chemistry. (Latest edition).
8. Bishop, M. L., Fody, E. P., &Schoeff, L. E. Clinical Chemistry: Techniques, Principles, Correlations. (Latest edition).
9. Skoog, D. A., Holler, F. J., & Crouch, S. R. (Year). Process Analytical Chemistry. (Latest edition).
10. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
11. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
12. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 Prentice Hall, Inc. New Delhi.
13. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint.2003 Pearson Education Pvt.

Ltd., New Delhi.
14. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
15. Instrumental Methods of Chemical Analysis, Chatwal and Anand - 5th Edn.
16. Chromatography, E. Heftman (ed). 5th Edition, Part A. and Part B. Elsevier Science Publishers, 1992.
17. Chromatography Today, C. F. Poole & S. K. Poole, Elsevier Science Publishers (1991).
18. Analytical chemistry by Alka L. Guptha, A pragathi edition.
19. Separation methods by M. N. Sastri, Himalaya publisher.
20. Modern analytical chemistry, Harvey, Harcourt publishers.

Course outcomes:

1.	Apply basic analytical methods for chemical analysis
2.	Able to understand the applications in environmental and pharmaceutical analysis
3.	Design and interpret the analytical data

Course Title: ENVIRONMENTAL CHEMISTRY	Course Code: SCT13
Teaching Hours/Week (L-T-P): 4- 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To understand the environment and its importance.
2.	To gain knowledge on environmental sample analysis
3.	To understand the theory and importance of environmental pollution
4.	To inculcate the skills for chemical analysis and treatment of data

Unit	Description	Hours
1	**Introduction to Environmental Chemistry:** Environmental Compounds and their Characteristics, Chemical Equilibria in Environmental Systems, pH and Redox Potential in Environmental Chemistry, Chemical Kinetics in Environmental Systems. **Water Analysis:** Water Quality Parameters and Standards,Safe drinking water, public health significance and measurement of colour, turbidity, total solids, acidity, alkalinity, hardness, sulphate, fluoride, phosphate and different forms of nitrogen in natural and polluted water, Methods for Water Quality Analysis, Analysis of Heavy metals such as Pb, Cd, Cr, Hg, As, Cu, Zn and Mn in Water, Nutrient Analysis in Water Samples. **Air Analysis:** Air Quality Parameters and Standards, Sampling and Analysis of Air Pollutants, Gas Chromatography in Air Quality Monitoring, Particulate Matter Analysis. .	15hrs
2	**Soil and Sediment Analysis:** Soil and Sediment Characteristics, Soil Sampling and Sample Preparation, Analysis of Soil Contaminants (Heavy Metals, Organic Compounds), Methods for Sediment Analysis. **Biomonitoring and Bioanalytical Techniques:** Introduction to Biomonitoring, Biological Indicators in Environmental Analysis, Bioanalytical Techniques (Enzyme Assays, Immunoassays) in Environmental Monitoring, Significance and measurement of DO, BOD, COD, TOD, and TOC, phenols, pesticides, surfactants and tannin and lignin as water pollutants and their determination. **Forensic analysis:** General discussion of poisons with special reference to	15hrs

	mode of action of cyanide, organophosphates and snake venom. Estimation of poisonous materials such as lead, mercury and arsenic in biological materials.	
3	**Quality Assurance and Quality Control (QA/QC):** QA/QC Principles in Analytical Chemistry, Calibration and Standardization, Method Validation and Verification, Data Quality Assessment and Reporting **Emerging Trends in Environmental Analysis:** Green Analytical Chemistry, Sensors and Biosensors for Environmental Monitoring, Remote Sensing and GIS Applications in Environmental Analysis. **Case Studies and Practical Applications:** Case Studies in Environmental Analysis, Interpreting Analytical Results in Real-world Context, Ethical Considerations in Environmental Analysis	15hrs
4	**Overview of Analytical Chemistry:** Techniques and Applications, Importance of Analytical Chemistry in Environmental Sciences, Sampling Techniques in Environmental Analysis, Basics of Environmental Sampling and Sample Preparation. **Instrumental Analysis Techniques:** Chromatographic Techniques (GC, HPLC) and their principles, theory and Applications, Mass Spectrometry in Environmental Analysis, Atomic Spectroscopy (AAS, ICP-MS) and its Applications, Introduction to NMR Spectroscopy in Environmental Chemistry.	15hrs

References:

1. Quantitative Chemical Analysis by Daniel C. Harris (Publisher: W. H. Freeman; Year: 2015)
2. Environmental Chemistry by Colin Baird and Michael Cann (Publisher: W. H. Freeman; Year: 2012)
3. Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch (Publisher: Cengage Learning; Year: 2017)
4. Environmental Analysis by Kenneth A. Hunter (Publisher: CRC Press; Year: 1998)
5. Analytical Chemistry: An Introduction by Douglas A. Skoog, Donald M. West, F. James Holler, and Stanley R. Crouch (Publisher: Cengage Learning; Year: 2013)
6. Environmental Analytical Chemistry by René P. Schwarzenbach, Philippe R. B. Fenter, and Thomas B. Hofstetter (Publisher: John Wiley & Sons; Year: 1999)
7. Introduction to Environmental Chemistry by Julian E. Andrews, Peter Brimblecombe, and Tim D. Jickells (Publisher: Wiley; Year: 2004)
8. Analytical Chemistry for Technicians by John Kenkel (Publisher: CRC Press; Year: 2017)
9. Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil, and Solid Wastes by Pradyot Patnaik (Publisher: CRC Press; Year: 1997)
10. Environmental Chemistry: A Global Perspective by Gary W. VanLoon and Stephen J. Duffy (Publisher: Oxford University Press; Year: 2019)
11. Environmental Monitoring Handbook by Frank R. Spellman and Nancy E. Whiting

(Publisher: McGraw-Hill Education; Year: 2004)
12. Analytical Chemistry in a GMP Environment: A Practical Guide by James M. Miller and Jonathan B. Crowther (Publisher: Wiley; Year: 2005)
13. Introduction to Environmental Engineering and Science by Gilbert M. Masters and Wendell P. Ela (Publisher: Pearson; Year: 2008)
14. Practical Environmental Analysis by Jerry A. Nathanson and Donald A. Sweitzer (Publisher: Wiley; Year: 1998)
15. Analytical Chemistry in a Changing World by D. W. Oxtoby, H. P. Gillis, and L. J. Butler (Publisher: W. H. Freeman; Year: 1991)

Course outcomes:

1.	Apply basic analytical methods for environmental sample analysis
2.	Evaluate and treat the analytical data
3.	Design and interpret the analytical data
4.	Able to handle and interpret the various environmental analysis techniques

Course Title: INORGANIC CHEMISTRY PRACTICALS-I	**Course Code: HCP11**
Teaching Hours/Week (L-T-P): 0 - 0 - 4	**No. of Credits:** 02
Internal Assessment: 10 Marks	**Semester End Examination:** 40 Marks

Course objectives:

1.	Hands-on training for quantitative estimation using volumetric and gravimetric analysis.
2.	Understand the importance of determination of common metallic traces affecting the biological system.
3.	Understand and appreciate common useful methods of detection of traces of elements.

List of Experiments: **60 hrs**

1.	Semimicro qualitative inorganic analysis of a mixture. Mixture containing three cations and three anions including one less common cations such as Mo, Ti, Zr, Ce, V and Li and one interfering anion.
2.	Analysis of sodium carbonate and sodium bicarbonate in baking soda by acid- base titration.
3.	Determination of acid content of vinegar.
4.	Preparation of hexamine nickel (II) chloride complex.

Books Recommended:

1.	Chemical Semi micro analysis- V.N.Alexeyev Mir Publishers (Mascow)
2.	Vogel's Qualitative Inorganic analysis, Revised by G.Suchla Longarman group ltd.
3.	Vogel's Text book of Quantitative Inorganic Analysis – J.Basett, R.C.Denney, G.H.Jeffery and J.Mendhaman, Longamans Green and Company Ltd.
4.	Advanced Inorganic Analysis by Agarwal and Keemtilal, A Pragati Edition, Eleventh Revised edition, 2011.

Course Outcomes:

1.	Analyse binary and complex mixtures of metallic ions by volumetric and gravimetric methods
2.	Design procedure for the quantification of inorganic compounds in various samples
3.	Identification of different radicals
4.	Interpret the analytical data to comply with regulatory standards

Course Title: ORGANIC CHEMISTRY PRACTICALS-I	**Course Code: HCP12**
Teaching Hours/Week (L-T-P): 0- 0 - 4	**No. of Credits:** 02
Internal Assessment: 10 Marks	**Semester End Examination:** 40 Marks

Course objectives:

1.	Expose to simple synthetic procedures in the laboratory.
2.	Correlate theoretical concepts for preparing, purifying, and identifying organic molecules.
3.	Comply with safety rules in conducting laboratorial experiments.
4.	To identify the components through various steps, derivative preparation, checking the purity of components.

List of Experiments: **60 hrs**

1.	**Qualitative analysis** Systematic separation of organic binary mixtures of solid type using chemical and physical methods. At least six experiments from the following combinations, Acid + Phenol Phenol + Base Base + Neutral Acid + Base Phenol + Neutral Acid + neutral

References:

1.	Advanced Practical Organic Chemistry, N K Vishnoi , Second edition, Vikas Publishing House Pvt. Ltd, 1996
2.	Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis
3.	Renu Aggarwal, V. K. Ahluwalia, Universities press (India), 2001
4.	Systematic Laboratory Experiments in Organic Chemistry, Arun Sethi, New Age International, 2003.
5.	Comprehensive Practical Organic Chemistry: Qualitative Analysis, Ahluwalia V.K. Sunitha Dhingra, First edition, Orient Longman, 2004
6.	Practical Organic Chemistry: Qualitative Analysis, Bhutani S.P. Chhikara A, First edition, ANE books-new Delhi, 2009
7.	Vogel's Textbook of Practical Organic Chemistry, Brian S. Furniss, 5th Edition, Pearson India, 2005.
8.	Laboratory techniques in Organic chemistry, V.K. Ahluwalia , Pooja Bhagat & Renu

	Aggarwal, I.K. International Publishing House Pvt.Ltd.
9.	Laboratory Manual of Organic Chemistry, Raj K. Bansal. 5th edition, New Age international, 2008

Course outcomes:

1.	Analyse and separate complex organic mixtures
2.	Design experimental approach for purification of organic compounds
3.	Develop methodology for synthetic reaction and characterization
4.	Hands on training in determining melting point , boiling point, TLC etc

Course Title: PHYSICAL CHEMISTRY PRACTICALS-I	**Course Code: HCP13**
Teaching Hours/Week (L-T-P): 0- 0 - 4	**No. of Credits:** 02
Internal Assessment: 10 Marks	**Semester End Examination:** 40 Marks

Course objectives:

1.	Study Kinetics of chemical reactions
2.	To understand varied solvents interaction by phase formation mechanism
3.	Analysis of samples using conductometric techniques

List of Experiments: **60 hrs**

1.	Study of kinetics of hydrolysis of an ester using HCl/H_2SO_4 at two different temperatures, determination of rate of constants and energy of activation.
2.	Study of kinetic reactions between $K_2S_2O_8$ and KI, first order, determination of rate constants at two different temperatures and Energy of activation.
3.	Conductometric titration of mixture of HCl and CH_3COOH against NaOH.
4.	Conductometric titration of mixture of HCl and CH_3COOH and $CuSO_4$ against NaOH.
5.	Conductometry-To determine the degree of hydrolysis and hydrolysisconstant of aniline hydrochloride.
6.	Conductometric titration of potassium iodide with mercuric perchlorate.
7.	Phase diagram for Three component liquid system, acetic acid, benzene and water.
8.	Kinetics of dissociation of trichloroacetic acid

References:

1.	Experimental Physical Chemistry: A Laboratory Textbook, A. Halpern & G. McBane III Ed. W. H. Freeman (2006)
2.	Practical Physical Chemistry- A.J.Findlay (2007).
3.	Experimental Physical Chemistry-F.Daniel et el (2006).
4.	Selected Experiments in Physical Chemistry- Latham (1974).
5.	Experimental Physical Chemistry- Janes and Parichard 3rd edition (1974).
6.	Experimental Physical Chemistry- Shoemaker 5th edition (1989).
7.	Experimental Physical Chemistry- Yadav, Goel Publishing House.
8.	Experimental Physical Chemistry- Das R.C and Behera B., Tata Mc Graw Hill.

Course outcomes:

1.	Skills in analysis of physical properties of materials and reactions
2.	Analyse and interpretation of physical properties
3.	Designing of methods for ionic substances
4	Evaluate the kinetics of reaction

M.SC. CHEMISTRY SECOND SEMESTER

Course Title: ADVANCED INORGANIC CHEMISTRY	**Course Code: HCT21**
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To acquaint the knowledge in the advanced and applied inorganic chemistry.
2.	To understand the concepts of organometallic chemistry and the properties of inorganic complexes, and their importance.
3.	To gain knowledge on bonding metal complexes and their spectra properties

Unit	Description	Hours
1	**Chemistry of Non-Transition Elements** Alkali and alkaline earth metal complexes of crown ethers, cryptands and calixarenes and their biological importance. Synthesis, properties and structures of boron, carbon and silicon compounds: Chemistry of higher boranes, classification, structures and MO description of bonding, framework electron counting, Wade's rules, chemistry of B_5H_9, $B_{10}H_{14}$ and $BnHn^{2+,}$ boron nitride, borazines, carboranes, metalloboranes, metallocarboranes; silicates, silicones, graphite, graphene, carbon nanotubes and zeolites. Hydrogen bonding and its influence on properties.	15hrs
2	**Bonding in Metal Complexes Metal-Ligand Bonding:** Concept of effective atomic number, electronic configuration of metal complexes by VBT, draw backs of VBT. Crystal Field Theory(CFT)-salient features, crystal field splitting of d orbitals in octahedral, tetrahedral, tetragonal and squarer planar fields Magnitude of Δ, factors affecting Δ, crystal field stabilization energy (CFSE), effects of crystal field splitting, energy of ligation, stabilities of oxidation states Co(III). Spectrochemical series, nephelauxetic series, short comings of CFT, evidences for covalence, John-Teller distortion in metal complexes and metal chelates. M.O treatment of coordination compounds involving σ and π bonding	15hrs
3	**Magnetic and Spectral Properties of Coordination Compounds** Magnetic properties of coordination compounds-Types of magnetic behaviour, magnetic susceptibility and its determination- Gouy, Faraday, VSM method. Diamagnetic correction, orbital contribution, spin-orbital coupling, ferro- and antiferromagnetic coupling, spincrossover. Magnetic properties of Lanthanide and Actinide metal complexes. Electronic spectra	15hrs

	of coordination compounds-Spectroscopic ground states, selection rules, term symbols for dn ions, Racah parameters, Orgel, Correlation and Tanaube-Sugano diagrams, spectra of 3d metal-aqua complexes of trivalent V, Cr, divalent Mn, Co and Ni, $[CoCl_4]^{2-}$ calculation of Dq, B and β parameters, CT spectra. Spectral properties of Lanthanide and Actinide metal complexes.	
4	**Organometallic chemistry** Classification & nomenclature of organometallic compounds – 16 & 18 electron rules – electron counting by neutral atom & oxidation state method. Organometallic compounds of main group elements:- General methods of synthesis structure and bonding in alkyls of Li, Mg, & Al. Transition Metal alkyls (synthesis and stability), Synthesis structure and bonding in metal olefins, carbonyls, nitrosyls, carbenes and metallocenes. Isobolality and Fluxionality	15hrs

References:

1. Inorganic Chemistry-Principles of Structure and Reactivity, 4thEdn-J. E. Huheey, E.A. Keiter, R. L. Keiter and O.K. Medhi. Pearson Education (2009).
2. Shriver & Atkins' Inorganic Chemistry, 5th Edn P. Atkins, Tina Overton, J. Rourke, Mark Weller and F.Armstrong.Oxford University Press (2010)
3. Electronic absorption Spectroscopy and Related Techniques D. N. Satyanarayana, OUP, 2001.
4. Concepts and models of Inorganic Chemistry B.Douglas, D. McDaniel & J.Alexander, 3rd Edn. Wiley Student Edn.(2013).

. Elements of Magnetochemistry-R. L. Dutta and A Syamal : Affiliated East-West, 1993.
. Inorganic Chemistry of Biological Processes, (2nd edn.) M. N. Hughes, Wiley, 1988.
. Bioinorganic Chemistry-Asim K. Das, Books and Allied (P) Ltd, (2007).

8. Principles of Bioinorganic Chemistry-S. J. Lippard and J. M. Berga. Panima Publishing Corporation.

Course outcomes:

1.	Acquint with non-transition elements and complexes of biological importance.
2.	Learn and skilled with Boron and Zeolite chemistry
3.	Able to comment on various inorganic bonding theories
4	Gain knowledge on organometallics

Course Title: REACTIONS IN ORGANIC CHEMISTRY	**Course Code: HCT22**
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To acquaint the knowledge in the oxidation and reduction reactions in organic chemistry.
2.	To Understand the concepts and mechanism of rearrangement reactions.
3.	Gain knowledge on reagents used in organic synthesis.

