ANDHRA KESARI UNIVERSITY:: ONGOLE
(A State University, Recognized by UGC)
M.Sc. ANALYTICAL CHEMISTRY SYLLABUS
Course Structure as per National Educational Policy-2020 under CBCS
(*For the students admitted from the academic year 2023-2024 onwards)*

Semester	Components of Study	Course Code	Title of the Course	No. of Credits	Hr/Week	Internal Assessment	Semester End Exams	Total
SEMESTER – I	Mandatory Core	R23CH11	Inorganic Chemistry-I	4	4	30	70	100
		R23CH12	Organic Chemistry-I	4	4	30	70	100
	Compulsory	R23CH13	Foundation for Chemistry	4	4	30	70	100
	Elective Foundation	R23CH14A	Physical Chemistry-I	4	4	30	70	100
		R23CH14B	Polymer Science					
		R23CH14C	Nuclear Chemistry and Applications					
	Core Practical-I	R23CH15	Inorganic & Physical Chemistry	4	6	30	70	100
	Core Practical –II	R23CH16	Organic Chemistry	4	6	30	70	100
	Audit Course	*R23CH17*	*Human Values and Professional Ethics*	*2*	*2*	*50*	--	--
	Sub-Total			**24**				**600**
SEMESTER – II	Mandatory Core	R23CH21	Physical Chemistry-II	4	4	30	70	100
		R23CH22	Organic Chemistry-II	4	4	30	70	100
	Compulsory	R23CH23	Essential Lab Techniques for Industry	4	4	30	70	100
	Elective Foundation	R23CH24A	Inorganic Chemistry-II	4	4	30	70	100
		R23CH24B	Nano Science & Technology					
		R23CH24C	Material Science					
	Core Practical-I	R23CH25	Inorganic & Physical Chemistry	4	6	30	70	100
	Core Practical –II	R23CH26	Organic Chemistry	4	6	30	70	100
	Core Practical-III	R23CH27	Comprehensive Viva-voce (1st & 2nd Semester)	2	--	--	50	50
	Skill Development	*R23CH28*	*Communicative English/MOOCS Online*	*2*	*2*	*50*	--	--
	Sub-Total			**26**				**650**
SEMESTER – III	Mandatory Core	R23AC31	Applied Inorganic Analysis	4	4	30	70	100
		R23AC32	Analysis of Applied Industrial Products	4	4	30	70	100
	Core Elective-I	R23AC33A	Optical Thermal & Radiochemical Methods of Analysis	4	4	30	70	100
		R23AC33B	Applications of Synthetic Products					
		R23AC33C	Basics of Biotechnology					
	Open Elective-II	R23AC34A	Principles and Techniques in Classical Analysis	4	4	30	70	100
		R23AC34B	Food Chemistry & Analysis					
		R23AC34C	Green Chemistry					
	Core Practical-I	R23AC35	Classical Methods of Analysis	4	6	30	70	100
	Core Practical –II	R23AC36	Instrumental Methods of Analysis	4	6	30	70	100
	Skill Enhancement	R23AC37	*MOOC's Online Course*	*2*	--	*50*	--	--
	Sub-Total			**24**				**600**
SEMESTER – IV	Mandatory Core	R23AC41	Advanced Methods of Analysis	4	4	30	70	100
		R23AC42	Analysis of Drugs, Foods, Diary Products& Biochemical Analysis	4	4	30	70	100
	Core Elective-I	R23AC43A	Separation Techniques & Electro Analytical Techniques	4	4	30	70	100
		R23AC43B	Analytical Chemistry of Oils & Fats					
		R23AC43C	Quality Control & Quality Assurance in Pharma Industry					
	Open Elective-II	R23AC44A	Environmental Chemistry & Analysis	4	4	30	70	100
		R23AC44B	Forensic Science in Solving Crime					
		R23AC44C	Engineering Chemistry					
	Core Practical-I	R23AC45	Classical & Instrumental Methods of Analysis	4	6	30	70	100
	Core Practical-II (Multi Disciplinary)	R23AC46	Project Work / Spectral Problems	4	6	--	100	100
	Core Practical-III	R23AC47	Comprehensive Viva-voce (3rd& 4th Semester)	2	--	--	50	50
	Sub-Total			**26**				**650**
	Grand Total			**100**				**2500**

Note: Pass in Audit course, skill development and skill enhancement courses are mandatory

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DEPARTMENT OF CHEMISTRY
SYLLABUS FOR M.Sc. ANALYTICAL/ORGANIC CHEMISTRY
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SEMESTER–I

PAPER–I: INORGANIC CHEMISTRY-I (R23CH11)
Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To know the fundamentals in VSEPR theory.
- ✓ To know the Crystal field theory.
- ✓ To know the Molecular Orbital Theory.
- ✓ To know the Hard and Soft Acids and Bases and Macro Cyclic complexes.
- ✓ To know the higher boranes, Isopoly and heteropoly anions.

UNIT-I **12H**

Structure and Bonding: VSEPR theory and its role in explaining the structures of inorganic molecules. Walsh diagrams for linear molecule (BeH_2) and bent molecule (H_2O). Molecular Orbital theory - Symmetry of Molecular orbitals, Molecular orbitals in triatomic (BeH_2) molecules and ions (NO_2^-) and energy level diagrams.

Participation of p and d orbitals in pπ - dπ bonding- Evidences from both non transition and transition metal compounds.

Non-valence cohesive forces, Hydrogen bonding - Symmetric and unsymmetric hydrogen bonds in inorganic molecules.

UNIT-II **12H**

Metal-Ligand Bonding: Crystal Field Theory of bonding in transition metal complexes Splitting of d-orbitals in Octahedral, tetrahedral, trigonal bipyramidal and Square pyramidal fields and energy orders of orbitals.

Tetragonal distortions - Jahn Teller effect. Static and dynamic Jahn -Teller effects. Chelates and Jahn - Teller effect

Spectrochemical series. Nephelauxetic effect. Calculation of crystal field stabilization energies. Factors affecting crystal field splitting energies. Applications and limitations of CFT.

UNIT-III **12H**

Molecular Orbital Theory: Evidence for covalence in complexes - Experimental evidences from both σ and π bonded complexes.