Unit	Description	Hours
1	**Oxidation:** Introduction, **oxidation by potassium permanganate**: alkenes, alcohols, alkynes, aldehydes, ketones and aromatic compounds. **Oxidation by manganese dioxide**: allylic and benzylic alcohols. **Oxidation of alcohols and phenols** by chromic acid and potassium dichromate, Jones reagent, chromium trioxide-pyridine complex, pyridinium chlorochromate (PCC), pyridinium dichromate (PDC), oxidation of alkanes, alkenes, aromatic side chains and aromatic rings. **Oxidation with per acids** – oxidation of alkenes, ketones. **Oxidation with miscellaneous oxidants**: Ozones (O_3), t-butyl hydroperoxide, aluminium lead tetra-acetate (LTA), SeO_2, OsO_4, periodic acid, DMSO, N-Bromosuccinimide.	15hrs
2	**Reduction:** **Reduction:** Catalytic hydrogenation; Classifications, reactions, and their applications, Hydrogenolysis and their applications. **Introduction** to Pt, Pd, Ni, catalysts, reduction of alkenes, alkynes and Nitro compounds. **Reduction with metal hydrides**: $LiAlH_4$, $NaBH_4$, $NaBH_3CN$ and B_2H_6. **Reduction by dissolving metals:** Na-alcohol, Na-liq.ammonia, Mg-Hg and Zn-HCl. **Reduction by miscellaneous reducing agents:** Di-imide, Hydrazine, $SnCl_2$, tin-hydrochloric acid, Zn-acetic acid, Zn-NaOH, sodium metabisulphite, Mg-alcohol and sodium hydrogen sulphide.	15hrs
3	**Molecular Rearrangements:** General mechanistic treatment of nucleophilic, electrophilic and free-radical rearrangements. **Rearrangements reactions involving migration to electron deficient Carbon:** Wagner-Meerwein rearrangement, pinacol-pinacolone	15hrs

	rearrangement, acid catalyzed isomerization of aromatic hydrocarbons; benzil-benzilic rearrangement, rearrangements involving diazomethane and alkanes, Wolf rearrangement and Bamberger rearrangement. **Rearrangements reactions involving migration to electron deficient Nitrogen:** Hoffmann, Curtius, Schmidt, Lossen and Beckmann rearrangement. **Rearrangements reactions involving migration to electron deficient Oxygen:** Baeyer-Villiger oxidation and Dakin rearrangement. **Rearrangements reactions involving migration to electron rich Carbon:** Favorskii, Sommlet-Hauser, Neber, Stevens and Wittig rearrangements	
4	**Reagents in Organic Synthesis:** **Reagents and reactions in organic synthesis:** Use of following reagents in organic synthesis and functional group transformations: Lithium diisopropylamide (LDA), Gilmann reagent, dicyclohexyl carbodimide (DCC), dichlorodicyanoquinone (DDQ), Silane reagentstrialkylsilyl halides, trimethylsilyl cyanide, trimethyl silane, phase transfer catalyst, crown ethers, cyclodextrins, Ziegler-Natta catalyst, diazomethane, Woodward and Prevost hydroxylation, Stark enamine reaction, phosphorous ylides - Wittig and related reactions, sulphur ylides – reactions with aldehydes and ketones, 1,3-dithiane anions – Umpolung reaction, Peterson reaction.	15hrs

References:

1. Organic Chemistry, J. Clayden, S. Warren, N. Greeves, P. Wothers, 1st Edition, Oxford University Press, UK, 2001.
2. Organic Chemistry – Solution Mannual, S. Warren, Oxford University Press, UK, 2009.
3. Advanced Organic Chemistry, Part-A:Structure and Mechanisms, 5th Edition, Francis A. Carey, Richard J. Sundberg, Springer, New York, 2007.
4. Principles of Organic Synthesis, R.O.C. Norman, J.M. Coxon, 3rd Edition (First Indian Reprint), Nelson Thrones, UK, 2003.
5. Advance Organic Chemistry – Reactions, mechanisms and structure, Jerry March, 4th Edition, Wiley India Pvt. Ltd., New Delhi, 2008.
6. Organic Reaction Mechanisms, V.K. Ahluwalia, R.K. Parashar, 3rd Edition, Narosa Publishing House, New Delhi, 2009.
7. Organic Chemistry, Solomons, Fryhle, 8th Edition (Wiley Student Edition), Brijbasi Art Press Ltd., Noida, India 2004.
8. Organic Chemistry, G. Marc Loudon, 4th Edition, Oxford University Press, UK, 2000.
9. Organic Chemistry, R.T. Morrison, R.N. Boyd, 6th Edition, Pearson Education (Singapore Pvt. Ltd.), Delhi, Indian, 2005.
10. Organic Chemistry, L.G. Wade, JR., 5th Edition, Pearson Education (Singapore Pvt. Ltd.), Delhi, Indian, 2004.
11. Organic Chemistry, M.A. Fox, J.K. Whitesell, 2nd Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts, London, 1997.
12. Organic Chemistry, Francis A. Carey, 5th Edition, Tata McGraw-Hill Publishing

Company Ltd., New Delhi, 2004.
13. Stereochemistry – Conformation and Mechanism, P.S. Kalsi, 7th Edition, New Age International Publishers, New Delhi, India, 2008.
14. Heterocyclic Chemistry, Thomas L. Gilchrist, 3rd Edition, Pearson Education, New Delhi, India, 2007.
15. Heterocyclic Chemistry, Raj K, Bansal, 4th Edition, New Age International Publishers, New Delhi, India, 2009.
16. Organic Chemistry, I.L. Finar, 5th Edition (Volume-2), Pearson Education, New Delhi, India, 2009.
17. Organic Chemistry, I.L. Finar, 6th Edition (Volume-1), Pearson Education, New Delhi, India, 2007.

Course outcomes:

1.	Acquint and able to carry out oxidation and reduction reaction of industrial importance.
2.	Learn to apply various regents in organic synthesis
3.	Able to comment on various rearrangement reactions along with mechanism
4	Gain knowledge for industrial application along with mechanism

Course Title: APPLIED ANALYTICAL METHODS	Course Code: HCT23
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To acquaint the knowledge in the basic methods of spectroscopic analysis.
2.	To Understand the concepts and mechanism of thermal methods of analysis.
3.	Gain knowledge on radiochemical methods.
4.	To train with advanced methods of separation techniques

Unit	Description	Hours
1	**Flame photometry and Atomic absorption spectrometry:** Energy level diagram –atomic absorption spectra. Flame characteristics, flame atomizers and electrothermal atomization. Comparison of spectral interferences, chemical and physical interferences in Flame Photometry and AAS. Use of organic solvents. Quantitative techniques –calibration curve procedure and the standard addition technique. Typical commercial instruments for Flame Photometry and AAS, Applications. Qualitative analysis and quantitative evaluations. Relative detectability of atomic absorption and flame emission spectrometry. **Inductively coupled plasma**: Atomic emission spectroscopy, Limitations of flame emission spectroscopy, principles of plasma spectroscopy, process of atomisation and excitation, plasma as an excitation source, inductively coupled plasma source, ICP-AES instrumentation, applications of plasma spectroscopy, comparison of ICP-AES with AES, comparison of AFS, AAS and ICP-AES.	15hrs
2	**Radioactive Tracers: Principles and Applications** **Radioanalytical Methods:** Radioactive decay and half-life. Calculation of decay rate and its relevance in tracer studies. Radioactive tracers, principles and applications. Isotopic dilution analysis – direct and inverse; special analytical applications and radiometric titrations. **Neutron activation analysis:** Principle, instrumentation, applications and limitations. Radiochromatography and radio immunoassay-principle, trace element analysis in various materials.	15hrs
3	**Thermogravimetric Analysis (TGA)**: Introduction, principles theory and instrumentation. Factors affecting the results – heating rate, thermobalance, and furnace, instrument control/data handling. Applications-purity and thermal stability, evaluation of correct drying temperature, analysis of complex mixture and determination of kinetic parameters of thermal	15hrs

	degradation. **Differential Thermal Analysis (DTA)**: Introduction, principles theory and instrumentation. Variables affecting the DTA curve. Applications – analysis of the physical mixtures and thermal behavior study,determination of decomposition point. **Differential Scanning Calorimetry (DSC):**Introduction, principles theory and instrumentation. Differences between DTA and DSC,power compensated DSC, heat Flux DSC, applications – studies of thermal transistors and isothermal crystallization, pharmaceuticalindustry for testing the purity of the samples. **Thermometric Titrations:** Applications, Enzyme Kinetics Studies, Applications in biochemistry and pharmaceuticals, Calorimetric Acid-Base Titrations,	
4	**Electromagnetic radiation:** Characterization, quantization of energy levels, regions of electromagnetic radiation spectrum, interaction electromagnetic radiation with matter, representation of spectra-intensity and width of spectral lines. **UV-Visible Spectroscopy:** Quantitative aspects of absorption, Beer-Lambert's law. Terminology associated with absorption measurements. Criteria for spectrophotometric determinations with examples (Fe, Mo and Ni). Limitations of the law, Types of absorption bands, modes of electronic transitions, simple chromophoric –auxochrome theory, Solvent effect and choice of solvent. Prediction of λ-max value by using Wood-Ward and Fieser rules for conjugated diens, trienes and cyclic, α, β-unsaturated aldehydes and ketones, Instrumentation (single beam and double beam spectrophotometers). Quantitative applications of UV-Visible spectroscopy in structural determination. **Clinical applications:** Applications of UV Visible spectroscopy in Pharmacokinetic Studies, Clinical Toxicology, Nucleic Acid Quantification.	15hrs

References:

1. Fundamental of Analytical Chemistry (8th edition, 2005) by D.A. Skoog, D.M. West, Holler, and Crouch, published by Saunders College Publishing, New York.

2. Analytical Chemistry (5th edition, 2001) by G.D. Christian, published by John Wiley & Sons, Inc., India.

3. Quantitative Analysis (6th edition, 1993) by R. A. Day and A. L. Underwood, published by Prentice Hall, Inc., New Delhi.

4. Vogel's Textbook of Quantitative Chemical Analysis (6th edition, 2003) by J. Mendham, R.C. Denney, J.D. Barnes, and M.J.K. Thomas, published by Pearson Education Pvt. Ltd., New Delhi.

5. Analytical Chemistry Principles (2nd edition, 1990) by John H. Kennedy, published by Saunders College Publishing, California.

6. Analytical Chemistry (Pragati edition) by Alka L. Gupta.

7. Introduction to Chromatography: Theory and Practice by V. K. Srivastava and K. K. Srivastava, published by S. Chand and Co. Ltd.

8. Chromatography by B. K. Sharma, published by Goel Publishing House, Meerut.

9. An Introduction to Practical Biochemistry (3rd edition) by David T. Plummer, published by Tata McGraw-Hill Publishing Company Limited.
10. Principles of Instrumental Analysis (5th edition) by Skoog, Holler, and Nieman, published by Harcourt Asia PTE. LTD.
11. Modern Analytical Chemistry by David Harvey, published by McGraw-Hill Publishing Company Limited.
12. Modern Methods of Chemical Analysis (II edn) by P. L. Descok, L. D. Shields, T. Carins, and F. G. Milliam.
13. Industrial Methods of Chemical Analysis by F. D. Sneel (Encyclopedia).
14. Instrumental Methods of Analysis (6th Edn.) by L.L. Merutt, J.A. Dean, F.A. Settle, published by Van Nostrand.
15. Principles of Instrumental Analysis by D.S. Kooj (Sander Colley).
16. Fundamentals of Analytical Chemistry (7th Edn.) by Skoog, West, Holler, published by Harcourt Agra, Publication Harcourt College Publishers.
17. Principles of Instrumental Analysis (5th Edn.) by Skoog, Haller, Nieman, published by Harcourt Agra, Publication Harcourt College Publishers.
18. Text Book of Quantitative Chemical Analysis by A.I. Vogel (ELBS).
19. Standard Methods of Chemical Analysis by Wekin E. J.
20. Instrumental Methods of Chemical Analysis by Gurudeep R. Chatwal and Sham. K. Anand, published by Himalaya Publishing House.
21. Separation Chemistry by R.P. Budhiraj, published by New Age International (P) Limited, Publisher.
22. Basic Concepts of Analytical Chemistry by S.M. Khopkar, published by New Age International (P) Limited, Publisher.

Course outcomes:

1.	A able to carry out simple flame and atomic absorption spectrophotometric analysis.
2.	Learn to apply various analytical methods in daily life and industries
3.	Able to handle advanced chromatographic methods
4	Skilled with thermal methods to characterise the materials for their thermal stability
5	Able to apply radioanalytical methods

Course Title: APPLIED PHYSICAL CHEMISTRY	**Course Code: SCT 21**
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	Understand the concepts of kinetics and catalysis
2.	Acquire knowledge on nanomaterials and their applications
3.	Gain information on catalysis

Unit	Description	Hours
01	**Chemical Kinetics:** Chain reactions, Examples of chain reactions, General aspects of Chain reactions, elementary and complex reactions - parallel, consecutive and opposite reactions. Chain initiation, chain propagation and chain termination steps. Kinetics of formation of HBr, HI, HCl. Pyrolysis of acetyl aldehyde, decomposition of ethane and N_2O_5 molecules. Kinetics of inhibition, chain transfer, kinetics of branching chain reaction and explosion limits. Kinetics of polymerization: Kinetics of linear step(Condensation) polymerization, Kinetics of condensation polymerization, Free radical, cationic and anionic polymerization and Co-polymerization.	15hrs
02	**Catalysis and Molecular Group Theory:** Adsorption, adsorption isotherms- Langmuir, Freundlich, BET and Gibb's adsorption isotherms, adsorption with dissociation, competitive adsorption, mechanism of Unimolecular and bimolecular surface reactions. **Homogenous catalysis:** Principle of general and specific acid-base catalysis, linear free energy relation and acidity function and Hamet equation, salt effect and base catalysis. Heterogeneous catalysis: Study of solid surface, employing surface techniques viz. BET and N_2 adsorption. **Enzyme catalysis:** single substrate mechanism, Michaelis-Menten equation, effect of pH, temperature and inhibitors on kinetics of enzyme catalyzed reaction. **Group Theory:** Symmetry operators and symmetry elements, products of symmetry operations C_{2V}, C_{3V}, groups, point groups, group multiplication table, character table, Application of group theory to IR and Raman spectra of typical molecules (NH_3, H_2O and CO_2).	15hrs

03	**Material and Nano systems:** **Preparative methods:** Solid state reaction, role of Chemistry in Materials design, chemical precursor method, co-Precipitation, sol-gel, metathesis, self-propagating high temperature synthesis intercalation / deintercalation reactions; hydrothermal and template synthesis; High pressure synthesis **Organic Materials** : Conducting organics - Metals from molecules, charge transfer materials and Organic superconductors. Fullerenes. and optical data storage materials. Light emitting diodes (organic and polymer light emitting diodes). **Materials possessing** high strain and energy: simple preparation techniques and properties (velocity of detonation) of organic molecules possessing cage structures. Understanding the energetics and properties of these molecules. Examples of the molecules to be studied include; nitramines (1,3,5-Trinitroperhydro-1,3,5-triazine, **1,3,5,7-Tetranitro-[1,3,5,7]tetrazocane,** Hexanitrohexaazaisowurtzitane, cubanes**).** **Nanochemistry**: classification of nanomaterials as zero, one and two dimensional materials. Synthesis of nanomaterials: chemical (sol gel, low temperature combustion, hydro and solvo thermal methods) and bio (microbial and plant extracts) routes. Synthesis of nanowires and nanorods with reference to carbon nanorods andnanowires (single- walled).	15hrs
04	**Atomic spectra and atomic structure:** Review of hydrogen spectrum, hydrogen like spectra. Terms, Term Symbols and multiplicities and couplings. Atomic spectra of alkali and alkali like elements (any one example) . Atomic spectra of helium, atomic spectra of alkaline earth and alkaline earth like elements (any one example), prohibition ofinter combination, Mosely lines, Multiplet structure, simple and compound doublets and triplets. Space quantization, Stern-Gerlach experiment, Normal Zeeman effect, AnomalousZeeman effect, Paschen Back effect, Stark effect. Comparison between Stark and Zeeman effect	15hrs

References:

1. Physical Chemistry by P. W. Atkins.
2. Introduction to kinetics of chemical chain reactions by
3. Gimblett (TMH).3.Chemical kinetics by Laidler.
4. X-ray diffraction by Clug and Alexander.

Course outcomes:

1.	Capable to predict the kinetics of reaatcion
2.	Able to synthesise and predict the properties of nanomaterials
3.	Apply the catalytic reactions and interpret the physical processes

Course Title: SELECTED TOPICS IN PHYSICAL CHEMISTRY	Course Code: SCT 22
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To understand foundation in the fundamentals and application of Polymer Chemistry.
2.	To understand the basics of biopolymers.
3.	To explore new areas of research in both chemistry and allied fields such as, Biochemistry, Material chemistry, Pharmaceutical chemistry and chemical biology and technology.
4.	To understand the central role of photonic devices

Unit	Description	Hours
01	**Natural polymers**: Classification, bio-polymers - introduction – functions –Cellulose, cotton, wool, silk, paper, rubber, collagen, hyaluroran-melanin, lignin – applications. Polymer fromrenewable resource: Introduction – Monomers and polymers from renewable resource materials: castor oil, natural gums, oleo chemicals, cashew nut shell liquid, carbohydrate derived monomers, furfural as a raw material for monomers and polymers. 14h	15hrs
02	**Structure of bio-polymers**: Proteins, nucleic acids and polysaccharides – the Macromolecular structure and biological functions of polymers-primary, secondary, tertiaryandquaternary structures – structure maintenance and transmission of the biological informations- structure and enzymatic activity – mechano structural function of bio-polymers-viruses andphages–living macromolecules.	15hrs
03	**Biological Sources and applications of Nanomaterials:** Carbon nanotubes, Nanomagnets and sensors, High density data storage materials, Nanofillers, spintronics devices, nanotechnology for biological systems and sensor applications Biological sources of nanomaterials: Microorgaism, plants and animals. Mechanism of bolilgical synthesis of functionalized nanomaterials for gold, silver and iron oxides, Diffraction, bonding and morphological (SEM/TEM) study biofunctionalised nanoparticles	15hrs
04	**Photonic devices** **LED and semiconductor lasers**: radiative transitions: Light emitting diodes, Theory, characteristics and applications of Semiconductor lasers. Photodetectors, Photoconducotors and Photo transistors **Solar Cells**: Solar radiation and ideal conversion efficience; p-n junction	15hrs

	solar cells, hetereojunction cells, thin film solar cells, optical concentration	

References:

1. Physics of Semiconductor devices : S.M. Sze (Wiley Eastern)
2. Introduction to Solid State Physics : C Kittel
3. Solid State Physics : A.J. Dekker
4. Introduction to NanoScience –Gabor L Hornyak,JoydeepDutta,Harry F Tibbbals and Anil K Rao-CRC Press
5. Nanomaterials: Synthesis, properties and application, A.S Edelstein, R Cammarada(IOPPub.)
6. Optical properties of metal clusters, UweKribig and Michael Vollmer, Springer.
7. Nanostructured Materials: Processing, Properties and Applications, Carl C Koch, Noyes Pub
8. Nano: The Essentials, T.Pradeep. Tata McGraw Hill, New Delhi (2007)
9. Introduction to Nanotechnology, Charles P Poole Jr and Frank J Ownes, John Wiley Sons, Inc(2003)
10. Nanocomposite Science and Technology, Pulickel M. Ajayan, Linda S.Schadler, Paul V.Braun,Wiley – VCH Verlag, Weiheim (2003)
11. Nanotechnology: Basic sciences and emerging technologies, Mick Wilson, KamaliKannangara,Geoff Smith, Michelle Simmons, BurkarRaguse, Overseas Press (2005).
12. Semiconductor Quantum Dots, L.Banyai and S.W.Koch (World Scientific) 1993
13. An introduction to the physics of low dimensional semiconductors, J.H. Davies, Cambridge Press,1998.

Course outcomes:

1.	Enormous job opportunities at all level of polymer chemistry**.**
2.	Specific placements in R & D and synthetic division of polymer industries & Allied Division**.**
3.	Facile development for the synthesis of biologically significant organic molecules using the green route for chemical reactions for sustainable properties**.**
4	To inculcate the scientific temperament in the students and outside the scientific community.

Course Title: BIOPHYSICAL CHEMISTRY	Course Code: SCT 23
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To understand the physico-chemical principles of biological fluids.
2.	To learn the pharmaco kinetics, pharmaco dynamics, toxico kinetics of biological systems.
3.	To gain the knowledge of bioenergetics and physical chemistry of biomaterials

Unit	Description	Hours
01	**Biophysical Chemistry:** Electrophoresis - Principles of free electrophoresis, zone electrophoresis, gel electrophoresis and its applications in qualitative and quantitative study of proteins. Determination of isoelectric point of a protein. Electro-osmosis and streaming potential and its biological significance. Biological significance of Donnan membrane phenomenon. Micelles and its involvement during digestion and absorption of dietary lipids. Diffusion of solutes across bio-membranes and its application in the mechanism of respiratory exchange. "Salting In" and "Salting Out" of proteins. Osmotic behaviour of cells and osmo-regulation and its application in the evolution of excretory systems of organisms. Effect of temperature and *p*H on the viscosity of bio-molecules (albumin solution). Significance of viscosity in biological systems - mechanism of muscle contraction, polymerization of DNA and nature of blood flow through different vessels. Effect of temperature, solute concentration (amino acids) on surface tension. Biological significance of surface tension - stability of Alveoli in lungs, interfacial tension in living cells (Danielli and Davson model). Application of sedimentation velocity and sedimentation equilibrium method for molecular weight determination of proteins.	15hrs
02	**Pharmacokinetics:** Introduction, biopharmaceutics, pharmacokinetics, clinical pharmacokinetics, pharmacodynamics, toxicokinetics and clinical toxicology. Measurement of drug concentration in blood, plasma or serum. Plasma level-time curve, significance of measuring plasma drug concentrations. **One compartment open model:** Intravenous route of administration of drug, elimination rate constant, apparent volume of distribution and significance. Calculation of elimination rate constant from urinary excretion data, clinical application. **Two compartment model:** Plasma level-time curve, relationship between tissue and plasma drug concentrations, Apparent volumes of distribution.	15hrs

	Drug clearance, clinical example. Plasma level-time curve for a three compartment open model. Drug absorption: Factors affecting the rate of drug absorption - nature of the cell membrane, Route of drug administration - Oral drug absorption, Intravenous infusion and intravenous solutions, Effect of food on gastrointestinal drug absorption rate.	
03	**Bioenergetics:** standard free energy change in biochemical reactions, exergonic, endergonic, hydrolysis of ATP, synthesis of ATP from ADP. **statistical mechanics in biopolymers:** chain configuration of macromolecules, statistical distribution end to end dimension, calculation of average dimensions for various chain structure polypeptide and protein structures introduction to protein folding problem. **Biopolymer interactions:** forces involved in by polymer interactions electrostatics charges and molecular expansion hydrophobic forces desperation force interaction multiple equilibria and various types of binding process in biological systems hydrogen ion titration curves.	15hrs
04	**Thermodynamic of biopolymer solutions:** thermodynamics of bio polymer solutions cosmetic pressure member in equilibrium muscular contraction and energy generation in mechanic chemical system. **Cell membrane and transport of ions:** structure and functions of cell membherance ion transport through cell membrance irreversible thermodynamics treatment of membrane transport nerve conduction. **Biopolymers and their molecular weight:** evaluation of size shape molecular weight and extent of hydration of bio polymers by various experimental techniques sedimentation equilibrium hydrodynamic methods diffusion sedimentation velocity viscosity electrophoresis and rotational motions.	15hrs

References:

1. Introduction to Physical Organic Chemistry, R.D. Gilliom, Madison – Wesley, USA (1970).
2. Physical Organic Chemistry- Reaction Rate and Equilibrium Mechanism – L.P. Hammett, McGraw HillBook, Co., (1970).
3. Biophysical Chemistry- Principle and Technique – A. Upadhyay, K. Upadhyay and N. Nath, Himalaya Publishing House, Bombay, (1998).
4. Essentials of Physical Chemistry and Pharmacy – H. J. Arnikar, S. S. Kadam, K.N. Gujan, Orient Longman, Bombay, (1992).
5. Applied Biopharmacokinetics and Pharmacokinetics - Leon Shargel, Andrew YuPrentice-Hall International, Inc (4^{th} edition).
6. Essentials of Physical Chemistry and Pharmacy – H.J. Arnikar, S.S. Kadam, K.N. Gujan, Orient Longman, Bombay, (1992).

Course outcomes:

1.	After the completion of this course, the students gain the knowledge on theory and principles of biophysical chemistry and pharmacokinetics.
2.	This course helps to understanding the bio-availability and different pharmacokinetic parameters of drugs in the living system.
3.	Students will be able to understand the bioenergetics and biomaterials

Course Title: **CHEMISTRY FOR DAILY LIFE**	**Course code**: OET21
Total Contact Hours : 30	**Course Credits**:02
Formative Assessment Marks: 10	**Duration of ESA/Exam**: 2 hrs
Summative Assessment Marks:40	

Course Objectives:

1.	Understanding the importance of Chemistry in daily life
2.	Inform on Drug chemistry and chemistry of soaps
3.	Study the use of some chemical products

UNIT	Description	Hours
01	**Chemistry in Household** Soaps, Detergents, surfactants, Diamond. Chemistry in Jewellary: Electroplating, metals and metal alloys. Chemistry of Batteries: cells, wax candals, mosquito coils and common salt. Chemistry of Cosmetics: Cosmetics formulation, perfumes, and fragrances, deodorants, Colour cosmetics, sun protections, Preservatives and its effects, Food toxicity Chemistry and uses of Paints, pigments, Varnishes and coatings, cleaners, stain removears, pesticides, Fire extinguishers, cement, glasses, fertilizers Fuel Chemistry: Fuels, Introduction, fossil fuels with example, biomass energy, Energy sources: Solar energy, wind energy, tidal energy, hydal energy, nuclear energy. Chemical toxicity	15hrs
02	**Chemistry of drugs** Drugs, classification, uses and side effects of pain relief drugs, antibiotics, antacids, Stimulants, ointments, syrups, tablets and capsules, Anesthetic drugs, energetic drugs. Storage and usage Action of drugs: Effects of narcotics and abuse of drugs **Water Chemistry**: Importance, sources, types, underground and surface water, water contents, water born deceases, Water pollution: Sources and Impacts on aquatic and human life Potable water: Specification and limits: pH, acidity and alkalinity, hardness, chloride, TDS, Conductivity, COD, BOD and DO	15hrs

References:

1) Chemistry in daily life by Kirpal Sing, PHI learning Pvt Ltd., 2012.
2) Engineering Chemistry by Dr. Suba Rameshm and Dr. S. Vairam, Wiley Publication, 2013

3) Drugs and pharmaceutical sciences Series, Marcel Dekkar, Vol.II, INC, New York, 2002.
4) Hand book of Fertilizer Technology By Swaminathan and Goswamy, 6th Edn., 2001.
5) Medicinal Chemistry (VEdition) by Asthoush Kar, New Age International publisher,2010.
6) Food 6 facts and principles by N. Shakuntala Manay and S. Swamy, 4th ED. New Age International, 2008.

Course Outcomes:

1.	Know the role of Chemistry in our daily uses
2.	Understand the applications of Chemistry in household activites
3.	Get information about drugs and its side effects

Course Title: AGRO AND ENVIRONMENTAL CHEMISTRY	Course code: OET22
Total Contact Hours: 30 hrs	**Course Credits:** 02
Formative Assessment Marks: 10	**Duration of ESA/Exam:** 2hrs
Summative Assessment Marks: 40	

Course Objectives:

1.	Understand the importance of safe environment
2.	Study the Sources and consequences of environmental pollution
3.	Gain knowledge on the composition and importance of fertilizers, pesticides for agriculture

Unit	Description	Hours
1	**Agricultural products** Micronutrients and macronutrients in soil, Importance of Nutrients for plants, Different nutrients for different crops **Fertilizers**; Different types, Composition and applications, Effects of excess use of fertilizers, pollution by fertilizers, Bio-based fertilizers and advantages **Insecticides:** Composition and applications, side effects **Pesticides:** Composition and applications, side effects **Weedicides:** Composition and applications, side effects **Preservative chemicals:** Composition and side effects **Chemicals used for Ripening:** Composition, uses and side effects **Food adulteratives and contaminants:** Difference and side effects with examples, Rancidity of oil	15
2	**Environment:** Segments of environment, Ecosystem, Laws to safeguard environment. Duties of state and Central pollution Control boards. Importance of safeguarding the environment; Measures to safeguard the environment; Case studies, Chernobyll accident, Bhopal tragedy, Minamota disease, etc **Soil pollution:** Causes, Soil erosion, loss of fertility and remedies **Air pollution:** Sources, greenhouse effect, causes and consequences, Control and remedies, Acid rain **Water pollution:** Sources, Effects, Control and procedure for purification **Noise pollution**: limits and units; effects	15
References:		

1. Environmental Chemistry – A.K. De, New Age International, 8th Edn., 2016
2. Environmental Chemistry – S.K. Banerji, (Prentice Hall India), 1993.
3. Chemistry of Water Treatment – S. D. Faust and O. M. Aly, (Butterworths), 1983.
4. Environmental Chemistry – I. Williams, John Wiley, 2001.
5. Food Analysis – A. G. Woodman, McGrawHill, 1971.
6. Foods: Facts and Principles – Shadaksharaswamy and Manay, Wiley Eastern, 1987.
7. A Text Book of Soil Chemical Analysis – P. R. Hesse, CBS Publishers, 1994

Course Outcomes:

1.	Capable to introduce and educate people about the environment
2.	Practice and adopt the skills for safe environment
3.	Able to properly use agro-products

Course Title: INORGANIC CHEMISTRY PRACTICALS-II	**Course Code: HCP21**
Teaching Hours/Week (L-T-P): 0 - 0 - 4	**No. of Credits:** 02
Internal Assessment: 10 Marks	**Semester End Examination:** 40 Marks

Course objectives:

1.	Hands-on training for synthesis and estimation of inorganic complexes.
2.	Understand the analysis of mixtures by volumetry and gravimetry.
3	Acquire skills for industry

List of Experiments: **60 hrs**

1.	I. Separation and determination of two metal ions involving volumetric and gravimetric methods from the following i) Fe + Ni ii) Cu + Fe
2.	II. Preparation and quantitative analysis of inorganic complexes: i) Cis and trans–potassium dioxalatoaquachromium(III) complex [analysis of oxalate and chromium] present in the above complex. ii) Hexaminecobalt(III)chloride [analysis of cobalt] iii) Chloropentammine cobalt(III) chloride iv) Tris (acetylacetonate) copper (II) sulphate v) Mercuric tetrathicynato cobalate (II). vi) Estimation of Ni^{+2} as Ni-DMG.

References:

1.	Chemical Semi micro analysis- V.N.Alexeyev Mir Publishers (Mascow)
2.	Vogel's Qualitative Inorganic analysis, Revised by G.Suchla Longarman group ltd.
3.	Vogel's Text book of Quantitative Inorganic Analysis – J.Basett, R.C.Denney, G.H.Jeffery and J.Mendhaman, Longamans Green and Company Ltd.
4.	Advanced Inorganic Analysis by Agarwal and Keemtilal, A Pragati Edition, Eleventh Revised edition, 2011.

Course Outcomes:

1.	Acquinted with synthesis and analysis of complexex
2.	Able to carryout separate the mixture and analyse them
3.	Able to apply for routine analysis in industries

Course Title: ORGANIC CHEMISTRY PRACTICALS-II	Course Code: HCP22
Teaching Hours/Week (L-T-P): 0 - 0 - 4	**No. of Credits:** 02
Internal Assessment: 10 Marks	**Semester End Examination:** 40 Marks

Course objectives:

1.	Hands-on training for synthesis of organic compounds.
2.	Understand the mechanism of synthetic reaction.
3.	Estimation of organic compounds using titrimetry

List of Experiments: **60 hrs**

Two step preparations:	
At least six preparations have to be carried out involving following types of reactions.	
1.	Preparation of acetanilide from acetophenone.
2.	Preparation of para nitroaniline from acetanilide.
3.	Preparation of para bromoaniline from acetanilide.
4.	Preparation of azlactone from hippuric acid
5.	Preparation of benzilic acid from benzil
6.	Preparation of anthranilic acid from phthalimide
7.	Preparation of 2-Phenyl indole from Phenyl hydrazine and acetophenone
8.	Preparation of 2,5 Dihydroxy acetophenone from Hydroquinone.
9.	Preparation of Acridone from 2- Chloro benzoic acid.
10.	Preparation of benzoic acid (Cannizarro reaction)
11.	Preparation of Chalcone **II. Estimations:** 1. Estimation of glucose by titration 2. Estimation of ascorbic acid by titration 3. Estimation of hydroxyl group by titration 4. Estimation of amino group by titration 5. Saponification value of oils by titration Estimation of ester group by titration

References:

1.	Advanced Practical Organic Chemistry, N K Vishnoi , Second edition, Vikas Publishing

	House Pvt. Ltd, 1996
2.	Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis Renu Aggarwal, V. K. Ahluwalia, Universities press (India), 2001
3.	Systematic Laboratory Experiments in Organic Chemistry, Arun Sethi, New Age International, 2003.
4.	Comprehensive Practical Organic Chemistry: Qualitative Analysis, Ahluwalia V.K. Sunitha Dhingra, First edition, Orient Longman, 2004
5.	Practical Organic Chemistry: Qualitative Analysis, Bhutani S.P. Chhikara A, First edition, ANE books-new Delhi, 2009
6.	Vogel's Textbook of Practical Organic Chemistry, Brian S. Furniss, 5th Edition, Pearson India, 2005.
7.	Practical Organic Chemistry , F.G. Mann, B.C Saunders, Fourth edition , Pearson India,2009.

Course Outcomes:

1.	Able to synthesise organic compounds
2.	Can comment on the mechanism involved in the reaction
3.	Skilled to determine the organic compounds

Course Title: PHYSICAL CHEMISTRY PRACTICALS-II	Course Code: SCP21
Teaching Hours/Week (L-T-P): 0 - 0 - 4	**No. of Credits:** 02
Internal Assessment: 10 Marks	**Semester End Examination:** 40 Marks

Course objectives:

1.	Hands-on training for the physical properties characterization.
2.	Understand the physical properties like equivalent conductance, rate constant, electrode potential, dissociation constant, etc
3.	Acquire knowledge on characterization

List of Experiments: **60 hrs**

1.	Determination of limiting equivalent conductance of a weak electrolyte.
2.	Determination of Concentration of given solution by spectrophotometer(Cu^{2+} and NH_3).
3.	Determination of optical rotation and rate constant by polarimeter.
4.	Determination of standard electrode potential by potentiometry
5.	Determination of dissociation of constant of dibasic acid potentiometrically
6.	Determination of rate constant and order of reaction between $K_2S_2O_8$ and KI.
7.	Determination of distribution coefficient for benzene, benzoic acid and water system.
8.	Construction of phase diagram for three component system.
9.	Determine the equilibrium constant for the reaction $KI + I_2 = KI_3$ by distribution method.
10.	Determination of molecular weight of a given solute by Beckmann thermometer.