Molecular Orbital Theory of bonding for octahedral, tetrahedral and square planar complexes. π-bonding and MOT - Effect of π-donor and π-acceptor ligands on Δ_o. Experimental evidence for π-bonding in complexes .

MOT and Resonance. Resonance in homoatomic molecules (H_2) and hetero atomic ions.
Molecular Orbital Theory and Hybridization. Bents Rule and energetic of Hybridization.

SEMESTER–I
PAPER–I: INORGANIC CHEMISTRY-I (R23CH11)
Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-IV **12H**

Metal-Ligand Equilibria in Solutions: Step wise and over all formation constants.Trends in stepwise constants, statistical effect and statistical ratio. Determination of formation constants by Spectrophotometric method (Job's method) and Limitations to Jobs method. Determination of formation constants by pH metric method (Bjerrum's method).
Stability correlations and Irwing -William's series for transition metal ions.
Hard and soft acids and bases (HSAB) – Acid-base strength and HSAB , Electro negetivity and HSAB.
Macrocyclic complexes - Crown ethers and Cryptates.

UNIT-V **12H**

Non Metal Cages and Ring Compounds: Preparation and structures of higher boranes, Electron counting rules in boranes-Wades rules and Polyhedral skeletal electron pair theory. Heterocyclic inorganic ring systems Boron-Nitrogen (B-N), Phosphorus–Nitrogen (P-N) and Sulphur-Nitrogen (S-N) cyclic compounds.
Cage compounds of Phosphorous-Oxygen (P-O) and Phosphorous-Sulphur (P-S).
Preparation and structures of Isopoly and heteropoly anions and their sats.

Reference Books:

1) Inorganic Chemistry Huheey, Harper and Row.
2) Physical methods in Inorganic Chemistry, R.S. Drago. Affiliated East-West Pvt. Ltd.
3) Concise Inorganic Chemistry, J. D. Lee, ELBS.
4) Modern Inorganic Chemistry, W. L. Jolly, McGrawHill.
5) Inorganic Chemistry, K. F. Purcell and J. C. Kotz Holt Saunders international.
6) Concepts and methods of inorganic chemistry, B.E. Douglas and D.H.M.C. Daniel.
7) Introductory Quantum mechanics, A. K. Chandra.
8) Quantum Chemistry, R. K. Prasad.
9) Inorganic Chemistry, Atkins, ELBS.
10) Advanced Inorganic Chemistry, Cotton and Wilkinson, Wiley Eastern.
11) Quantum Chemistry, R. K. Prasad.
12) Concise Coordination Chemistry, R.Gopalan and V.Ramalingam.

Learning Outcomes:

- ✓ The student will understand the VSPER theory, symmetric and unsymmetric Hydrogen bonds in inorganic molecules.
- ✓ Understanding the Crystal field theory and Jahn Teller Effects.
- ✓ The Students are able to understand the basics of molecular orbital theory and energetic of hybridization.
- ✓ The Students are able to understand the Jobs method, hard and soft acids and bases.
- ✓ The Students are able to understand the study of age compounds of oxygen, phosphorous and sulphar compounds and also isopoly and heteropoly anions.

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SEMESTER–I
PAPER-II: ORGANIC CHEMISTRY-I (R23CH12)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To Know about Aromaticity in Benenoid compounds and Non-Benzenoid compounds.
- ✓ To know about basics on heterocyclic compounds, their synthesis and importance.
- ✓ To know the importance of natural products, their medicinal use.
- ✓ To know particularly about terpenoids and their classification and synthesis.
- ✓ To discuss stereochemistry more elaborately.
- ✓ To know about the conformations of acyclic, monocyclic and fused ring systems.

UNIT-I **12H**

Aromaticity Benzenoid & Non-Benzenoid: Concept of aromaticity, Huckel's rule for aromaticity in benzenoid compounds, Aromaticity of five membered, six membered rings and fused systems.

***Non benzonoid aromatic compounds*:**Cyclopropenyl cation, Cyclobutadienyldication, cyclopentadienyl anion, tropyllium cation and cyclooctatetraenyl dianion. Ferrocene. Azulenes, Fulvenes, Annulenes, Fullerenes. Homo aromaticity, and Anti aromaticity.

UNIT-II **12H**

Heterocyclic Compounds and Natural Products:

a) Synthesis, Properties and Reactions of furan, thiophene, pyrrole, pyridine, quinoline, isoquinoline and indole; Skraup synthesis, Fisher indole synthesis.
b) Heterocyclic compounds more than one hetero atom-: synthesis, properties and reactions of Pyrazole, Imidazole, Oxazole Iso-Oxazole, Thiazole.

Natural Products: Importance of natural products as drugs.

Terpenoids: General methods in the structure determination of terpenes. Isoprene rule. Structure determination and synthesis of α-terpeniol, β-carotene, and camphor.

UNIT-III **12H**

Stereochemistry

a) *Molecular representations of organic molecules* –Wedge, Fischer, Newman and Saw-horse formulae, their description and inter-conservation. Stereoisomerism-Definition, classification.
b) *Concept of Chirality and Molecular Symmetry*: Symmetry operations, Recognition of symmetry elements (Cn, Ci and Sn), Dissymmetric and asymmetric molecules. Chiral structures (one and more than one chiral centers); D-L and R–S nomenciature, diastereoisomerism; Threo and Erythro isomers, Racemic mixture, racemization and methods of resolution, stereo specific and stereoselective synthesis. Stereochemistry of compounds containing nitrogen, sulphur and phosphorous.
c) *Geometrical isomerism*–E,Z- nomenclature–Spectral and chemical methods of determining the configuration of geometrical isomers. Determination of configuration in aldoximes and ketoximes.

UNIT-IV **12H**

Conformational Analysis-I

a) Conformation of acyclic molecules –alkanes and substituted alkanes (Ethane and 1,2-disubstituted ethane derivatives like butane, dihalobutane halohydrin, ethylene glycol, butane-2,3-diol, amino alcohols and 1,1,2,2-tetrahalobutanes). Klyne-Prelog terminology for conformers and torsion angles.

b)Factors affecting the conformational stability and conformation equilibrium-Attractive and Repulsive interactrions. Use of Physical and Spectral methods in conformational analysis.

c)Conformational effects on the stability and reactivity of diastereomers in cyclic molecules-steric and stereo electronic factors-examples.