References:

1.	Fridley's Practical physical chemistry by B. P. Levitt
2.	Advanced practical physical chemistry by G. B. Yadhav
3.	Experiments in practical physical chemistry by Shomaker
4.	Systematic experimental physical chemistry by S.W. Rajbhoj and T K Chondeker.
5.	Senior physical chemistry practical's by Khosla et. al

Course Outcomes:

1.	Able to understand the physical properties
2.	Can comment on the equivalent conductance, ate constant, 3 phase system, etc
3.	Skilled to determine the physical properties

M.SC. CHEMISTRY THIRD SEMESTER

Course Title: APPLIED INORGANIC CHEMISTRY	**Course Code: HCT31**
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To acquint with the applications of organometallic chemistry
2.	Understand the importance and applications of nuclear chemistry
3.	To gain knowledge on bioinorganic chemistry related to biological processes
4.	To provide advanced aspects of halogen chemistry

Unit	Description	Hours
01	**Reactions and Catalytic Applications of Organometallic Compounds** Fundamental reactions: Substitution in carbonyl complexes, Mechanisms, Insertion reactions, CO, SO2, olefin insertions, oxidative additions, one electron, addition of oxygen, reductive elimination, CH activation, Use of Organometallic Compounds as catalysts – Catalytic behaviour – Homo catalysis –. Anchoring of Catalysts Hydrogenation. Hydrogenation of olefins (oxo reaction-cobalt and rhodium oxo catalysts), carbonylation of alcohols – Monsanto acetic acid process, Wacker process. Polymerization of olefins and acetylenes: Ziegler – Natta catalysis systems. Fischer – Tropsch reaction, Water Gas Shift reactions.	15hrs
02	**Bioinorganic Chemistry-I** Metal ions in biological systems, essential and trace metals, disease due to metal deficiency and treatment: Iron, zinc, copper, manganese, sodium, potassium, magnesium and calcium. Metal complexes as therapeutic agents: Metal complexes in cancer therapy, metal complexes for the treatment of rheumatoid arthritis, vanadium in diabetes, metal complexes as radio diagnostic agents. Treatment of toxicity due to inorganics: Chelation therapy and requirements of a chelate/antidote. Mechanism of antidotes with poison rendering it inert: Arsenic, lead, mercury, iron, copper, plutonium, cyanide and carbon monoxide poisoning. Ion transport across membranes and active transport of ions across biological membranes, ionophores. Metal complexes in transmission of energy: Chlorophyll, photo systems-I and II in cleavage of water and model systems.	15hrs

03	**Nuclear Chemistry** Nuclear Stability – Mass Defect and Binding Energy.. Radioactivity: Radioactive elements, general characteristics of radioactive decay, interaction of α, β and γ – rays with matter. Nuclear reactions Types of nuclear reactions, Nuclear fission. Applications of Radioactivity: Synthesis of various useful isotopes, use of isotopes in the elucidation of reaction mechanism, structure determination, kinetics of exchange reactions, measurement of physical constants including the diffusion constants, isotope dilution techniques, NAA, PGNAA, neutron absoptiometry and age determination, radio isotopes in field of medicine	15hrs
04	**Halogens in positive oxidation states, Chemistry of Astatine.** Lanthanide series: Review on electronic structure, oxidation states, spectral and magnetic properties, lanthanide contraction, abundance and extraction. Lanthanides as shift reagents. Separation of lanthanides: Solvent extraction and ion–exchange. Chemical properties of compounds of lanthanides in II, III, and IV oxidation states. Actinides: Review on Electronic structure and position in the periodic table, oxidation states, occurrence and synthesis of the elements. Spectral and magnetic properties of compounds of actinides in comparison with those of lanthanides and d-block elements. Trans actinides Chemistry of Trans –uranium elements.	15hrs

References:

1. Inorganic Chemistry-Principles of Structure and Reactivity, 4thEdn-J. E. Huheey, E.A. Keiter, R. L. Keiter and O.K. Medhi. Pearson Education (2009).
2. Shriver & Atkins' Inorganic Chemistry, 5th Edn-P. Atkins, Tina Overton, J. Rourke, Mark Weller and F.Armstrong.Oxford University Press (2010)
3. Concepts and models of Inorganic Chemistry-B.Douglas, D. McDaniel & J.Alexander, 3rd Edn. Wiley Student Edn.(2013).
4. Fundamentals of photochemistry-K. K. Rohatgi-Mukherjee, Revised Edn. New Age International.
5. Ferraudi G. L, Elements of Inorganic photochemistry, Wiley Eastern, 1988
6. Photochemistry and Photophysics of Ru(11) polylpyridine complexes in the Bologna group. From early studies to recent developments, Coodinatiom chemistry reviews, Vincenzo Balzani, Alberto Juris, 211, 97-115 ((2001).
7. F.A.Cotton and G.Wilkinson : Advanced Inorganic Chemistry, Wiley, 1991.
8. Environmental Chemistry-A. K. De (Wiley Eastern).
9. Environmental Chemistry-S. K. Banerji, (Prentice Hall India), 1993.

Course outcomes:

1.	Acquint and able to apply organoometallic reactions.

2.	Learn to apply nuclear chemistry to related applications
3.	Able to prepare and comment on properties of various halogen compounds
4	Gain knowledge on the importance of inorganic chemistry in biological porcesses

Course Title: THEORETICAL AND SOLID STATE CHEMISTRY	Course Code: HCT32
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	Understand the concepts of thermodynamics and statistics
2.	Gain knowledge in the area of quantum chemistry
3.	Study the solid state properties of materials
4.	Acquint with the knowledge of colloids

Unit	Description	Hours
01	**Statistical Thermodynamics and Quantum Statistics:**Microstates' and Microstates, Assemblies of localized and Non-localized systems, Phase space, γ-Space, μ-Space, andEnsembles. Classical Statistics: Maxwell-Boltzman distribution law for ideal gases and mixture of gases equipartition of energies, Maxwell-Boltzman distribution of velocities and energies(no derivation). Quantum Statistics: Relationships between probabilities and entropy, Sterling approximation. Bose-Einstein, Fermi-Dirac and Maxwell-Boltzmann Statistics and comparison between them. Heat capacity of Ortho-Para hydrogen systems. Einstein'sheat capacity for solids. Partition Function: Definition and separation of partition functions. Translational, Vibrational, Rotational and Electronic partition functions for Monoatomic, Diatomic, andPolyatomic gaseous molecules. Sackur-Tetrode equation. Calculation of thermodynamic quantities in terms of partition functions, Residual entropy.	15hrs
02	**Quantum Chemistry:** Review of concepts of operators. Applications of Schrödinger wave equation to Hydrogen like atoms, rigid Rotor, Harmonic oscillators and HartreeSelf consistent field theory. Ab intio and Density functional analysis. Approximation Methods-Variation theory and Perturbation theory (zero, first,). MO Theory: MO Theory of Hydrogen molecule and ion, Bonding and Anti-bonding orbitals. Examples of MO of simple HOMO and HETERO nuclear molecules. Notations of few molecular orbitals, correlation diagrams and Non-crossing rules, Simple Huckel theory of linear conjugated systems (HMO) and applications to systems like, ethylene and butadiene molecules. VB Theory: Secular equation and determinants, Columbic, exchange and overlap integrals. VB theory of H_2 molecule. Comparison of VB	15hrs

	and MO theories.	
03	**Solid State Chemistry:** Solid state reactions: General principles and classification of reactionsMethods of Single Crystal Growth: Solution growth; Melt Growth-Bridgeman, **Instrumentation** **Thermal analysis:** TGA, DTA, DSC (Instrumentation, applications in characterizing solid materials) **Electrical properties**: Band theory of solids; semiconductors - extrinsic and intrinsic, Hall effect; thermoelectric effects (Seebeck); Fermi energy levels and their determination for semiconductors. ferroelectric, pyroelectric and piezoelectric properties; ionic and superionic conductors.Superconductivity: Basics, discovery and high Tc materials **Magnetic properties**: dilute and concentrated magnetic systems. Dia, para, ferro, ferri, and antiferro magnetic types; soft and hard magnetic materials; select magnetic materials such as spinels, garnets and perovskites and hexaferrites magnetoresistance and giant magnetoresistance. Understannding. **Optical properties optical, reflectance, photoconductance structure and properties** of amorphous materials (glasses) and zeolites	15hrs
04	**Themodynamics, Non-equilibrium Thermodynamics and Colloids:** Solutions: Introduction, partial molar quantities, Gibb's function of mixing and other thermodynamic mixing functions(Gibbs-Duhmen and Duhmen-Margules equations), chemical potential of liquids and liquid mixtures, Excess function for non-ideal solutions. Non-equilibrium Thermodynamics: Microscopic reversibility, entropy production in irreversible process. Different types of forces and fluxes, stationary states. phenomenological equations. Onsagar's reciprocity relations (quantitative), Principle of minimum entropy production, phenomenological in non-linear region. Colloids: Electro kinetic phenomena of colloids, Classification of Surface active agents, Critical Micellar concentration (CMC), determination of Surface tension by different Method'.	15hrs

References :

1. Theoretical Chemistry- Glasstone.
2. Statistical Mechanics- Davidson.
3. Elements of Statistical Thermodynamics- E. K. Nash
4. Statistical Thermodynamics- M.C.Gupta
5. Introduction to Quantum Chemistry- A.K.Chandra
6. Quantum Chemistry- R.K.Prasad
7. Textbook of Quantum Mechanics-P M Mthews & P Venkateshan
8. Problems in Quantum Mechanics- G.L.Squiras.
9. Introduction to Solids- I. V. Azarrof.
10. Solid State Chemistry- A.R.west

11. Modern aspects of Solid State Chemistry- Ed. By C.N.Rao
12. New direction in Solid State Chemistry- C.N.Rao & Gopal Krishnan
13. Thermodynamics by L.M. Koltz & R.M. Rosenberg
14. Thermodynamics by Glasstone
15. Physical Chemistry by P.W. Atkins.
16. Molecular Quantum Chemistry by A. J. Atkins.
17. P. Ball, Designing the Molecular World: Chemistry at the Frontier,

Course outcomes:

1.	Able to apply thermodynamic aspects in chemical reactions
2.	Apply quantum chemistry aspects for various compounds
3.	Interpret the the properties of solid state materials and colloids

Course Title: SPECTROSCOPY	Course Code: HCT33
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To understand the basic concepts of spectroscopy
2.	To gain knowledge on principle and instrumentation
3.	To familiarize with the working and applications

Unit	Description	Hours
01	**IR Spectroscopy** **IR Spectroscopy:** Basic principles of vibrational spectroscopy, Theory of Infrared Absorption, Vibrational modes and molecular vibrations, calculation of vibrational frequencies. Relationship between molecular structure and IR spectra.**Instrumentation**:Types of IR spectrometers, Single bean and double beam, Key components: source, interferometer, detector, **Quantitative Analysis with IR Spectroscopy:** Basics of Quantitative Analysis, Beer-Lambert Law and its application in IR spectroscopy, Calibration methods for quantitative measurements, Sample Preparation and Handling of solid, liquid, and gaseous samples, interpretation of IR spectra, factors affecting group frequencies and band shapes. IR spectra of coordination modes of ligands like nitrate, thiocyanate, sulphate, carbonate (bridging, bidentate etc.,) and water.Applications in Analytical Chemistry. **Advanced IR Techniques**: **ATR (Attenuated Total Reflection) Spectroscopy**: Principles and applications, Advantages over traditional transmission measurements.	15hrs
02	**HNMR Spectroscopy** Introduction – Nuclear spin and magnetic moment, origin of NMR spectra, Theory of NMR spectroscopy, resonance flipping, instrumentation and sampling, inter pretation of NMR spectrum, equivalent and non-equivalent protons, chemical shifts(down field and up field), factors influencing chemical shifts, anisotropic effects, NMR scale, units, internal references, simple and complex splitting / coupling, coupling constant, correlation chart of chemical shifts, spin-spin relaxations, equivalence of protons–chemical and magnetic equivalence, spin– systems. solvent effects and Nulear Overhauser Effect. Karplus relationships (Karplus curve–variation of coupling constant with dihedral angle), double resonance techniques, first order and second order patterns, lanthanide shift reagents, exchange phenomena. . High resolution 1H NMR. FT NMR and its advantages. Applications of NMR spectroscopy in structure elucidation of simple organic	15hrs

	and inorganic molecules. Pulse techniques in NMR, two dimensional and solid state NMR. Use of NMR in Medical diagnostics. Deuterium exchange techniques limitations of H NMR spectroscopy .	
03	**Introduction and applications of 13C NMR spectroscopy**, Broad band and off resonance coupling methods of detection. 13C Chemical shifts of different classes of organic compounds–alkanes, alkyl halides, alkenes, alcohols, ethers, carbonyl compounds and aromatic compounds. 2 DNMR spectroscopy, use of PMR spectrum in structural elucidation of organic compound.^{31}P and ^{19}F NMR. COSY, NOESY (Nulear Overhauser Effect) and EXSY (Exchange Spectroscopy), MRI. Conformational analysis, keto-enol tautomerism, Hbonding. Spectra of simple organic molecules, phosphates, polyphosphates, PH_3, phosphor halides, fluoro acetic acid, SF_4, P_4S_4, HPF_2. Raman Spectroscopy: Raman and Rayleigh scattering, Stokes and anti-Stokes lines, polarization of Raman lines, depolarization factor, polarizability ellipsoid. Classical theory of Raman Effect – rotational Raman spectra – Linear – Vibrational Raman Spectra, rule of mutual exclusion principle.Instrumentation. Resonance Raman Spectroscopy: Resonance Raman Effect and its applications. Non-linear Raman effects: Hyper, stimulated and inverse Raman effects. Coherent Anti-Stokes Raman Scattering and its applications..	15hrs
04	**Mass Spectroscopy:** Introduction, Basic theory, ionsation, types of ions, molecular ion, fragment ion, meta stable ion, base peak, instrumentation, factors affecting fragmentation, intensity of M^+ peaks of alkanes, alkenes, alkynes, alcohols, amines, aldehydes and other compounds, Mc Laffarty rearrangement nitrogen rule, some simple examples of fragmentations, applications of mass spectrometry. **Advanced Mass Spectrometry Techniques:** Introduction to advanced MS techniques such as tandem MS (MS/MS) and high-resolution MS (HRMS). **Gas Chromatography (GC):** Principle, instrumentation, columns, detectors (thermal conductivity, flame ionization, electron capture, mass spectrometry), factors affecting separation, applications, GC-MS and its applications. **High-Pressure Liquid Chromatography (HPLC):** Apparatus, pumps, column packing, characteristics of detectors (UV, IR, refractometer, fluorescence), advantages, applications, HPTLC, and its applications. **Hyphenated Techniques:** Introduction to hyphenated techniques like LC-MS/MS and GC-MS/MS. Advantages and applications of combining chromatography with mass spectrometry.	15hrs

References:

1. Mass Spectrometry: Principles and Applications" by Edmond de Hoffmann and Vincent Stroobant (John Wiley & Sons).

2. Interpretation of Mass Spectra by Fred W. McLafferty and FrantišekTureček (University Science Books).

3. Mass Spectrometry in Chemistry and Biochemistry by Victor R. Preedy (CRC Press).

4. "Introduction to Mass Spectrometry: Instrumentation, Applications, and Strategies for Data Interpretation" by J. Throck Watson and O. David Sparkman (John Wiley & Sons).

5. "Liquid Chromatography-Mass Spectrometry: An Introduction" by Robert E. Ardrey (John Wiley & Sons).

6. Fundamental of Analytical Chemistry. D.A.Skoog, D.M.West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.

7. Analytical Chemistry. G.D. Christian, 5thedn, 2001 John Wiley & Sons, Inc,India.

8. Gas Chromatography Mass Spectrometry: Principles, Applications, and Reference Standards" by Jean-Francois Focant and Pat Sandra (Academic Press).

9. Tandem Mass Spectrometry: Molecular Characterization" by G. L. Glish and J. V. F. Martin (Wiley-Interscience).

10. "Practical LC-MS Method Development" by John W. Dolan and Thomas J. Moon (CRC Press).

11. An introduction to Magnetic Resonance spectroscopy, D.N. Sathyanarayana, I.K. International, 2013.

12. Spectroscopy of Organic compounds – P.S. Kalsi, New Age International Publications, New Delhi (6th Edn.), 2007.

13. Organic Spectroscopy – William Kemp 3rd Edn. ELBS, 1991

14. Instrumental methods of analysis. L. L. Meritt, J. A. Dean, F.A., settle 6th Edn. (Van Nostnoand).

15. Principles of Instrumental Analysis. D. S. Kooj (Sander Colley).

16. Fundamentals of Analytical Chemistry. Skoog, West, Holler, 7Th Edn. Harcourt Agra. Publication Harcourt College Publishers.