UNIT-V **12H**

Conformational Analysis-II

a) *Conformations of monocyclic compounds*–cyclohexane-chair, boat and twist boat cyclohexanes, energy profile diagram–mono-and di-substituted cyclohexanes–conformations. Effect of conformation on stability and reactivity in mono and disubstituted cyclohexane derivatives.
b) *Conformations of unsaturated acyclic compounds*: Propylene, and 1-Butene
c) *Elementary treatment of fused and bridged ring systems* –Decalines and Bornanes. Conformation of sugars. Steric strain due to unavoidable crowding.

Reference Books:

1) Advanced organic chemistry – reaction, mechanism and structure, Jerry March, John Wiley.
2) Advanced organic chemistry, F.A. Carey and R.J. Sundberg, Plenum.
3) A guide book to Mechanism in organic chemistry, Peter Sykes, Longman.
4) Organic chemistry, I.L.Finar, Vol. I & II, Fifth ed. ELBS, 1975.
5) Organic chemistry, Hendrickson, Cram and Hammond (Mc Graw – Hill).
6) Stereo Chemistry of carbon compounds – E.L. Eliel.
7) Modern organic Reactions, H.O. House, Benjamin.
8) An introduction to chemistry of Heterocyclic compounds, R.M.Acheson.
9) Structure and mechanism in organic chemistry, C.K.Ingold, Cornell University Press.
10) Principles of organic synthesis, R.O.C.Norman and J.M.Coxon, Blakie Academic & Professional.
11) Reaction Mechanism in Organic Chemistry, S.M.Mukherji and S.P.Singh, Macmillan.
12) Basic Principles of Organic Chemistry by J. B. Roberts and M. Caserio.
13) Stereo Chemistry of Organic compounds, P. S. Kalsi, New Age International pubs.

Learning Outcomes:

- ✓ Students can able to understand aromaticity in Benenoid compounds and Non-Benzenoid compounds.
- ✓ Students are able to understand formation of various heterocyclic compounds and their synthesis and importance.
- ✓ Students can understand the importance of natural products in medicinal chemistry
- ✓ Students can able to write the stereo chemical forms for different organic molecules.
- ✓ Understand the conformations of acyclic, monocyclic and fused ring systems and applying it to organic compounds.

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SEMESTER–I

PAPER-III: FOUNDATION FOR CHEMISTRY (R23CH13)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To know the fundamentals in analytical &inorganic estimations.
- ✓ To know the possible intermediates formed during course of chemical reactions.
- ✓ To know the type of bonding in organic molecules.
- ✓ To know about molecular symmetry, molecular representations and their applicationalaspects.
- ✓ To know the types & characterisation of environmental segments.

UNIT-I **10H**

Titrimetric analysis: Acid-base titrations, redox titrations, complexometric titrations, precipation titrations-principle, example and corresponding indicators, Pri., Sec.-standards.

UNIT-II **10H**

Treatment of analytical data: Errors, classification, accuracy, precision, SD, MD, Student-T test F-test, Gassiandistributation

UNIT-III **14H**

Reactive Intermediates: Generation, Structure, Stability and reactivity of Carbocations, Carbanions, free radicals, Carbenes, nitrenes and Benzyne; Electrophiles, Nucleophiles, Catalysts-definition and examples.

Nature of bonding in organic molecules: Localised and Delocalized covalent bonds, Delocalised chemical bonding conjugation, cross conjugation, hyper conjugation, tautomerism.

UNIT-IV **14H**

Symmetry and Group theory in Chemistry - Symmetry elements, symmetry operation, definition of group, suib group, relation between order of a finite group and its sub group. Point symmetry group. Schonfiles symbols, representation of groups by Matrices (representation for the Cn, Cnv, Cnh, Dn etc. groups to be worked out, explicitely). Character of a representation. The great orthogonality theorem (without proof) and its importance. Character tables and their use. Application of group theory in IR and Raman spectroscopy.

UNIT-V **12H**

Environmental chemistry:

Classification of environmental segments, types of pollutions, acid rains, Global warming.

Chemistry of Biomolecules: Definition, functional uses and examples for Carbohydrates, lipids (fats and oils), enzymes. Chemistry of purines and pyrimidines, Nucleic acids- Structure and functions ofDNA & RNA.

SEMESTER–I

PAPER-III: FOUNDATION FOR CHEMISTRY (R23CH13)

Max. Marks: 100 **(Internal-30M & External-70M)**

Reference Books:

1) Advanced organic chemistry – reaction, mechanism and structure, Jerry March, John Wiley.
2) Advanced organic chemistry, F.A.Carey and R.J.Sundberg,Plenum.
3) A guide book to Mechanism in organic chemistry, Peter Sykes, Longman.
4) Organic Chemistry, I.L.Finar, Vol. I & II, Fifth ed. ELBS, 1975.
5) Organic Chemistry, Hendrickson, Cram and Hammond (Mc Graw – Hill).

Learning Outcomes:

- ✓ The student will understand the required tools in analytical and inorganic estimations.
- ✓ Understanding of various types of reaction intermediates and the bonding present in various organic compounds.
- ✓ Students are able to understand the basics on various environmental concerns.
- ✓ Students know about types of various biomolecules and their functions with reference to structure.
- ✓ Student understa the types of pollutions.

SEMESTER–I

PAPER-IV(Elective–A): PHYSICAL CHEMISTRY-I (R23CH14A)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To know the first and second law of thermo dynamics.
- ✓ To know the surface tension, Gibbs-Adsorption, X-ray flouresence and Augar electron spectroscopy.
- ✓ To know the micelles-Hydrophobic interaction.
- ✓ To know the Nernst equation and Debye Huckel-Onsagar equation.
- ✓ To know the complex reactions, Collision theory and chain reactions.