17. Principles of instrumental analysis. Skoog, Haller, Nieman, 5th Edn. Harcourt.

18. Treatise an analytical chemistry. F. J. Kohthiff& F. T. Elhiy, (M. Interscience).

19. Nuclear and Radiochemistry. G. Dridelandey, J. M. Millar, M. M. Keondy& E. S. Macias (John Willey).

20. Essentials of Nuclear Chemistry. H. J. Arnikar (Wiley Eastern).

21. Text Book of quantitative chemical analysis. A.I. Vogel (ELBS).

22. Introduction to NMR Spectroscopy – R.J. Abraham, J. Fisher, P. Loftus, - Wiley Publications, 1988.

Course outcomes:

1.	Acquint and able to apply spectroscopic techniques for qualitative and quantitative analysis
2.	Skilled with their handling and interpretation of data

Course Title: HETEROCYCLIC AND SYNTHETIC ORGANIC CHEMISTRY	Course Code: SCT31
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To understand the basic concepts of heterocyclic compounds
2.	To gain knowledge on principle and mechanism involved in photochemical, pericyclic and retro synthesis.
3.	To acquire theroretic skills in bond extension reactions

Unit	Description	Hours
01	**Heterocyclic compounds:** Nomenclature of heterocyclic compounds. Synthesis (Each two methods) and reactivity (towards electrophilic and nucleophilic reactions) – Pyrroles, Furans, Thiophenes, Pyridines, Azepines, Oxepins, Thiepins. **Fused heterocycles: S**ynthesis (Each two methods) and chemical properties towards electrophilic and nucleophilic reactions of benzopyrroles, benzofurans, benzothiophenes, quinolines and isoquinolines. **Mesoinonic compounds:** Nomenclature, synthesis, reactions and applications of Sydnones	15hrs
02	**Photochemistry and Pericyclic reactions:** **Photochemistry and concerted reactions**: Introduction, light absorption and electronic transitions, Jablonski diagram, intersystem crossing, energy transfer, sensitizers, quenchers Photochemistry of olefins, conjugated dienes, aromatic compounds, ketones, enones, photooxidations, photoreductions Norrish type I and II reactions, Paterno-Buchi reaction, Barton reaction, Di-pi-methane rearrangements. **Pericyclic reactions**: Electrocyclic reactions: Stereochemistry, Symmetry and Woodward-Hofmann rules for electro cyclic reactions, FMO theory of electrocyclic reactions, correlation diagram for cyclobutadine and cyclohexadiene systems. **Cycloaddition reactions**: [2+2] [3+2] and [4+2] cycloadditions, analysis by FMO and correlation diagram method. **Sigmatropic reactions**: Classification, stereochemistry and mechanisms.	15hrs
03	**Retro synthesis via disconnection approach:** **Organic Synthesis:** Introduction to synthons, synthetic equivalents, functional group interconversions, **Protection and de-protection in organic synthesis –** Protection of	15hrs

	hydroxyl, carboxyl, carbonyl, amino, thiol groups and their de-protection. Illustration of protection and deportation in organic synthesis with examples. **Disconnection approach:** One group C-X disconnection- Carbonyl compounds, ethers and sulphides (Benzyl benzoate, propanil, p-methyanisole, isopentyl benzyl ether, chlorobenside). **Two group disconnection**- 1, 1- difunctionalized compounds (Acetals, cyanohydrins, amino acids etc.), 1,2-difunctionalized compounds (1,2-dicarbonyl compounds, α- hydroxyl carbonyl compounds). **Retrosynthesis:** Retrosynthesis of benzocaine, 4-methoxy acetophenone, saccharin, bisvoline, canthredine, lycorane and multstrin.	
04	**Named reactions:** **C–C Bond forming reactions:** Aldol condensation, Claisen condensation reaction, Michael reaction, Robinson annulations, Stobbe condensation, Wittig reaction, Acylion synthesis. Alder – Ene reaction, Bischler – Napieralski, Dieckmann condensation, Knoevenagel condensation, Mannich reaction. **Coupling reactions:** Hiyama cross-coupling reaction, Negishi cross-coupling reaction, Stille coupling, Suzuki – Miyaura coupling, **C–N Bond forming reactions:** Buchirer reaction, Buchwald – Hartwig amination, Stork enamine reaction, Hofmann – Loffler – Freytag reaction, Barton reaction. **C–O Bond forming reactions:** Dakin reaction, Mislow – Evans rearrangement, Mukaiyama reagent, Bayer – Villager reaction.	15hrs

References:

1. Modern Synthetic Reactions, H.O. House, W.A Benjamin
2. Some Modern Methods of Organic Synthesis, W Carruthers, Cambridge Univ. Press
3. Principles of Organic Synthesis, R.O.C Norman and J.M. Coxon, Blackie Academic & Professional
4. Advanced organic chemistry.F.A.carey and R.J.sunderberg
5. Rood's Chemistry of Carbon Compounds, S. Coffey.
6. Organic Synthesis-Concept, Methods and Starting Materials, J. Fuhmop and G. Penzillin.
7. Guide Book to Organic Synthesis, R.K. Mackie & D.M. Smith, ELBS.
8. Organic Synthesis, V.K. Ahuwalia and Renu Agarwal, Narosa
9. Synthesis, Approaches in Organic Chemistry, R.K. Bansal, Narosa
10. Advanced Organic Chemistry -Reactions, Mecha- nism and Structure, Jerry March, John Wiley.
11. Designing Organic Synthesis, S.Warren, Wiley.
12. Organic Synthesis , Stuart warren, 2012 John Wieley and sons camebridge University.

Course outcomes:

1.	Able to carry out complex organic reactions
2.	Predict the reaction mechanism and conditions for reaction and synthetic applications.

Course Title: MEDICINAL CHEMISTRY	Course Code: SCT32
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To understand the basic concepts of medicinal chemistry
2.	To gain knowledge on drug action, designing and pharmacokinetics.
3	To acquint with the process of drug discovery

Unit	Description	Hours
01	**Introduction to Medicinal Chemistry**: History and development of medicinal chemistry, Physicochemical properties in relation to biological action, Ionization, Solubility, Partition Coefficient, Hydrogen bonding, Protein binding, Chelation, Bioisosterism, Optical and Geometrical isomerism. Drugs: Essential Drugs, Nomenclature of Drugs, Routes of Drug Administration, Adverse effects of Drugs, IUPAC Naming of Drugs.	15hrs
02	**Drug discovery process**: Brief introduction to bioinformatics and chemo informatics, Molecular modeling: Energy minimization, geometry optimization, conformational analysis. Drug discovery process: Computer Aided Drug Design (CADD), Development of New Drugs, Factors Affecting development of New Drugs. Concept of prodrugs and soft drugs, Drug Receptors. Molecular docking: Rigid docking, flexible docking, manual docking. Autodock and Dock softwares with examples.	15hrs
03	**Pharmacokinetics**: Introductions, Drug Absorption, Distribution, Metabolism (Phase I and Phase II), Excretion and Toxicity (ADMET). Pharmacodynamics: Introduction, Drug receptor interaction, Types of Interactions, Enzyme Stimulation, Enzyme Inhibition, Membrane Active Drugs, QSAR- 2D QSAR and 3D-QSAR.	15hrs
04	**Drug Action**: Theories of Drug Action, Molecular Recognition in Drug-Receptor Binding, Enzyme Inhibitors (Modes of inhibition). Antibacterial, Antifungal, Antiviral and Anticancer drugs (Major drug classes, mechanism of drug action, Drug resistance). Analgesic Drugs, anesthetics (general, local), Neurotransmitters (adrenergic, cholinergic effects; psychopharmacology), CNS depressants (sedative/hypnotic, major/minor tranquilizers), CNS stimulants, Steroids.	15hrs

References:

1. The Organic Chemistry of Drug Design and Drug Action, by Richard B. Silverman, 2nd Edition. Elsevier Academic Press, 2004, ISBN 0-12-643732-7.
2. Foye's Principles of Medicinal Chemistry, 5th Edition, by David A. Williams and Thomas L. Lemke, Lippincott Williams & Wilkins, 2002.
3. Medicinal Chemistry: A Molecular and Biochemical Approach, 3rd Edition, by Thomas Nogrady and Donald F. Weaver, 2005.
4. Medicinal Chemistry, An Introduction, by Gareth Thomas, John Wiley & Sons, 2000.
5. The Practice of Medicinal Chemistry, ed. Camille Wemuth, Academic Press, 1996.

Selected Medicinal Chemistry Journals

1. Journal of Medicinal Chemistry
2. Journal of Medicinal Chemistry Letters (starting with 2010, Volume 1)
3. Bioorganic & Medicinal Chemistry
4. Bioorganic & Medicinal Chemistry Letters

European Journal of Medicinal Chemistry 6.ChemMedChem

Course outcomes:

1.	Able to comments on the drug action
2.	Design the drug molecules based on their pharmacokinetics

Course Title: AGRO, HEALTH AND MEDICINAL CARE CHEMICALS	Course Code: SCT33
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To understand the chemistry of general chemicals of routine use
2.	To gain knowledge on the composition of agro chemicals and health care chemicals.
3.	To acquire concepts and metholdology of clinical chemistry

Unit	Description	Hours
01	**Fertilizers:** Introduction, Essential plant Nutrients, Classification of Essential Nutrients, Primary Nutrients, Secondary Nutrients, Micronutrients, Macronutrients, Classification of Fertilizers Straight Fertilizers, Compound/Complex Fertilizers, Fertilizer Mixtures, Feed Stock/ Raw materials- Nitrogenous Fertilizers, Phosphatic Fertilizers, Potassic Fertilizers, Manufacture and general properties of Fertilizer products- Intermediates- Ammonia, Nitric Acid, Sulphuric Acid, Phosphoric Acid, Nitrogenous Fertilizers- Ammonium Sulphate, Ammonium Nitrate, Calcium Ammonium Nitrate, Calcium Nitrate, Ammonium Chloride, Urea, Phosphatic Fertilizers, Ground Rock Phosphate, Single Superphosphate, Triple Superphosphate, Potassic Fertilizers- Potassium Chloride (Muriate of Potash), Potassium Sulphate (Sulphate of Potash), Potassium Nitrate, Complex Fertilizers- Ammonium Phosphate Sulphate, Ammonium Phosphates, Mono Ammonium Phosphate (MAP), Di-Ammonium Phosphate (DAP), Nitrophosphates, Urea Ammonium Phosphates, NPK Complex Fertilizers, Fertilizer mixtures-Physical Mixtures, Granulated Mixtures.	15hrs
02	**Insecticides:** Introduction, classification, Organochlorine insecticides- BHC, DDT, endosulfan, sevin, Insect pheromones, general introduction and applications in integrated pest management. **Repellents:** Survey & synthesis of the repellents-N,N-diethyltoluamide, 2-ethyl-1,3-hexanediol. **Fungicides:** Introduction, Inorganic & organic fungicides, Systemic fungicides-types & examples. **Herbicides:** Introduction, study of sulfonyl ureas, Mechanism of action and toxicities of insecticides, fungicides and herbicides.	15hrs

03	**Perfumery**: Introduction, Compounds used in perfumery and their classification, methods of preparation and importance of phenyl ethanol, Yara yara, Ionone musk ketone, musk ambrette, musk xylene, phenyl acetic acid and its esters, benzyl acetate, synthetic musks and jasmine. Essential oils: Source, constituents, isolation & uses. **Dyes:** Classification of dyes according to the mode of applications and according to the chemical constitution; Methods of preparation of commercial dyes of different classes with suitable examples; Typical manufacturing processes of dyes; Fluorescent brightening agents	15hrs
04	**Oils, soaps and Detergents**: Refining of edible oils, manufacturing of soaps, detergents classification-anionic, cationic, non-ionic and amphoteric detergents, detergent builders and additives, liquid soaps. Manufacturing of fatty acids and glycerol, greases from fatty acids, Turkey red oil. **Clinical Chemistry**: Composition of blood collection, and preparation of samples, clinical analysis – serum electrolytes, blood glucose, blood urea nitrogen, uric acid, albumin, globulin, barbiturates, acidic and alkaline phosphates, Immunoassay , principals of radio immunoassay and applications. The blood- gas analysis –trace elements in the body.	15hrs

References:

1. Statistical Quality Control, 2nd Edn., Manohar Mahajan Dampat Rai and Sons, 1995.
2. Quality management: a process improvement approach,Fryman Mark A, Cengage learning, 2002.
3. Quality Control, Paranthaman D, Tata, McGraw Hill,1987. 4. Gupta R. N. Chemical warfare and casuality management 2011
5. Vyas M. N. Safety and hazards management in chemical industries 2013.Atlantic publication. 6. Dikshith T.S.S Safety evaluation of environmental chemicals. New Age International, 1996.
7. Chemical Safety Matters-IUPAC-IPCS, Cambridge univ. Press, 1992.
8. Environmental Chemistry, A.K. Dey, Wiley Eastern.
9. Environmental Chemistry, S.K.Banerji, Prentice Hall India, 1993.
10. Chemistry of Water Treatment, S.D. Faust and O.M. Aly, Butterworths, 1983.
11. Environmental chemistry, Ahluwalia V K, Anne Books India, 2008.
12. Chemistry for Environmental Engineering, Sawyer and McCarty, McGraw Hill, 1978.
13. Environmental Chemistry, I.Williams, John Wiley, 2001 14. Engineering Chemistry by Jain and Jain.
15. Industrail electrochemistry by Peltcher 16. Modern Electrochemistry, Vol I, IIA & IIB(1998) J.O.M. Bockries and A.K.N.Reddy
17. Chemical Engineers Hand Book, 8th Edn., Robert H. Perry, Mc Graw Hill, 1995. 18.

Principles of Industrial Chemistry, C. A. Clausen and G. Matts

Course outcomes:

1.	Able to understand the synthesis and composition of routinely used dyes, fertilizers and health care products
2.	Comment on their use and applications

Course Title: INSTRUMENTAL ANALYTICAL TECHNIQUES	Course code: OET 31
Total Contact Hours: 30	**Course Credits: 02**
Formative Assessment Marks: 10	**Duration of ESA/Exam: 2h**
Summative Assessment Marks: 40	

Course Objectives:

1.	Study the basics and fundamentals of analytical techniques
2.	Acquire knowledge on spectroscopic techniques for the analysis of simple compounds
3.	To understand the principle and applications of spectroscopic techniques for qualitative and quantitative analysis

Unit	Description	Hours
1	**Introduction:** Qualitative and quantitative analysis; Concentration terms; Sampling and its Importance **Conductometry:** theory, types of conductometric curves , Instrumentation and applications **Potentiomtry**: principle, instrumentation and applications **Polarography**, reference electrodes, dropping mercury electrode, instrumentation and applications **Spectroscopic techniques:** Interaction of electromagnetic radiation with matter, Beer-Lambart's law-Limitations; **UV-Vis-Spectroscopy**: Principle, Instrumentation and applications for determination of composition of metal to ligand; metal ions like Fe, Ti and biological samples **FTIR spectroscopy**: Principle, sample preparation, Instrumentation and applications for determination of functional groups of hydrocarbons, alcohols, carbonyl compounds, amines, etc **Fluorescence Spectroscopy:** Principle and applications	15

2	**NMR Spectroscopy**: Principle, sample preparation, chemical shift, factors affecting chemical shift, Interpretation of spectra and applications for simple molecules **Mass spectroscopy:**Principle, fragmentation process, factors affecting fragmentation, base peak and molecular ion peak, nitrogen rule, Interpretation of spectra and applications for simple molecules. **Raman Spectroscopy**: Principle , Instrumentation and applications **X-ray diffraction:** measurement of X-rays, GM counter, Ionization counter, Semicinductor detectors, Scintillation counters, X-ray absorption and emission spectroscopy, Bragg's law, Debye Scherrer X–ray diffraction method, applications **Electron microscopic techniques:** Principle, Instrumentation and applications of SEM, TEM and AFM	15

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York, (2005).
2. Analytical Chemistry, G.D. Christian, 5th ed, John Wiley & Sons, Inc, India (2001).
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th Edn, prentice Hall, Inc. New Delhi, 1993.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint. Pearson Education Pvt. Ltd., New Delhi, (2003).
5. Spectroscopy of Organic compounds – P.S. Kalsi, New Age International Publications, New Delhi (6th Edn.), 2007.

Course Outcomes:

1.	Capable to predict the structure of simple compounds
2.	Helps in scientific career

Course Title: BIOANALYTICAL TECHNIQUES	Course code: OET 32
Total Contact Hours: 30	**Course Credits: 02**
Formative Assessment Marks: 10	**Duration of ESA/Exam: 2h**
Summative Assessment Marks: 40	

Course Objectives:

1.	Study the basics principles of separation techniques
2.	Understand the importance of separation techniques for qualitative and quantitative analysis
3.	Learn the principle and applications of basic spectroscopic techniques

Unit	Description	Hours
1	**Distillation:** Importance, Principle, methodology, distillation of high boiling solvents, applications **Filtration:** Principle, methodology and application **Crystallization:**Principle, methodology and application **Ultracentrifugation:** Principle, sedimentation constant, sedimentation equilibrium, sedimentation velocity, methodology and applications. **Solvent extraction:** Principle, Distribution law, types, methodology, application for the extraction of Fe, Cu **Thin layer Chromatography:** Principle, methodology, RF value, application in identification and monitoring of the reaction **Electrophoresis:** types, the basic of electrophoretic separations, migration rates and plate heights, electro osmotic flow, instrumentation, capillary zone electrophoresis, capillary gel electrophoresis, capillary isolectrophoresis	15

2	**Column chromatography:** Principle, methodology, application in identification and monitoring of the reaction **Gas chromatography:** Mobile phase, stationary phase**,** Principle, Components and instrumentation, applications in the analysis of volatile compounds**,** Assay **High Performance liquid chromatography:** Principle, Components and instrumentation, applications in the analysis of volatile compounds**,** Assay and purity **UV-Vis-Spectroscopy**: Principle, Instrumentation and applications for determination of composition of metal to ligand; metal ions like Fe, Ti and biological samples **FTIR spectroscopy**: Principle, sample preparation, Instrumentation and applications for determination of functional groups of hydrocarbons, alcohols, carbonyl compounds, amines, etc	15

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York, (2005).
2. Analytical Chemistry, G.D. Christian, 5th ed, John Wiley & Sons, Inc, India (2001).
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, prentice Hall, Inc. New Delhi, (1993).
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint. Pearson Education Pvt. Ltd., New Delhi, (2003).

Course Outcomes:

1.	Capable to separate the simple products in a mixture
2.	Able to adopt the skills of separation

Course Title: INORGANIC CHEMISTRY PRACTICALS-III	**Course Code: HCP31**
Teaching Hours/Week (L-T-P): 0 - 0 - 4	**No. of Credits:** 02
Internal Assessment: 10 Marks	**Semester End Examination:** 40 Marks

Course objectives:

1.	To acquint with the analysis of industrial samples
2.	Hands-on training for the colorimetric analysis of the samples.
3.	Acquire knowledge o the analsis of natural samples.