UNIT-I **12H**

Thermodynamics-I: Classical thermodynamics-Brief review of first and second laws of thermodynamics - Entropy change in reversible and irreversible processes-Entropy of mixing of ideal gases-Entropy and disorder-Free energy functions-Gibbs-Helmoboltz equation - Maxwell partial relations-Conditions of equilibrium and spontaneity-Free energy changes in chemical reactions: Van't Hoff reaction isotherm- Van't Hoff equation-Classiuss Clapeyron equation-partial molar quantities-Chemical potential- GibbsDuhem equation-partial molar volume-determination of partial molar quantities – Fugacity- Determination of fugacity-Thermodynamic derivation of Raoult's law.

UNIT-II **12H**

Surface Phenomena and Phase Equilibria: Surface tension-capillary action-pressure difference-across curved surface (young - Laplace equation)-Vapour pressure of small droplets (Kelvin equation)- Gibbs-Adsorption equation - BET equation-Estimation of surface area-catalytic activity of surfaces-ESCA , X- ray flouresence and Augar electron spectroscopy.

UNIT-III **12H**

Surface Active Agents: Classification of surface active agents-Micellisation-critical Micelle concentration (CMC)-factors affecting the CMC of surfactants, microemulsions-reverse micelles-Hydrophobic interaction.

UNIT-IV **12H**

Electrochemistry-I: Electrochemical cells-Measurement of EMF-Nernst equation-Equilibrium constant from EMF Data-pH and EMF data-concentration cells with and without transference-Liquid junction potential and its determination-Activity and activity coefficients-Determination by EMF Method- Determination of solubility product from EMF measurements. Debye Huckel limiting law and its verification. Effect of dilution on equivalent conductance of electrolytes-Anamolousbehaviour of strong electrolytes. Debye Huckel-Onsagar equation-verification and limitations-Bjerrum treatment of electrolytes-conductometric titrations.

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SEMESTER–I

PAPER-IV(Elective–A): PHYSICAL CHEMISTRY-I (R23CH14A)

Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-V **12H**

Chemical Kinetics: Methods of deriving rate laws - complex reactions - Rate expressions for opposing, parallel and consecutive reactions involving unimolecular steps. Theories of reaction rates - collision theory - Steric factor - Activated complex theory - Thermodynamic aspects - Unimolecular reactions - Lindemann's theory - Lindemann-Hinshelwood theory. Reactions in solutions - Influence of solvent - Primary and secondary salt effects - Elementary account of linear free energy relationships - Hammet - Taft equation - Chain reactions - Rate laws of H_2-Br_2, photochemical reaction of H2 - Cl2 Decomposition of acetaldehyde and ethane - Rice-Hertzfeld mechanism.

Reference Books:

1) Physical Chemistry P.W. Atkins, ELBS
2) Chemical Kinetics - K.J.Laidler, McGraw Hill Pub.
3) Text Book of Physical Chemistry. Samuel Glasstone, Mcmillan Pub.
4) Physical Chemistry, G.W.Castellan. Narosa Publishing House
5) Thermodynamic for Chemists. Samuel Glasstone
6) Electrochemistry, Samuel Glasstone, Affiliated East West
7) Physical Chemistry, W.J. Moore, Prentice Hall
8) Atomic structure and chemical bond. Manas Chanda. Tata McGraw Hill Company Limited.

Learning Outcomes:

- ✓ Students can able to understand the classical thermo dynamics, fugacity.
- ✓ Students are able to understand Kelvin equation, Gibbs-Adsorption equation - BET equation.
- ✓ Students are able to understand the Classification of surface active agents.
- ✓ Students are able to understand the Electrochemical cells, Liquid junction potential.
- ✓ Understand the complex reactions, chain reactions.

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SEMESTER–I

PAPER-IV (Elective–B): POLYMER SCIENCE(R23CH14B)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To learn basic types of polymerization processes and techniques.
- ✓ To learn how to characterize polymers.
- ✓ To learn the rheological characteristics of polymers.
- ✓ To learn how the processing and testing of polymers are done.
- ✓ To learn about high temperature polymers, polymers blends and composites.

UNIT-I **12H**

Introduction to Polymer Science: Monomers, functionality, degree of polymerizations; classification of polymers, polymerization methods: addition and condensation; new techniques of polymerization; copolymerization, monomer reactivity and its significance; azeotropic copolymerization, block and graft copolymers; techniques for copolymerization: bulk, solution, suspension and emulsion.

UNIT-II **12H**

Polymer Synthesis and Characterization: Synthesis of thermoplastics,Fluoropolymers, Thermosetting polymers and Unsaturated polyesters. Polymer Solubility and swelling, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights. Polymer crystallinity, analysis of polymers using optical and thermal techniques :Infra Red spectroscopy, X-Ray diffraction, DSC, DMTA and TGA.

UNIT-III **12H**

Polymer Rheology: The flow of Newtonian and non-Newtonian fluids and flow equations. Measurements of rheological parameters by capillary rotating, parallel plate and cone-plate rheometer. Mechanical models, control of rheological characteristics through compounding, rubber curing in parallel plate viscometer, Oscillating Disc Rheometer (ODR) and Moving die Rheometer (MDR).

UNIT-IV **12H**

Processing and Testing of Polymers: Types of mouldings: Compression moulding, transfer moulding, injection moulding, blow moulding,reaction injection moulding, extrusion, pultrusion, calendaring, rotational moulding and rubber processing. Testing for Mechanical-static and dynamic tensile, compressive, abrasion, hardness, tear, impact and toughness. Testing for thermal and electrical conductivity, dielectric constant, electric resistance, swelling, ageing and resistance and environmental resistance.

UNIT-V **12H**

Polymer Applications: *High temperature polymers:* synthesis,processing and applicationsof Aromatic liquid crystalline polyesters, Phenolics, polyimide and polyether ketones.
*Polymer blends and Composites:*Difference between blends and composites, their significance, miscible and immiscible blends, polymer alloys, polymer eutectics, plastic-plastic, rubber-plastic and rubber-rubber blends. Fibre Reinforced Polymers (FRP), particulate, long and short fiber-reinforced composites.

SEMESTER–I

PAPER-IV (Elective–B): POLYMER SCIENCE (R23CH14B)

Max. Marks: 100 **(Internal-30M & External-70M)**

Recommended Books:

1) Text Book of Polymer Science, 3rd Ed. (1984), F. W. Billmayer, Jr., Willey-Interscience.
2) Principles of Polymer Chemistry, P. J. Flory, Cornell Press (recent edition).
3) Principles of Polymerization, G. Odian, 3rd Edition (1991), John Wiley, Singapore
4) Principles of Polymer Sciences, P. Bahadur and N.V. Sastry, Narosa Publishing House, NewDelhi (2002)
5) Polymer Sciences, V.R. Gowarikar, N.V. Vishwanathan, J. Shreedhar, Wiley Eastern, NewDelhi (1986)
6) The Elements of Polymer Science and Engineering, Alfred Rudin, 3 rd Ed. Academic Press, New York (2012).
7) Experiments in Polymer Science, E. A. Coolins, J. Bares and E. W. Billmeyer, WileyInterscience, New York (1973).
8) High performance materials in Aerospace, H.M.Flower, Ist ed, Chapman & Hall (1995).
9) Advanced Aerospace materials, B.Horst, B.Ilschner, K.C.Russel, Springer-verlag, Berlin (1992).
10) Applications of high temperature Polymers, R.R.Luise, I ed., CRC Press (1996).

Learning Outcomes:

- ✓ The student is provided with basic theoretical background on polymers.
- ✓ Understands various synthetic techniques used for preparation of polymers.
- ✓ Equipped with necessary knowledge to develop new polymers and new techniques.
- ✓ Familiarized withhigh temperature polymers uses.
- ✓ Understands various important and diverse applications of polymers in most fields of sciences.

SEMESTER–I

PAPER-IV(Elective–C): NUCLEAR CHEMISTRY AND APPLICATIONS(R23CH14C)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To learn the principles and importance of Nuclear chemistry.
- ✓ To learn about the detection of radiations from radio active sources.
- ✓ To learn about the radio isotope tracers and their numerous applications.
- ✓ To learn about the nuclear reactors and their working methods.
- ✓ To learn about the handling, safety and protection from radiations.

UNIT-I **12H**

Nuclear Theory and Nuclear Reactions: Radioacive decay processes, Natural radio active series, Determination of half - lives of short and long lived isotopes. α-β-γdecays and K-capture
Nuclear reactions(NR) : NR induced by neutron and charged particles . Nuclear fission and fusion, Interaction of radiation and particles with matter. Determination of energies of α-β-γ particles.

UNIT-II **12H**

Detection of Radiations : Types and principles of measuring instruments, GM tubes and GM counter- their characteristics. Ionization chambers: Scintillation counters and solid state detectors. Neutron detection methods.Energy production in stars, Stellar evolution and Genesis of chemical elements.

UNIT-III **12H**

Radioisotope tracers: Radiometric analysis, various types of dilution techniques. Applications of radio isotopes in the study of isotopic exchange and electron transfer reactions.Applications of radio nuclides in therapeutic and diagnostic purposes. Radio carbon dating and age of earth and minerals by various dating techniques. Radiolysis of water and aqueous solutions. Identification reactions and properties of solvated electrons.

UNIT-IV **12H**

Nuclear reactors: Homogenous and heterogenous reactors: Power reactors, Boiling water reactors, Pressurized water reactors, Fast breeder reactors, Research reactors and Reactors for special purposes. Neutron sources and moderation, Criticality factors, moderators, coolants, Cladding and structural materials.

UNIT-V **12H**

Radio Activity in the Environment, Safety and Protection: Natural radio active nuclides and their distributon in the environment, nuclear process in the atmosphere, radio activity contributions to the environment from nuclear tests, nuclear reactors, nuclear fuel reprocessing plants and waste management of radioactive isoptopes like Cs-137,I-131,H-3 and Ra-226. Plutonium isotopes in the environment. Hazards associated with radiations, Biological effects of radiations, Radioactive waste handling, disposal and treatment.

SEMESTER–I

PAPER-IV(Elective–C): NUCLEAR CHEMISTRY AND APPLICATIONS(R23CH14C)

Max. Marks: 100 **(Internal-30M & External-70M)**

Reference Books:

1) Principles of Radiochemistry , H.A.CMcKay, Butterworths, London (1971).
2) Essentials of Nuclear Chemistry, H.J.Arnikar, 4th ed, New age International, New Delhi, (1997).
3) Nuclear Chemistry and its Applications, M.Haissinsky, Wesely publishing comp.Inc, London(1964).
4) Radiochemistry ,An.N.Nesmeyanov, Mir publishers, Moscow (1974).
5) Nuclear and Radiochemistry , G. Friedlander, J.W.Kennedy, Wiley-Inter. NY, (1981).
6) Nuclear Radiation Detection, W.J.Price, 2nd ed, Mc Graw Hill, NY, (1968).

Learning Outcomes:

- ✓ Student understands the basic principles and importance of Nuclear chemistry.
- ✓ Familiarized with the methods of detection of radiations from radio active sources.
- ✓ Essential knowledge is imparted on radio isotope tracers and their numerous applications.
- ✓ Understands the importance of the nuclear reactors and their working modes.
- ✓ Understands how the environment is affected by radioactive sources either natural or waste produced from reactors, knows safety methods to handle radio active. Chemicals to protect from radiations.

SEMESTER–I

PRACTICAL–I: INORGANIC & PHYSICAL CHEMISTRY (R23CH15)

Max. Marks: 100 **(Internal-30M & External-70M)**

A total Six (6)Experiments must be carryout taking minimum of '3' in each section

LIST OF EXPERIMETNS:

SECTION-I: INORGANIC CHEMISTRY

1) Determination of Zn^{2+} with potassium ferrocyanide (Volumetric).
2) Complexomatric titrations: Determination of Mg^{2+}, Ni^{2+} and hardness of water using EDTA.
3) Determination of Fe^{3+} by photochemical reduction.
4) Argentometry: Determination of chloride by argent metric titration using.
   a) K_2CrO_4 (b) Fluorescein as indicators.

SECTION-II: PHYSICAL CHEMISTRY

1) Relative strengths of acids by studying the hydrolysis of ethylacetate / methyl acetate.
2) Determination of equilibrium constant of KI3 ↔ KI + I2 by partition coefficient method and determination of unknown concentration of potassium iodide.
3) Distribution coefficient of Benzoic acid between Benzene and water.
4) Determination of critical solution temperature of phenol-water system Study of the effect of eletrolyteon the miscibility of phenol-water system.