List of Experiments: **60 hrs**

1.	Analysis of solder.
2.	Analysis of copper- nickel alloy.
3.	Analysis of pyrolusite ore.
4.	Analysis of steel
5.	Estimation of Iron content in Heamatite
6.	Estimation of Calcium and Magnesium by complexometric titrations
7.	Colorimetric determination of Fe, Ti and V

References:

1.	Vogel's Text book of Quantitative Inorganic Analysis – J.Basett, R.C.Denney, G.H.Jeffery and J.Mendhaman, Longamans Green and Company Ltd.
2.	Practical Inorganic Chemistry-G.Pass and H.Sutchliff
3.	General Chemistry Experiment- A.J.Elias
4.	Practical Inorganic Chemistry, G. Marr and B. W. Rockett, VonNostrand Reinhold Co., London 1972.

Course outcomes:

1.	Evaluate the industrial products for quantitative analysis
2.	Capable to perform spectrophotometric analysis

Course Title: PHYSICAL CHEMISTRY PRACTICALS-III	Course Code: HCP32
Teaching Hours/Week (L-T-P): 0 - 0 - 4	**No. of Credits:** 02
Internal Assessment: 10 Marks	**Semester End Examination:** 40 Marks

Course objectives:

1.	To acquint with the conductometric and potentiometric titrations
2.	Study of kinetics, phase diagram, etc
3.	Gain knowledge on the surface tension.

List of Experiments:

1.	Effect of added salt (Uni-Uni and Bi-Bi salts.
2.	Determination of rate constant and order of reaction between $K_2S_2O_8$ and KI
3.	Determination of equilibrium constant of reaction between KI + I_2 = KI_3 by distribution method.
4.	Kinetic study of iodination of an acetone
5.	Study of kinetics of inversion of cane sugar by Polarimetry
6.	Phase diagram of three component system.
7.	Titration of p-Toludine against HCI by conductometry.
8.	Determination of end point of some typical titrations. (Precipitation & replacement) conductometrycally.
9.	Potentiometric titration of o-phosphoric acid against alkalies NaOH.
10.	Potentiometric titration of halide mixture against $AgNO_3$.
11.	Titration of mixture of HCl, AcOH ,$CuSO_4$ against conductometrycally
12.	Determination of equivalent conductance at infinite dilution of a strong electrolyte and verification of Onsgars law.
13.	Potentiometric titration of $Pb(NO_3)_2$ vs EDTA
14.	Potentiometric titration of mixture of weak acids, HCOOH, CH+COOH, $ClCH_2COOH$ Vs NaOH Estimation of metal ions solution by plarographic method.
15.	Determination of surface tension.

References:

1.	Fridley's Practical Physical Chemistry- B.P.levitt.
2.	Advanced Practical Physical Chemistry- G.B.Yadav

3.	Experiments Practical Physical Chemistry- Shomaker
4.	Systematic experimental Physical Chemistry- S.W.Rajbhoj & T.K.Chondeker
5.	Senior Physical Chemistry Practical- Kholsa et.al

Course outcomes:

1.	Evaluate the conductometric and potentiometric titrations
2.	Capable to perform kinetics of reactions

Course Title: ORGANIC CHEMISTRY PRACTICALS-III	Course Code: SCP31
Teaching Hours/Week (L-T-P): 0 - 0 - 4	**No. of Credits:** 02
Internal Assessment: 10 Marks	**Semester End Examination:** 40 Marks

Course objectives:

1.	To acquint with the analysis of industrial samples
2.	Hands-on training for the colorimetric analysis of the samples.
3.	Acquire knowledge on synthetic principles of simple organic compounds

List of Experiments:

I. Preparation of dyes and drug	
1.	Preparation of Methyl Orange
2.	Preparation of Fluorescein
3.	Synthesis of Crystal violet
4.	Synthesis of Phenolphthalein
5.	Preparation of paracetamol (acetaminophen)
6.	Preparation of phenacetin
7.	Synthesis of Sulfanilamide
8.	Synthesis of Antipyrine
9.	Synthesis of Aspirin
II. Estimations	
1.	Estimation of Cholesterol by Colorimetry.
2.	Estimation of Amino acids by Colorimetry.
3.	Estimation of Proteins by Colorimetry.
4.	Estimation of Carbohydrates by Colorimetry.
5.	Iodine value of fat or oils
6.	Estimation of Aspirin by titration

References:

1.	Advanced Practical Organic Chemistry N K Vishnoi Second edition, Vikas Publishing House Pvt. Ltd, 1996
2.	Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis Renu Aggarwal
3.	Systematic Laboratory Experiments in Organic Chemistry Arun Sethi, New Age International, 2003.
4.	Comprehensive Practical Organic Chemistry: Qualitative Analysis Ahluwalia V.K. Sunitha Dhingra
5.	Practical Organic Chemistry: Qualitative Analysis Bhutani S.P. Chhikara A, First edition, ANE books-new Delhi, 2009
6.	Vogel's Textbook of Practical Organic Chemistry Brian S. Furniss, 5th Edition, Pearson India, 2005.
7.	Laboratory techniques in Organic chemistry, V.K. Ahluwalia , Pooja Bhagat & Renu Aggarwal, I.K. International Publishing House Pvt. Ltd.
8.	Laboratory Manual of Organic Chemistry Raj K. Bansal. 5th edition, New Age international, 2008
9.	Practical Organic Chemistry F.G. Mann, B.C Saunders, Fourth edition, Pearson India, 2009.

Course outcomes:

1.	Evaluate the industrial products for quantitative analysis
2.	Capable to perform spectrophotometric analysis

M.SC. CHEMISTRY FOURTH SEMESTER

Course Title: NATURAL PRODUCTS	**Course Code: HCT41**
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To understand the properties and composition of natural products
2.	To gain knowledge and importance of natural products.
3	To acquire knowledge on properties of natural products

Unit	Description	Hours
01	**CHEMISTRY OF NATURAL PRODUCTS-I:** **Carbohydrates:** Classification of carbohydrates, D,L-notations, configuration and conformations of carbohydrates. redox reactions of monosaccharides, osazone formation, chain elongation (Kiliani-Fischer synthesis), chain shortening (Ruff degradation), cyclic structure of monosaccharides (hemiacetal formartion), stability of glucose, acylation and alkylation of monosaccharides, formation of glycosides, anomeric effect, reducing and non-reducing sugars. Disaccharides- structural elucidation of sucrose, cellobiose, maltose and lactose, Polysaccharides- structural elucidation of cellulose, starch (amylose and amylopectin) and glycogen.	15hrs
02	**Amino acids and Proteins: Amino acids:** Classification and nomenclature of amino acids, general properties and reactions of amino acids, configuration of amino acids. General methods of synthesis of amino acids – Amination of α-haloacids, Gabriel's phthalimide synthesis, Strecker synthesis, Malonic ester synthesis, Darapsky synthesis, Azlactone synthesis. **Proteins:** Structure and nomenclature of peptides and proteins, automated solid phase peptide synthesis (Bruce-Merrifield synthesis), cleavage of disulphide linkages, determination of amino acid composition, sequencing the peptide from N-terminus (Edman degradation) and C-terminus, determination of structure of proteins (primary, secondary and tertiary structures).	15hrs

	Nucleic acids: Classification of nucleic acids, structure of nucleosides and nucleosides containing pyrimidine and purine bases, sequence of nucleic acids, Crick-Watson model of DNA, structure of RNA (m-RNA, t-RNA and r-RNA), genetic code – salient features.	
03	**Chemistry of natural products – II** **Alkaloids**: Introduction, occurrence, nomenclature, classification, isolation, properties determination of molecular structure. Synthesis and structural elucidation of Papaverine and Reserpine. Synthesis of ephedrine, hygrine, nicotine and nicotinic acid. **Terpenoids:** Introduction, occurrence, classification, isolation, general characteristics, isoprene rule. Synthesis and structural elucidation of Citral and α-Pinene. **Vitamins:** Classification, nomenclature, biological functions, isolation, structure, biological importance and co-enzymes of Vitamin-B_1, B_2, B_3, B_6, B_{12}, Folic acid (Folate), Vitamin-A., A_1, A_2, Vitamin-E, Vitamin-C, Nicotinic acid and Nicotinamide.	15hrs
04	**Lipids:** Introduction, simple lipids (fats, oils, waxes), compound lipids, phospholipids (Lecithins, Cephalins, Plasmalogens, Sphingomyelins), glycolipids, galactolipids. **Steroids:** Introduction, Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon, Sterols – Cholesterol, Lanosterol, Ergosterol, Stigmasterol (elementary account). Structural analysis of Cholesterol (structure of nucleus, position of double bond and hydroxyl group, nature and position of side chain, position of angular methyl group). Stereochemistry and structural elucidation of Androsterone, Testosterone, Estrone, Progestrone, Aldosterone.	15hrs

References:

1. **Organic Chemistry,** Solomons, Fryhle, 8th Edition (Wiley Student Edition), Brijbasi Art Press Ltd., Noida, India 2004.
2. **Organic Chemistry**, G. Marc Loudon, 4th Edition, Oxford University Press, UK, 2000.
3. **Organic Chemistry,** R.T. Morrison, R.N. Boyd, 6th Edition, Pearson Education (Singapore Pvt. Ltd.), Delhi, Indian, 2005.
4. **Organic Chemistry**, L.G. Wade, JR., 5th Edition, Pearson Education (Singapore Pvt. Ltd.), Delhi, Indian, 2004.
5. **Organic Chemistry**, M.A. Fox, J.K. Whitesell, 2nd Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts, London, 1997.
6. **Organic Chemistry**, M. Jones, Jr., 2nd Edition, W.W. Norton and Company, New York, 2000.
7. **Organic Chemistry,** Francis A. Carey, 5th Edition, Tata McGraw-Hill Publishing

Company Ltd., New Delhi, 2004.
8. **Organic Chemistry,** I.L. Finar, 5th Edition (Volume-2), Pearson Education, New Delhi, India, 2009.
9. O**rganic Chemistry of Natural products**, Gurudeep R. Chatwal, (Edited by M. Arora), Vol. 2, Himalaya Publishing House, Mumbai, India, 2008.
10. **Organic Chemistry – Natural Products**, O.P. Agarwal, Vol. I, GOEL Publishing House, Meerut, India, 2003.
11. **Organic Chemistry – Natural Products**, O.P. Agarwal, Vol. II, GOEL Publishing House, Meerut, India, 2004.
12. Introduction to Alkaloids – G.A. Swan
13. The Alkaloids - K.W. Bently
14. Steroids – L. Fiescher and M. Fischer
15. Steroids – Shoppe
16. Chemistry of Natural Products by Sujata V. Bhat, Bhimsen A. Nagasampagi, Meenakshi Sivakumar
17. Organic Chemistry 2nd Edition, Nick Greeves), Stuart Warren , Jonathan Clayden

Course outcomes:

1.	Able to comment on natural products
2.	Predict the properties and applications of natural products

Course Title: SPECTROSCOPY AND CHROMATOGRAPHY	**Course Code: HCT42**
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To understand the concept of advanced spectroscopic techniques
2.	To gain knowledge and applications of spectroscopic techniques applied to inorganic chemistry.
3.	To gain theoretical knowledge abt spectroscopic techniques

Unit	Description	Hours
01	**Mossbauer Spectroscopy:** Basic principle, spectral parameters, spectral display. Doppler Effect, Zeeman splitting, isomer shift, Quadrupole splitting, magnetic interaction. Mossbauer spectrometers, components. Applications of Mossbauer techniques to the studies of (i) Bonding and Structure of Fe+2 and Fe+3 compounds (ii) Detection of oxidation states. **NQR Spectroscopy**: Consequence of nuclear spin larger than ½, prolate and oblate nucleus, nuclear Quadra polar charge distribution-theory and instrumentation, relationship between electric field gradients and molecular structure, applications and interaction of eQq data. Effect of crystal lattice on the magnitude of eQq. Structural information from NQR spectra. **Electron Spin Resonance Spectroscopy:** Basic principles, zero field splitting, Kramer's degeneracy, factors affecting g-values. Interpretation of g-values. Isotopic and anisotropic hyperfine coupling constants. Spin Hamiltonian, spin densities and Mc Connel relationship. Measurement techniques. ESR spin – orbit coupling and significance of g tensors application to first row transition metal complexes.	15hrs
02	**Turbidimetry and Nephelometry:** Tyndall, Rayleigh and Raman Scattering,Factors Influencing Turbidity Measurements, Particle size distribution and shape, Effect of temperature, pH, and sample composition Principles, Instrumentation and Turbidity and nephelometry in assessing water quality, Quality control in beverage and pharmaceutical industries, Monitoring suspended solids in industrial processes. **Fluorimetery and Phosphorimetry:** Principles, laws governing; Instrumentation, quantitative analysis, application in real sample analysis (e.g. in environment, biology, medicine, rock, minerals, etc.) Fluorescent	15hrs

	Probes and Labels, Fluorescence Lifetime and Quantum Yield, Quenching and Stern-Volmer Equation, **Chemiluminesescence Methods:** Principle, Apparatus, Quantitative, Chemiluminescence - Gas phase and liquid phase chemiluminescent analysis andtitrations. **Optical Rotator Dispersion and Circular Dichroism**: Rotatory dispersion, instrumentation for ORD and CD, Cotton effect, Anomalous ORD curves, Octant rule, applications of Octant rule, applications of ORD and CD.	
03	**Ultracentrifugation:** Principle, sedimentation constant, sedimentation equilibrium, sedimentation velocity, methodology and applications. **Electrophoresis:** Overview, types, the basic of electrophoretic separations, migration rates and plate heights, electro osmotic flow, instrumentation, capillary zone electrophoresis, capillary gel electrophoresis, capillary isolectrophoresis, capillary isoelectric focusing. **Capillary Electrochromatography:** Packed column Electrochromatography, micellar electro kinetic electro chromatography, capillary electro chromatography and applications. **Supercritical fluid chromatography:** Properties of supercritical fluids, instrumentation and operating variables, comparison of supercritical to other types of chromatography, applications. **Supercritical fluid extraction:** Advantages of supercritical fluid extraction, instrumentation, supercritical fluid choice, off-line and on-line extractions, typical application of supercritical fluid extraction.	15hrs
04	**X-ray Absorption Spectroscopy (XAS):** X-ray production and measurement, Principle of XAS, Instrumentation and applications. **X-ray diffraction:** Crystal systems, crystallographic axes and angles, nomenclature and point groups. Space lattice, Reciprocal lattice, Bravis lattice, Unit cell, Weiss indices, Miller indices, Bragg's equation, Single crystal rotation methods, Powder methods analytical procedures for powder diffraction analysis, structure factor. Fourier series, Fourier refinement. Phase problem. **Electron diffraction:** Introduction, Scattering intensity versus scattering angle, Wierl's equation, Radial distribution function, Refinement radial distribution function, Rotation sector method. **Neutron diffraction:** Introduction, Scattering of neutrons by solids and liquids. Difference between neutron and X-ray diffraction. **Photoelectron Spectroscopy**: Basic principles, photo-electric effect, ionization process, Koopman's theorem. Photoelectron spectra of simple molecules, chemical information from ESCA, instrumentation and applications. Auger electron spectroscopy principles, instrumentation and applications.	15hrs
References:		

1. Standard Methods of chemical Analysis. A. J. Welcher (part B), Robert E.Kriegor Publishing Co. USA, 1975.
2. Qualitative inorganic analysis by A. I. Vogel.
3. Chemical analysis of terms and nonferrous and foundry materials. Westword and Mayar.
4. Chemical methods of analysis. Snell and Snell.
5. A text book of inorganic analysis. A.I.Vogel.
6. Laboratory manual for Environmental chemistry. SunitaHooda&Sumanjeet Kaur.
7. Analytical Chemistry. Dr. ALKA L. GUPTA apragati edition.
8. Applied Chemistry theory and practice second edition. O. P. Vermani. A. K. Narula.
9. Principles of Photoelectron Spectroscopy" by R.M. Silverstein and G.C. Bassler
10. "Introduction to Surface Chemistry and Catalysis" by Gabor A. Somorjai
11. "Modern Photoelectron Spectroscopy" by J.C. Hance and J.P. Desvergne
12. "Electron Spectroscopy: Theory, Techniques, and Applications" by Petr Carsky and Karel Tsuji
13. "Photoelectron and Auger Spectroscopy" by J. H. D. Eland
14. "Introduction to Modern X-ray Spectrometry" by Ron Jenkins
15. "Introduction to Synchrotron Radiation" by Philip Willmott and Clemens Heske
16. "Electron Spectroscopies Applied to Low-Dimensional Structures" by Claudio L. Bianchi and P. Rudolf
17. "Angle-Resolved Photoemission Spectroscopy on High-Temperature Superconductors: Studies of Bi2212 and Single-Layer FeSe Film Grown on SrTiO3 Substrate" by Takayoshi Yokoya
18. "Handbook of X-ray Photoelectron Spectroscopy" by John F. Moulder, William F. Stickle, and Peter E. Sobol.
19. Fundamentals of Molecular Spectroscopy- CN Banwell& Mc Cash

Course outcomes:

1.	Apply spectroscopic techniques for qualitative and quantitative analysis
2.	Predict the structure and properties
3.	Apply for structural characterization

Course Title: ADVANCED CONCEPTS IN PHYSICAL CHEMISTRY	Course Code: HCT 43
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	Understand the advanced concepts of electrochemistry and photochemistry
2.	Gain knowledge in applied aspects of nanomaterials and polymers
3.	Acquint with the theoretical aspects of spectroscopy