Reference Books:

1) Vogels Text Books of Quantitative Analysis, Revised. J. Asset, R.C. Denny, G.H. Jeffery and J. Mendhan. ELBS.
2) Synthesis and Characterisation of Inorganic Compounds, W.L. Jolly. Prentice Hall.
3) Practical Inorganic Chemistry by G. Pass and H. Sutcliffe Chapman and Hall.
4) Practicle Inorganic Chemistry by. K. Somasekhar Rao and K.N.K. Vani.

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SEMESTER–I

PRACTICAL–II: ORGANIC CHEMISTRY (R23CH16)

Max. Marks: 100 **(Internal-30M & External-70M)**

(Minimum Five Experiments must be carryout)

LIST OF EXPERIMENTS:

1) One step & Two step Organic compounds preparation–Yield of crude and crystallized samples and reporting of the melting point/Boiling points.
   Preparations: i) Iodoform ii) n-Dinitroderivative iii) Asprin iv) p-Nitroaniline v) Bezophenone vi) Benzoic acid vii) p-Bromo Acetanilide viii) Acetanilide ix) any other organic compound.
2) Purification of organic compound-The student has to do Recryastallization to final compound(s) (for both steps) and submit the sample.
3) Distillation of Alcohol, Toluene.
4) Chromatography- The student has to submit purity of the final product with TLC
5) Chromatographic separation of impurities by TLC.
6) Student should practice solvent extraction methods.

Note: Apart from (1) & (2) each student must practice S.No. (3) to (6).

SEMESTER–I

PAPER-VII: HUMAN VALUES AND PROFESSIONAL ETHICS(R23CH17)

Max. Marks: 50(Internal)

Learning Objectives:

- ✓ To know the nature of ethics and goals.
- ✓ To know the basic moral concepts.
- ✓ To know the non-violance of non possession.
- ✓ To know the crime and theories of punishment.
- ✓ To know the Bhagavd Gita, Buddhism, Jainism.

Unit-I: **6H**

Definition and Nature of Ethics – Is relation to Religion, Politics, Business, Law, Medicine and Environment. Need and Importance of Professional Ethics – Goals – Ethical Values in Various Professions.

Unit-II: **6H**

Nature of Values-Good and Bad, Ends and Means, Actual and Potential Values, Objective and Subjective Values, Analysis of Basic Moral Concepts-Right, Ought, Duty, Obligation, Justice, Responsibility and Freedom, Good Behavior and Respect for Elders, Character and Conduct.

Unit-III: **6H**

Individual and Society: Ahimsa (Non-Violence), Satya (Truth), Brahmacharya (Celibacy), Asteya (Non Possession) and Aparigraha (Non-stealing). Purusharthas (Cardinal virtues) - Dharma (Righteousness), Artha (Wealth), Kama (Fulfillment Bodily Desires), Moksha (Liberation).

Unit-IV: **6H**

Crime and Theories of Punishment – (a) Reformative, Retributive and Deterrent, (b) Views on Manu and Yajnavalkya.

Unit-V: **6H**

Bhagavd Gita – (a) Niskama Karma, (b) Buddhism – The Four Nobel Truths – Arya astangamarga, (c) Jainism - Mahavratas and Anuvratas. Values Embedded in Various Religions, Religious Tolerence, Gandhian Ethics.

PAPER-VII: HUMAN VALUES AND PROFESSIONAL ETHICS(R23CH17)

Max. Marks: 50(Internal)

Reference Books:

1) Johns S Mackenjie: A Manual of ethics
2) "The Ethics of Management" by Larue Tone Hosmer, Richard D. Irwin Inc.
3) Management Ethics – Integrity at work by Joseph A. Petrick and John F. Quinn, Response Books, New Delhi.
4) "Ethics in Management" by S.A. Shelekar, Himalaya Publishing House.
5) Harold H. Titus: Ethics for Today
6) Maitra, S.K: Hindu Ethics
7) William Lilly: Introduction to Ethics
8) Sinha: A Manual of Ethics
9) Manu: Manava Dharma Sastra or the Institute of Manu: Comprising the Indian System of Duties: Religious and Civil (ed) G.C. Haughton.
10) Sasruta Samhita: Tr. KavirajKunjanlal, KunjanlalBrishagratha, Chowkamba Sanskrit Series, Vol I,II and III, Varanasi, Vol I PP, 16-20, 21-32 and 74-77 only.
11) Charaka Samhita: Tr. Dr. Ram Karan Sarma and Vaidya Bhagavan Dash, Chowkambha Sanskrit Series Office. Varanasi I, II, III Vol I PP 183-191.
12) Ethics, Theory and Contemporary Issues. Barbara Mackinnon, Wadsworth/Thomson Learning, 2001.
13) Analyzing Moral Issues, Judith A. Boss, Mayfield Publishing Company, 1999.
14) An Introduction to Applied Ethics (Ed.,) John H. Piet and Ayodya Prasad, Cosmo Publications.
15) Text Book for Intermediate First Year Ethics and Human Values, Board of Intermediate Eduction – Telugu Academy, Hyderabad.
16) I.C. Sharma Ethical Philosophy of India. Nagin& Co Julundhar.

Learning Outcomes:

- ✓ Students are able to understand relation to religion & ethical values.
- ✓ Students are able to understand to character & conduct.
- ✓ Students are able to understand to crime & theories of punishment.
- ✓ Students are able to understand to Gand
- ✓ hian ethics & values embedded in various religions.
- ✓ Studetns are able to understand various individuals of society.

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SEMESTER–II

PAPER–I: PHYSICAL CHEMISTRY-II(R23CH21)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To know the Third law and Statistical thermodynamics and Nernst Heat theorem, Entropy and probability.
- ✓ To know the classification of polymers, molecular weights determination.
- ✓ To know the Butler-Volmer equation, polarography and Amperometric titrations.
- ✓ To know the Hydrogen-oxygen reaction, Quantum yield and Stern - Volmer equation.
- ✓ To know the hydrolysis of ATP, thermodynamics of biopolymer solutions.

UNIT-I **12H**

Thermodynamics II: Third law and Statistical thermodynamics-Nernst Heat theorem - Third law of thermodynamics - Its limitations - Determination of absolute entropy - Concept of districution - Thermodynamic probability and most probable distribution - Ensemble-ensemble averaging - Maxwell-Boltzmann distribution law - Partition function - Fermi-Dirac statistics - Bose Einstein statistics - Entropy and probability - Boltzmann-Plank equation - Calculation of thermodynamic properties in terms of partition function - Application of partition function - Chemical equilibrium and partition function - Translational, rotational and electronic partition function - Entropy of Monoatomic gases (Sackur - Tetrode equation).

UNIT-II **12H**

Polymer Chemistry: Classification of polymers - Free radical, ionic and Zeigler -Natta Polymerisation - kinetics of free radical polymerisation - Techniques of polymerisation - Glass transition temperature - Factors influencing the glass transition temperature - Number average and Weight average, Molecular weights - molecular weights determination - End group analysis - Osmometry - Light scattering and ultra centrifugation methods.

UNIT-III **12H**

Electro Chemistry II: Electrode potentials - Double layer at the interface - rate of charge transfer - Decomposition potential - Over potential - Tafel plots - Derivation of Butler - Volmer equation for one electron transfer - electro chemical potential. Electro catalysis - Fuel cells-Theory of polarography - Diffusion current - Ilkovic equation - Equation for half- wave potential – Applications of polarography - Amperometric titrations -Corrosion - Forms of corrosion - prevention methods.

UNIT-IV **12H**

Chemical Kinetics: Branching Chain Reactions - Hydrogen-oxygen reaction - lower and upper explosion limits - Fast reactions - Study of kinetics by flow methods - Relaxation methods - Flash photolysis - Acid base catalysis - protolytic and prototropic mechanism - Enzyme catalysis.

Photo Chemistry: Quantum yield and its determination - Actinometry - Reactions with low and high quantum yields - Photo sensitisation - Exciplexes and Excimers - Photochemical equilibrium – Chemieluminescence - Kinetics of collisional quenching-Stern - Volmer equation - Photo Galvanic cells.

PAPER–I: PHYSICAL CHEMISTRY-II(R23CH21)

Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-V **12H**

Biophysical Chemistry: Standard free energy change in biochemical reactions, exergonic and endergonic reactions, hydrolysis of ATP, thermodynamics of biopolymer solutions, chain configuration of bio polymers, calculation of average dimensions. Membrane equilibrium, ion transport through cell membrance, dialosis and its function. Structure and functions of proteins, enzymes, DNA and RNA in living systems, forces involved in bio polymer interactions, electrostatic forces, hydrophobic forces, molecular expansion and dispersion forces.

Reference Books:

1) Physical chemistry, G.K. Vemulapalli (Prentice Hall of India).
2) Physical chemistry, P.W. Atkins. ELBS
3) Chemical kinetics - K.J. Laidler, McGraw Hill Pub.
4) Text book of Physical Chemistry, Samuel Glasstone, Macmillan pub.
5) Statistical Thermodynamics - M.C. Gupta.
6) Polymer Science, Gowriker, Viswanadham, Sreedhar
7) Elements of Nuclear Science, H.J. Arniker, Wiley Eastern Limited.
8) Quantitative Analysis, A.I. Vogel, Addison Wesley Longmann Inc.
9) Physical Chemistry-G.W. Castellan, Narosa Publishing House, Prentice Hall
10) Physical Chemistry, W.J. Moore, Prentice Hall
11) Polymer Chemistry - Billmayer
12) Fundamentals of Physical Chemistry, K K Rohatgi-Mukherjee. Wiley Eastern Limited Publications.
13) Statistical Thermodynamics - M.Dole.
14) M.N. Hughes, The Inorganic chemistry of Biological Processes, John Wiley and Sons, New York 2nd Edition, 1981.
15) A text book of Biochemistry, AV.S.S. Rama Rao.
16) Physical Chemistry by Atkenes.

Learning Outcomes:

- ✓ Students understand the Third law of thermodynamics, Maxwell-Boltzmann distribution law and Sackur - Tetrode equation.
- ✓ Students understand the Free radical, ionic and Zeigler -Natta Polymerisation.
- ✓ Students understand the Butler - Volmer equation and Ilkovic equation.
- ✓ Students understand the Branching Chain Reactions, Enzyme catalysis and Photochemical equilibrium.
- ✓ Students understand the free energy change in biochemical reactions, exergonic and endergonic reactions, DNA and RNA in living systems in biopolymer interactions.

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SEMESTER–II

PAPER–II: ORGANIC CHEMISTRY-II(R23CH22)

Max. Marks: 100 **(Internal-30M & External-70M)**

SYLLABUS

Learning Objectives:

- ✓ To know the general methods of synthesis involving carbon-carbon multiple bonds.
- ✓ To know various mechanisms involved in aliphatic and aromatic Nucleophilic/electrophilic substitution reactions.
- ✓ To know about various elimination mechanisms in different types of substrates.
- ✓ To know the importance of functional group protection in organic synthesis.
- ✓ To know the mechanisms involved in various types of named reactions and their applications in organic synthesis.

UNIT-I **12H**

General Methods for Synthesis: Addition reactions involving electrophiles (Br_2, HBr, HOBr, and H_2O/H_2SO_4); nucleophilic additions (Michael addition, Mannich, and Grignard reactions); Addition to C-C multiple bonds-stereo chemistry of addition, formation and reactions of epoxides, syn and anti hydroxylation; hydrogenation (catalytic and Non catalytic).

UNIT-II **12H**

Aliphatic Nucleophilic Substitutions: The SN_2, and SN_1: Mechanisms, energy profile diagram and stereochemistry; SNi, mixed SN_1& SN_2, and SET mechanisms; Factors influencing nucleophilic substitution reactions: Effect of structure, nucleophile, solvent, and leaving group.

The neighbouring group mechanism: Neighbouring group participation by O, N, S, halogens, in nucleophilic substitution reactions..Concept of classical and Non-classical carbocations-Participation of Pi and Sigma bonds as neighbouring groups. Anchimeric assistance-steric requirement.