Unit	Description	Hours
01	**Electrochemistry and Photochemistry:** Ion-solvent interaction, Born model, solvation number and their determination, over voltage, Decomposition potential, Butler-Volmer equation, Taffel equation, Factors important in elucidating electrode reaction and some electrochemical systems of technological importance, Electroplating. Electrochemical energy systems: Introduction, fundamentals of batteries, primary and secondary batteries, fuel cells, types of fuel cells, Interaction of radiation with matter, review of laws of photochemistry, Jablonski's diagram, radiative and non-radiative processes. Stern – Volmer equation, photophysical kinetics of uni and bimolecular processes. Photolysis of water. Theories of Fluorescence, Phosphoroscence and Bioluminescence.	
02	**Chemistry of nanomaterials**: General introduction to nanomaterials,synthesis and applications of nanoparticles of gold, silver, rhodium, palladium and platinum,synthesis and applications of metal oxides of transition and non-transition elements-SiO_2, TiO_2, ZnO, Al_2O_3, iron oxides and mixed metal oxide nanomaterials, non-oxide inorganic naomaterials, porous silicon nanomaterials- fabrication and chemical and biological sensing applications. **Characterization of Nanomaterials**: UV-visible, Raman, XRD, SEM, TEM and AFM techniques.	
03	**Molecular Spectroscopy:** Characterization of electromagnetic radiation, quantization of energy levels, rotational spectroscopy, classification of molecules based on their moment of inertia, rotation of rigid diatomic molecules and non rigid diatomic molecules and rotational energy levels. Infrared Spectra: Vibration of diatomic molecule, simple harmonic oscillator model, vibrational energy levels and vibrational spectra, The	

	anharmonic oscillator model, fundamental bands, overtones and hot bands. Vibrational and rotational spectra of diatomic and polyatomic molecules and its applications to CO, CO_2 and H_2O molecules. Overtones and combination frequencies PQR branches, Born-Oppenheimer approximation. Electronic spectra of diatomic molecules, Electron transition in diatomic molecule V` and V`` progressions. Frank-Condon principle, rotational fine structure of electronic vibrations Fortrate diagrams and pre dissociation. Raman Spectroscopy: Introduction, stokes and anti stokes lines, classical and quantum theory of Raman Effect, Raman activity of vibration, rotational and vibrational Raman spectra, mutual exclusion principle, Resonance Raman Spectroscopy.	
04	**Polymer Science and Technology:** Determination of molecular weight by end group analysis and GPC method, determination of chain dimension from light scattering technique. Understanding of thermo mechanical behavior from TMA and DMA techniques.Physical properties v/s applications: plastic, fibers, elastomers, and additives. Swelling of polymers, stress strain behavior, viscoelastic behavior and elastomers. Conduction polymers: synthesis through chemical oxidation understanding of structure and properties of polyaniline, polypyrrole and polythiophene,	

References:

1. Modern aspects of electrochemistry Vol-I & Vol-II- J.O.M.Bockris & A.K.N Reddy
2. Electrochemistry by Glasstone
3. Heterogeneous catalysis- G.C.Bond
4. The basic applications of heterogeneous catalysis- Michael Bowker.
5. Fundamentals of Molecular Spectroscopy- CN Banwell & Mc Cash
6. Introduction to molecular Spectroscopy- G.M.barrow
7. Polymer Chemistry- Billayer
8. Polymer Chemistry- P.J.Flory
9. Physical chemistry of macromolecules by D.D.Deshpande
10. Polymer Science- Gowarikar
11. Physical chemistry- P.W. Atkins
12. Chemical Kinetics- Laidler

Course outcomes:

1.	Skilled with applied aspects of electrochemical systems
2.	Apply the advanced aspects of physical chemistry
3.	Apply theoretical knowledge of spectroscopy and nanomaterials

Course Title: SELECTED TOPICS IN INORGANIC CHEMISTRY	Course Code: SCT41
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To gain information on biological processes, solid state chemistry, photochemistry.
2.	To understand the advanced concepts of inorganic chemistry
	To understand te biological processes

Unit	Description	Hours
01	**Bioinorganic Chemistry-II** Transport and storage of dioxygen, heme proteins, oxygen uptake, functions of haemoglobin, myoglobin, hemerythrin and hemocyanins, synthetic oxygen carriers. Metal storage and transport: Ferritin, transferrin and ceruloplasmin. Electron transfer proteins: Cytochromes, iron-sulphur proteins. Metalloproteins as enzymes: Carboxy peptidase, carbonic anhydrase, catalases, peroxidases, cytochrome P-450, cytochrome coxidase, superoxide dismutase, copper oxidases and vitamin B12 coenzyme. Biological nitrogen fixation, in vivo and in vitro nitrogen fixation	15hrs
02	**Photo inorganic chemistry:** Photochemical Reactions: Prompt and delayed reactions, quantum yield, laws of photochemistry, recapitulation of fluorescence and phosphorescence, d-d and charge transfer reactions. Excited states of metal complexes, energy transfer under conditions of weak interaction and strong interaction, exciplex formation. Conditions of the excited states to be useful as redox reactants: Photosubstitution, photooxidation, photoreduction and photochemical reactions of transition metal complexes including $[Ru(bipy)_3]^{2+}$ and $[Fe(bipy)_3]^{2+.}$ Application to photovoltaics: Water photolysis and carbon dioxide reduction. Solar energy conversion and storage.	15hrs
03	**Metal Clusters:** Metal π-acceptor complexes: Metal carbonyls, preparative methods, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, magnetic and X-ray evidences of structures, MO representation of bi and tri-nuclear carbonyls, reactions of metal carbonyls. Metal carbonylates and carbonyl halides: Preparation and important reactions. Chemistry of metal nitrosyls: Preparation, structure and bonding, dinitrogen and dioxygen complexes. Metal-metal bonding in	15hrs

	carbonyls and halides, evidences for M-M bonding, factors favouring M-M bond formation. Metal clusters: Bi-, tri-, tetra-, penta- and hexanuclear metal clusters and bonding in metal clusters.	
04	**Solid State Chemistry:** Crystal lattice: Unit Cell, Miller indices and planes, X-ray diffraction method, molecular solids, hydrogen bonding, metallic, covalent and ionic solids; structural classification of binary and tertiary compounds, determination simple structure, spinel and perosvskite structures. Band theory, conductors, semiconductors and insulators, energy bands, intrinsic and extrinsic semiconductors. Perfect and imperfect crystals, intrinsic and extrinsic defects, point-, line- and plane- defects. Vacancy, Schottky and Frenkel defects. Schottky and Frenkel defect formation, colour centres, non-stoichiometry.	15hrs

References:

1. Inorganic Chemistry Principles of Structure and Reactivity, 4thEdn-J. E. Huheey, E.A. Keiter, R. L. Keiter and O.K. Medhi. Pearson Education (2009).
2. Shriver & Atkins' Inorganic Chemistry, 5th Edn-P. Atkins, Tina Overton, J. Rourke, Mark Weller and F. Armstrong.Oxford University Press (2010)
3. Inorganic Chemistry, 2nd Edn. Catherine E. Housecroft and A.G. Sharpe, Pearson Prentice Hall (2005)
4. Concise Inorganic Chemistry-J. D. Lee, 5th Edn, New Age International (1996).
5. Solid State Chemistry and its Applications-A. R. West, John-Wiley and sons.
6. Solid state Chemistry-N. B. Hannay, Prentice-Hall of India Pvt. Ltd. New Delhi.

Course outcomes:

1.	Apply the advanced topics in various processes
2.	Predict the importance of biological processes and solid state chemistry in different fields.

Course Title: INORGANIC INDUSTRIAL MATERIALS	Course Code: SCT42
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To gain information on various inorganic materials used routinely.
2.	To understand the preparation and properties of these materials
3.	To learn the properties and applications of inorganic systems

Unit	Description	Hours
01	**Refractories and Allied Materials** Ceramics: Classification and general properties of ceramics, basic raw materials, chemical conversions, manufacturing process, white wares and porcelain – manufacturing process. Industrial carbon, Lampblack, carbon black, activated carbon, natural graphite, manufactured graphite and carbon, Industrial diamonds. Refractories: Classification, properties and manufacture of refractories, vitreous – enamel, raw materials, manufacture of enamel glass and application of enamel.	15hrs
02	**Glass and Cement** Glass: Commercial glass, composition of glass, Properties of glass, raw materials and met hods of manufacturing of some special glasses. Portland cement: Types, raw materials, manufacture and process of Portland cement, Setting and hardening of cement, Other cements, gypsum, calcium and magnesium compounds. Chlor-alkali Industries: Manufacture of soda ash, sodium bicarbonate, chlorine and caustic soda, Bleachng powder, calcium and sodium hypochlorites, sodium chlorite	15hrs
03	**Metallurgy of Cu, Fe and Steel** Copper– occurrence, extraction, hydrometallurgy and pyrometallurgical methods, refining of copper-electrolytic, alloys of copper – brass, German silver, bell metal and bronzes. Iron – Raw materials, manufacture of pig iron, cast iron and wrought iron. Steel – manufacture steel by different methods Extraction and refining of zinc and nickel, extraction of Magnesium.	15hrs
04	**Fuels and Petroleum Products** Fuels – essential requirements of fuels, modern concept of fuels, origin, classification and selection of solid, liquid and gaseous fuels. Coal – composition and carbonization of coal, proximate and ultimate analysis of coal – moisture, ash, crude, proteins, calcium, potassium,	15hrs

	sulphur and phosphorus. Analysis of petrol and petroleum products – flash point, fire point, cloud point, pour point, aniline point, viscosity, specific gravity and vapour pressure.Detection and estimation of lead an antiknock compound in gasoline and sulphur in petroleum products.	

References:

1. Industrial Chemistry – B.K. Sharma, Goel publishing House, Meerut, 2010
2. Standard Methods of Chemical Analysis – F.J. Welcher, 6th Edn. Vol.3, Part-B, D. Van Nostrand Company, Inc.,
3.Petrochemical Industries – A.V.C. Hann,
4. Roger's Manual of Industrial Chemistry Furnas, Vol. I & II.
5. Engineering Chemistry – P.C. Jain and M.Jain.
6. Shreve's Chemical Process Industries, George T Austin, 5th Ed., McGraw-Hill,

Course outcomes:

1.	Apply the knowledge in the synthesis and characterization of various routine materials
2.	Predict the properties and improve their characteristics

Course Title: ENERGY AND INDUSTRIAL INORGANIC CHEMISTRY	Course Code: SCT43
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 20 Marks	**Semester End Examination:** 80 Marks

Course objectives:

1.	To gain information on various inorganic materials in energy applications.
2.	To understand the properties of these materials and applications
3.	Make an attempt to know the importance of renewable energy systems

Unit	Description	Hours
01	**Renewable energy sources** Introduction: Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India. Energy from Sun: Sun- earth Geometric Relationship, Layer of the Sun, Earth – Sun Angles and their Relationships, Solar Energy Reaching the Earth's Surface, Solar Thermal Energy Applications Solar Thermal Energy Collectors: Types of Solar Collectors, Configurations of Certain Practical Solar Thermal Collectors, Material Aspects of Solar Collectors, Concentrating Collectors, Parabolic Dish – Stirling Engine System, Working of Stirling or Brayton Heat Engine, Solar Collector Systems into Building Services, Solar Water Heating Systems, Passive Solar Water Heating Systems, Applications of Solar Water Heating Systems, Active Solar Space Cooling, Solar Air Heating, Solar Dryers, Crop Drying, Space Cooing, Solar Cookers, Solar pond.	15hrs
02	**High energy materials** High efficiency solar cells, PERL Si solar cell, high efficiency solar cells, GaAs solar cells, tandem and multi-junction solar cells, solar PV concentrator cells and systems, III-V, II-VI thin- film solar cells (GaAs, Cu(In,Ga)Se2, CdTe) Nano-, micro- and poly-crystalline Si for solar cells, mono-micro silicon composite structure, crystalline silicon deposition techniques, material and solar cell characterization, advanced solar cell concepts and technologies (Porous Si layer transfer, Metal induced crystallization, etc.). Basic of electrochemical energy devices; mechanism and materials for different types of batteries, supercapacitor and hybrid; fuel cells	15hrs

	(Polymer membranes for fuel cells, PEM fuel cell, Acid/alkaline fuel cells.), electrochemical and photoelectrochemical water splitting. Details of Pb-acid Nickel-metal hydride (Ni-MH), NiCd-alkaline battery, Ni-iron, Li/Na-ion, Mg-ion, Li/Na-S batteries.	
03	**Electrometallurgy** Introduction to Electrometallurgy, Electrochemical principles and basic concepts,Important milestones in the development of electrometallurgy, Conductivity,Electrolytic conduction, Molar conductivity, Transport numbers, Chemical changesin electrolysis, Examples of electrolysis, Electrode reactions, Stoichiometry ofelectrolysis (Faraday's Laws), Technological applications; Leaching,Precipitation, Metal extraction and refining, Electrorefining and Electrowinning ofmetals, Fused salt electrolysis of aluminium and magnesium, Electroplating,Electroforming, Electrochemical polishing, Batteries, Fuel cells.	15hrs
04	**Fertilizer Industries** Production aspects of the following; Phosphate rock, superphosphate, phosphoric acid, phosphates, baking powders, fire retardant chemicals. Potassium chloride, sulphate, bisulphate, hydroxide, carbonate, acid tartarate, permanganate and dichromate.Synthetic ammonia, ammonium nitrate, sulphates, phosphates, urea, nitric acid, cyanamide.	15hrs

References:
1. . Lancaster, M. Green Chemistry: An Introductory Text, Third Edition; RSC Publishing; 2 016. ISBN: 978-1-78262-294-9
2. Supramolecular Chemistry: from Molecules to Nanomaterials Eds. by P.A. Gale and J.W. Steed (2012).
3. Modern Supramolecular Chemistry by F. Diederich, P. J. Stang, R. T. Tykwinski (2008). . Page 20 of 21
4. Core Concepts in Supramolecular Chemistry and Nanochemistry by J. W. Steed, D. R. Turner, K. J. Wallace (2007).
5. Supramolecular Chemistry by J.W. Steed and J.L. Atwood (2011).
6. Supramolecular Chemistry: Concepts and Perspectives by J.-M. Lehn, Wiley VCH, Weinheim (1995).
7. Supramolecular Chemistry by V. Balzani (Editor), L. De Cola, Kluwer, Dordrecht (1992).
8. Introduction to Supramolecular Chemistry by H. Dodziuk, Kluwer Academic Publishers, The Netherlands (2002).
9. Supramolecular Assemblies Y. Murakami (Editor), Mita Press, Tokyo, (1990).
10. Advances in Supramolecular Chemistry, Vol 1 (1990), Vol 2 (1992), Vol 3 (1993) by G. W. Gokel (Editor), JAI Press, Greenwich.
11. Supramolecular Chemistry – Fundamentals and Applications. Advanced Textbook by T. Kunitake, K Ariga, Berlin: Springer-Verlag Heidelberg, 2006. 208 p. ISBN 978-3-54001298-6.
12. C. Brechignac, P. Houdy, M. Lahmani, "Nanomaterials and Nanochemistry", Springer publication 2007.
13. Kenneth J. Klabunde, "Nanscale materials in chemistry", Wiley Interscience Publications 2001.
14. C. N. Rao, A. Muller, A. K. Cheetham ,"Nanomaterials chemistry", Wiley-VCH 2007.

Course outcomes:

1.	Apply the knowledge in the s characterization and application to energy sector
2.	Predict the properties and improve their characteristics

Course Title: SPECTRAL DATA INTERPRETATION	Course code: HCP41
Total Contact Hours: 60	**Course Credits: 02**
Formative Assessment Marks: 10	**Duration of ESA/Exam: 4h**
Summative Assessment Marks: 40	

Course Objectives:

1.	Practical approach for the interpretation of spectra of organic and inorganic compounds**.**
2.	Train to predict the structure of compounds using spectral data

SL No	List of experiments	Hours
1	a. Preparation and Spectral analysis of few complexes and organic compounds (UV- Visible, IR, TGA). b. Interpretation of Spectral data (UV-Vis, IR, NMR,& Mass)	60

References:

1. Vogel's Qualitative analysis, G Svehla and Sivasankar, Pearson press, 7th Ed 2012
2. Vogel's Textbook of Quantitative Chemical analysis, Mendham, Denney, Barnes, Thomas, Sivasankar, 6th Ed, Pearson publishers, 2009
3. A text book of quantitative inorganic analysis- A.I.Vogel, 3rd edition, 1966.
4. Vogel's text book of quantitative chemical analysis – J.Basset, R.C.Denney, G. H. Jeffere and J. Mendhom, 5th edition, 1989.
5. Vogel's Qualitative Inorganic Analysis, revised, G. Svehla, Longman, 7th Ed, 1996.
6. Practical Inorganic Chemistry, Marr and Rocket, 1972.

Course outcomes:

1.	Able to interpret the spectral data which helps in the structural elucidation of compounds.
2.	It strengthens the spectral analytical knowledge for Research, Industrial and teaching assignments.

Course Title: RESEARCH PROJECT /INTERNSHIP	Course code: HCRP41
Total Contact Hours: 120	Course Credits: 04
Formative Assessment Marks: 20	Duration of ESA/Exam: 4 h
Summative Assessment Marks: 80	

Course Objectives:

1.	Students are exposed to research to motivate them for research career.
2.	Trained for undertaking chemistry project works

SL No	List of experiments	Hours
1	Project work either In-house or Research Institutes as Internship	120

Course Outcomes:

1.	Students gain expertise in research oriented work to develop the research knowledge in the concerned field.
2.	It helps them to work in group as well as develop skills.

QUESTION PAPER PATTERN FOR I-IV SEMESTER CHEMISTRY ANNUAL EXAMINATION

Time Duration: 3 Hrs **Total Marks=80**

Part – A (Compulsory)

Q.1 Ten sub questions carry two mark each. **2X10= 20 marks**.

Part – B

Will consist of six questions with each question containing sub-divisions a, b, & c. Each question carries 15 marks, and the subdivisions can be either having marks 5+5+5=15 or 4+5+6=15. Out of six main questions students have to answer full four main questions.

Q.2 to Q.5 (Q.2-Unit-I, Q.3-Unit-II, Q.4-Unit-III, Q.5-Unit-IV)
Q.6- Unit I and Unit-II,
Q.7- Unit-III and Unit-IV.

15X4=60 marks

M.Sc. I/II/III/IV Semester Examination, Month and Year

CHEMSITRY

(New Syllabus 2023-24)

Paper and Code:

Time: 3 hrs **Max. Marks: 80**

Instructions: 1. All the questions in Part A are compulsory.

2. Answer any 4 questions from Part B.

PART-A

1. Answer all the following questions: 2x10=20 Marks

a.
b.
c.
d.
e.
f.
g.
h.
i.
j.

(Question No 1 shall contain atleast two questions from each unit and at the maximum of three questions from a unit)

PART-B 4X15=60 Marks

2. a.
b.
c.

(Question No 2 shall contain 3 subdivisions from Unit –I of either 5 marks each or 4+5+6 pattern)

3. a.
b.
c.

(Question No 3 shall contain 3 subdivisions from Unit –II of either 5 marks each or 4+5+6 pattern)

4. a.
b.
c.

(Question No 4 shall contain 3 subdivisions from Unit –III of either 5 marks each or 4+5+6 pattern)

5. a.
b.

c.

(Question No 5 shall contain 3 subdivisions from Unit –IV of either 5 marks each or 4+5+6 pattern)

6. a.

b.

c.

(Question No 6 shall contain 3 subdivisions from Unit – I and Unit-II of either 5 marks each or 4+5+6 pattern. Atleast one subdivision of the question shall be from each Unit)

7. a.

b.

c.

(Question No 7 shall contain 3 subdivisions from Unit – III and Unit-IV of either 5 marks each or 4+5+6 pattern. Atleast one subdivision of the question shall be from each Unit)

***CHP HCP: 4.7 Project work:**

The project work may include in plant training* in an Industry/Short term work in the department/other educational institutes/R&D organization/Data mining/Review of current literature/Theoretical methods/Computer applications. Experimental work may involve studies on Synthesis/Measurements, Study of properties/Characterization by physico-chemical methods/activities for reported/unreported research or any suitable combination thereof.

Incase of the student who would work outside the campus, the supervising staff members may visit to the work place at least once during the period and may be eligible for TA/DA as per the University rules. The other general academic regulations will be same as laid by University.

Scheme of examination for project work:

Thesis evaluation: 50 marks; Viva-Voce: 30 marks

Scheme for Practical examination:

Viva-voce: 10 Marks; Experiment:30 Marks

DEPARTMENT OF STUDIES IN CHEMISTRY

Panel of Examiners for M. Sc. Chemistry

External Examiners: Inorganic Chemistry/ Analytical Chemistry

1. Dr. K. S. Lokesh Dept of Studies in Chemistry, VSK University, Balalri
2. .Dr. Sadu Suryakanth S, VSK University, PG Center, Balalri
3. Dr. H. D. Revanasiddappa, Dept of Chemistry, Mysore University, Mysore-06
4. Dr. Nagaraja Naik, Dept. of Chemistry, Mysore University, Mysore-06
5. Dr. V. Gayathri, Dept. Of Chemistry, Central College, Bangalore.
7. Dr. M. Pandurangappa, Dept of Chemistry, Central College, Bangalore.
8. Dr. D. K. Koppikar, Dept. of Chemistry, St. Joseph's P. G. Centre, Shanthinagar, Bangaolore-57
9. Dr. N. Nagaraj, Dept. of Chemistry, St. Joseph's P. G. Centre, Shanthingar, Bangalore-57
10. Prof. J Keshavayya, Dept. of Chemistry, Kuvempu University, Shankaraghatta
11. Dr. T. B. Gudasi, Dept. of Chemistry, Karnataka University, Dharwad.
12. Dr. J. Seetharamappa, Dept. of Chemistry, Karnataka University, Dharwad.
13. Dr. K. Sidappa, Dept. of Chemistry, Gulbarga University, Kalburgi.
14. Dr. Abraham Joseph, Calicut University, Kerala.
15. Dr. B. D. Desai, Dept of Chemistry, Goa University, Goa.
16. Dr. Arun Kumar, Dept. of Chemistry, Tumkur University, Tumkur.
17. Dr. Raghavendra, Dept. of Chemistry, Tumkur University, Tumkur.
18. Dr. S. Jagannatha Swamy, Dept of Chemistry Kakathiya University, Warangal A P
19. De. V. Ravidra, Dept of Chemistry Kakathiya University, Warangal A P.
20. Dr. G. Dayakar, Dept of Chemistry Kakathiya University, Warangal A P
21. Prof. K. Veera Reddy, Dept. of Chemistry, Osmania University, Hyderabad, A.P.
22. Prof. A. V. Chandrapal, Dept. of Chemistry, Osmania University, Hyderabad, A.P.
23. Prof. Ravindra Reddy, Dept. of Chemistry, Osmania University, Hyderabad, A.P.
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25. Prof. P. Ramamohan Rao, Dept. of Chemistry, Andhra University, Waltair, A. P.
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27. Dr. N. Venkatasubba Reddy, , Dept. of Chemistry, S. V. University, Tirupati, A P
28. Dr. N Y Sridhar, , Dept. of Chemistry, S. V. University, Tirupati, A P
29. Dr. G. Shiva Reddy, , Dept. of Chemistry, S. V. University, P. G. Centre Cuddappa
30. Prof. B. Shyamasundar, Dept. Chemistry, Nagarjuna University, Guntur, A P
31. Prof. K. Somasekhar Rao, N. U. P. G. Centre Nujvid, A. P. 521201.

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33. Prof. P.N, Bhosle, Dept. of Chemistry, Shivaji University, Kolhapur.
34. Dr. Anushe, Dept. of Chemistry, Shivaji University, Kolhapur.
35. Dr. B. S. Mohite, Dept. of Chemistry, Shivaji University, Kolhapur.
36. Prof. K. Krisnan Kutti, Department of Chemistry, Calicut University, Kerala.
37. Prof. Arvindakshan , Department of Chemistry, Calicut University, Kerala.
38. Dr. K. Manmohan, Department of Chemistry, Kerala University, Trivendram , Kerala.
39. Prof. P. K. Radhakrishnan, Dept. of Chemistry, M. G. University, Kottayam, Kerala.
40. Prof. K. Natarajan, Dept. of Chemistry, Bharatiya University, Coimbatore, T.N.
41. Dr. S. Govindarajan, Dept of Chemistry, Bharatiyar University, Coimbatore T.N.
42. Prof. M. Kandaswamy, Dept. of Chemistry, Madaras University, Chenni T.N.
43. Dr. M. K. Ramamurthy, Dept. of Chemistry, Madaras University, Madaras Chenni T.N.
44. Dr. K. K. M. Tusauff, Cochin University of Sci. & Technology, Kochi, Kerla.
45. Prof. Manwal,Dept. fo Chemistry, Osmania University, Hyderabad.
46. Dr. G. K. Nagaraja, Mangalore University, Konaje.
47. Dr. M. P. Sadashiva, Dept. of Chemistry, Mysore University, Mysore 06.
48. Dr. B. P. Dayananda, Dept. of Chemistry, Maharanis, College, Mysore-06.
49. Dr. S. Manjappa, Dept. of Chemistry, UBDT, Davanagere.
50. Dr. B. Vijaya, Dept. of Chemistry, UBDT, Davanagere
51. Dr. G. Krishanamurthy, Dept. of Chemistry, SSC Shivamoga.
52. Dr. Ahmmadi Khatoon, Yuaraja College, Mysore.
53. Dr. B. C. Chennu, Maharanis College, Mysore.
54. Dr. Deubhange, Dept. of Chemistry, Shivaji University, Kolhapur.
55. Dr. H. S. Bhojya Naik, Dept. of Chemistry, Kuvempu University,
56. Dr. Prabhakar, Sri. S. M. V. College, BDVT
57. Dr. Ullas Shetty, Govt, Science college, Karwar.
58. Dr. Gurubasavaraja, Rani Channamma University, Belagavi.
59. Dr. Ramesh, Tumkur University, Tumkur.
60. Dr. Pramila, Govt. Science College, Hassan
61. Dr. Anitha, SK University, Ananthapuram
62. Dr. Chidanand, Davanger University, Davangere
63. Prof. Nagaswaroop, Davanger University, Davangere
64. Dr. Keerthi Kumar, Davanger University, Davangere
65. Dr. Shivaraj Y, Bangalore University

66. Dr. Sanjay, Mangalore FGC, Mangalore University
67. Prof. Sudhakar Babu, SK University, Anathapur
68. Prof. L. Subramanyam Sarma, Yogi Venama, University, Kadapa
69. Dr. Anjaneyalu, Central University, Kalburgi
70. Prof. Raghavaiah, Central University, Kalburgi
71. Dr. Raghavendra, Tumkur University
72. Dr. Suresh, Tumkur University

External Examiners: Organic Chemistry

1. Dr. Anand soundane, Dept. of Chemistry, Gulbarga University, Kalburgi
2. Dr. S. Hariprasad, Dept. of Chemistry, Central College, Bangalore.
3. Dr. V. V. Suresh Babu, Dept. of Chemistry, Central College, Bangalore.
4. Dr. Y B Basavaraju, Dept. of Chemistry, Mysore University, Mysore.
5. Dr. R. L. Jagadish. Dept. of Polymer Science, P. G. Centre, Mandya.
6. Dr. Bhoja Poojary, Dept. of Chemistry, Mangalore University, Konaje
7. Dr. J. K. Kirthaney, Dept. of Chemistry, Goa University, Goa.
8. Dr. S. P. Kamath, Dept. of Chemistry, Goa University Goa.
9. Prof. Gunasekhar, , Dept. of Chemistry, S. V. University Tirupati.
10. Prof. G. M. Subbaraju, Dept. of Chemistry, S. V. University Tirupati.
11. Prof. Venkat Rao, Dept. of Chemistry, S. V. University Tirupati.
12. Prof. Dalpati Rao, Dept. of Chemistry, Osmania University, Hyderabad, A. P.
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15. Dr. Chakaravarthi, Dept. of Chemistry, P. G. Centre, Karnool, A.P.
16. Prof. Venkateswara Rao, Dept. of Chemistry, Kakatiya University Warangal, A.P.
17. Prof. Srinivasa Roa, Dept. of Chemistry, Kakatiya University Warangal, A.P.
18. Dr. P.S. Mohan, Dept. of Chemisty, Bharatiyar University Coimbatore T. N.
19. Prof. N. S. Prakash Roa, Dept of Chemistry, Calicut University, Calicut, Kerala.
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22. Dr. Jagdish Prasad, Mangalore University, Konaje
23. Dr. Shivashankar, Bangalore University.
24. Dr. Perumal Madhurai Kamaraj University, Madhurai.
25. Dr. P. T. Perumal, Direct, Grede Scientist, Central Leather Institute, Adiya, Chennai
26. Dr. K. Mantelingu, Dept of Chemistry, Mysore University, Mysore-06.
27. Dr. Basappa, Dept. of Chemistry, Bangalore University, Bangalore.
28. Prof. Basavaraj Padmashali, Dept. of Chemistry, Rani Channamma University, Belagavi
29. Dr. Ajaykumar, Yuaraja College, Mysore.
30. Dr. Umesh, Yuaraja College, Mysore.
31. Dr. Shoukat Ara Khanum, Yuaraja College, Mysore.
32. Dr. Nanjunda Swamy, Yuaraja College, Mysore.
33. Dr. Abdul Rehman. Govt. College Hasan.

34. Dr. Vijayakaumar, Tumkur University, Tumkur.
35. Dr. Srinivas, Tumkur University, Tumkur.
36. Dr. Jayashankar, Tumkur University, Tumkur
37. Dr. S. K. Giri, KSW University, Bijapur.
38. Dr. Ramesh Gani, Mangalore University, Mangalore.
39. Prof. B. K. Sarojani, Mangalore University, Mangalore.
40. Dr. Lokesh Shashtri, Dept. Chemistry, Karnataka University, Dharwad.
41. Prof. K M Mahadevan, Kadur PG Centre, Kuvempu University, Kadur.
42. Prof.B N Satyanarayana, Kadur PG Centre, Kuvempu University, Kadur.
43. Dr. K S Vithhal Rao, SS College, Shivamogga.
44. Dr. Nagaraja, Govt. Science College, Chitradurga.
45. Prof. Gopal, Govt. Science College, Chitradurga.
46. Dr. Mamatha, Dept. Chemistry, Davanagere University, Davanagere.
47. Prof. Kantharaj, Dept. of Chemistry, Rani Channamma University, Belagavi.
48. Dr. Sridhara, Dept. of Chemistry, Rani Channamma University, Belagavi.
49. Prof. Yadav Bodke, Dept. of Chemistry, Kuvempu University, Shankaraghatta.
50. Dr. Venkatesh Talwar, Kuvempu University, Shivamogga
51. Dr. Prabhakar Chavan, SSC, Shivamogga.
52. Prof. Nandeeshappa, Davangere University, Davangere
53. Dr. Maddani, Mangalore University, Mangalore
54. Dr. Umashankar, KSOU Mysore
55. Prof. Venkataramana, SK University, Ananthapur.
56. Prof. Holla, Central University, Kalburgi
57. Prof. Katagi, KCD, Dharwad
58. Prof. Vasudeva Reddy, Kakatiya University, Warrangal.
59. Prof. Ullas Shetty, GFGC, Karwar
60. Prof. Jaganmohan Reddy, Adikavi Nannayya University, Rajamundry.
61. Dr Sadu Suryakanth, VSK University, PG Center, Yalburga
62. Dr Sridar, Maharani Cluster University, Bangalore

External Examiners: Physical Chemistry

1. Prof Arunkumar Lagashetty, VSK University, PG Center, Yalburga
2. Prof M.K. Amshumali, VSK University, PG Center, Yalburga
3. Dr. S. Mohan, Dept. of Chemistry, Mysore University, Mysore.

4. Dr. Arthoba Nayaka, Dept. of Chemistry, Kuvempu University, Shankaraghatta.
5. Dr. Vishalakshi, Dept of Chemistry, Mangalore University, Konaje.
6. Dr. Nooshahina Begum, Dept. of Chemistry, Central College, Bangalore.
7. Prof. A. Krishnaiah, Dept. of Chemistry, S. V. University, Tirupati, A.P.
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9. Dr. Dyamappa, Mysore University, P.G. Centre, Mandya.
10. Prof. Kannan, Dept. of Chemistry, Calicut University, Calicut, Kerala.
11. Prof. Harikrishna, Dept. of Chemistry, Kakatiya University, Warangal, A.P.
12. Prof. K. J. Patil, Dept. of Chemistry, Shivaji University, Kolhapur.
13. Prof. S. R. Patil, Dept. of Chemistry, Shivaji University, Kolhapur.
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17. Dr. Naveenchandra, Dept. of Chemistry, St. Joseph's P.G. Centre, Shanthinagar, Bangalore-57.
18. Prof. I Krishna Reddy, S. V. University, P. G. Centre, Caddappa, A. P.
19. Prof. P. Raghunatha Rao, Dept. of Chemistry, Kakatiya University, Warangal, A.P.
20. Prof. Ravi Prasad, Dept. of Chemistry, Kakatiya University, Warangal, A.P.
21. Dr. B. Harikishan, Dept. of Chemistry, Kakatiya University, Warangal, A.P.
22. Dr. Ponnaiah, Dept. of Chemistry, Kakatiya University, Warangal, A.P.
23. Prof. Vijayaraghavan, Dept. of Chemistry, MadrasUniversity, Chennai.
24. Prof. J. Shanthanalaxmi, Dept. of Chemistry, MadrasUniversity, Chennai.
25. Prof. Gangaderi, Calicut University, Kerala.
26. Dr. Asha Iyengar, Yuvaraja College, Mysore.
27. Dr. Anirudhan, Kerala Univeristy, Trivandrum.
28. Dr. Venkatesh, Yuvaraja College, Mysore.
29. Dr. K. A.Vishnumurthy, Sri. M. V. College, Mysore.
30. Prof. Karidurgannanavar, Dept. Chemistry, Karnataka University, Dharwad.
31. Prof. Mamatha, Kuvempu University, PG Centre, Kadur
32. Prof, J Manjanna, Rani Channamma University, Belagavi.
33. Dr. Vidhyashankar, Rani Channamma University, Belagavi.
34. Prof. B E Kumarswamy, Dept. of Chemistry, Kuvempu University, Shankaraghatta.

35. Dr. Priya, University of Mysore, Mysore.
36. Dr. I. Pushpavathi, Kuvempu University, Shivamogga
37. Dr. Amshumali, VSK University, Ballari
38. Prof. Krishnamurthy, Bangalore University.
39. Prof. Garadkar, Shivaji University, Kolhapur
40. Prof. Rajendra Shirsat, Goa University, Panaji
41. Prof. Venkatnarayanan, Central University, Kalburgi
42. Dr. Arunkumar, Tumkur University, Tumkur
43. Dr. Ramesh, Tumkur University, Tumkur
44. Prof. Chougale, Karnatak University, Dharwad.
45. Dr. Suchetan, Tumkur University, Tumkur
46. Dr. Jayalakshimi, Karnataka College, Dharwad.
47. Dr. Mallikarjun, Maharani Science College, Mysore.
48. Prof. Kumar, Yuvaraja college, Mysore

List of Examiners from Colleges where PG Courses are running

1. Dr. G. Krishanmurty, Sayhadri College, Shivamoga.
2. Dr. K. P. Latha, Sayhadri Science College, Shivamoga
3. Dr. P. Parameshwar Naik, Sayhadri Science College, Shivamoga
4. Dr. M. P. Somashkaharappa, IDSG. Govt. College, Chickmaglure
5. Dr. Mohankumar, IDSG, govt. College, Chickmagalur.
6. Dr. Kumar Swamy, Govt. College Bhadravathi
7. Dr. Anitha, Sayhadri Science College, Shivamogga.