UNIT-III **12H**

Aromatic Nucleophilic Substitutions: The SNAr, SN1 mechanisms and benzyne mechanism. Reactivity-effect of substrate structure, leaving group and attacking nucleophile. The Von-Ritcher, Sommelet-Hauser and Smiles rearrangements.

Aromatic Electrophillic Substitution reactions -Friedel Crafts Alkylation, Acylation, Halogenations.

UNIT-IV **12H**

Elimination and Protecting Groups:

a) Types of elimination (E1, E1CB, E2) reactions, mechanisms, stereochemistry and orientation, Hofmann and Saytzeff's rules, Syn elimination versus anti elimination. Competitions between elimination and substitution.
b) Dehydration, dehydrogenation, decarboxylative elimination, pyrolytic elimination, molecular rearrangement during elimination.
c) *Importance of functional group protection in organic Synthesis:* Protecting agents for the protection of functional groups- Hydroxyl group, Amino group, Carbonyl group and Carboxylic acid group.

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SEMESTER–II

PAPER–II: ORGANIC CHEMISTRY-II(R23CH22)

Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-V **12H**

Familiar Named Reactions: Benzoin, Perkin, Cannizaro,Dieckmann and Stobbe condensations; Hofmann, Schmidt, Lossen, Curtius, Clasien, Backmann and Fries rearrangements; Reformatsky, Favoursky, Wittig reaction, Baeyer Villiger reaction and Chichibabin reaction, Oppenaur oxidation, Clemmensen, Wolff-Kishner, Meerwein–Ponndorf–Veriey and Birch reductions..

Reference Books:

1) Advanced organic chemistry – reaction, mechanism and structure, Jerry March, John Wiley.
2) Advanced organic chemistry, F.A.Carey and R.J.Sundberg, Plenum.
3) A guide book to Mechanism in organic chemistry, Peter Sykes, Longman.
4) Organic chemistry, I.L.Finar, Vol. I & II, Fifth ed. ELBS, 1975.
5) Organic chemistry, Hendrickson, Cram and Hammond (Mc Graw – Hill).
6) Stereo Chemistry of carbon compounds – E.L. Eliel.
7) Modern organic Reactions, H.O.House, Benjamin.
8) An introduction to chemistry of Heterocyclic compounds, R.M.Acheson.
9) Structure and mechanism in organic chemistry, C.K.Ingold, Cornell University Press.
10) Principles of organic synthesis, R.O.C.Norman and J.M.Coxon, Blakie Academic & Professional.
11) Reaction Mechanism in organic chemistry, S.M.Mukherji and S.P.Singh, Macmillan.

Learning Outcomes:

- ✓ Students understand the mode of addition reactions involving addition by electrophile and nucleophiles over unsaturated bonds between carbons
- ✓ Students understand and apply the substitution and elimination reaction mechanisms at aliphatic and aromatic substrates for various reactions leading to research
- ✓ Understand how to protect various functional groups in organic synthesis and can apply the same to novel molecules useful for research also.
- ✓ Students understand the mechanisms of studied named reactions and their applications in organic synthesis.
- ✓ To learn the molecular rearrangements.

SEMESTER–II

PAPER–III: ESSENTIAL LAB TECHNIQUES FOR INDUSTRY (R23CH23)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To know the fundamentals in separation analysis using various chromatographic techniques.
- ✓ To know the techniques involving reliable separation by HPLC & GC instrumental techniques.
- ✓ To know the purification by ion exchange chromatography.
- ✓ To know the instrumentation and applications of AAS & ICP-OES.
- ✓ To know the basic principles, instrumentation and advantages UV, IR, NMR, ESR, TEM, SEM- techniques in structural analysis.

UNIT-I **14H**

Chromatography–Adsorption and Partition

1) **Introduction to Chromatography:**Different types of Chromatography. Adsorption chromatography- adsorbents, solvents, solutes, apparatus. Column Chromatography-stationary phase, Mobile phase, packing of column, advantages and disadvantages.
2) **Thin Layer Chromatography:** Basic Principles. Common stationary phases, Methods of preparing TLC plates, Selection of mobile phase, Development of TLC plates, Visualization methods, R_f value. Application of TLC in monitoring organic reactions.
3) **Paper Chromatography:** Basic Principles. Ascending and descending types. Selection of mobile phase, Development of chromatograms, Visualization methods. Application of paper chromatography in the identification of sugars and amino acids. One and two dimensional paper paper chromatography.

UNIT-II **14H**

High Performance Liquid Chromatography (HPLC): Basic Principles. Normal and reversed Phases. Selection of column and mobile phase. Instrumentation. detectors; RT values. Applications in the separation, identification and quantitative estimation of organic compounds. Concepts on HPLC method development.

UNIT-III **12H**

Gas Chromatography: Basic Principles. Different types of GC techniques. Selection of columns and carrier gases. Instrumentation. detectors; RT values. Applications in the separation, identification and quantitative analysis of organic compounds.

Ion Exchange Chromatography: Basic Principles. Preparation of cross linked polystyrene resins. Different types of cation and anoin exchange resins. Application in the purification of carboxylic acids and amines.

UNIT-IV **10H**

AAS: Principle, instrumentation and applications

ICP-OES: Principle, instrumentation, applications and advantages over AAS.

UNIT-V **10H**

UV, IR, NMR, ESR, TEM, SEM-Basic principles, instrumentation and advantages.

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SEMESTER–II

PAPER–III: ESSENTIAL LAB TECHNIQUES FOR INDUSTRY (R23CH23)

Max. Marks: 100 **(Internal-30M & External-70M)**

Reference Books:

1) Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and T. A. Nieman, Harcourt College Pub.
2) Separation Techniques by M. N. Sastri, Himalaya Publishing House (HPH), Mumbai.
3) Bio Physical Chemistry by A. Upadhyay, K. Upadhyay and N. Nath, (HPH), Mumbai.
4) A Hand Book of Instrumental Techniques for Analytical Chemistry- Ed-F. A. Settle, PrearsonEdn.,
5) Delhi. Introduction to Organic Laboratory Techniques-D. L. Pavia, G. M. Lampman, G. S. Kriz and R. G. Engel, Saunders College Pub. (NY).
6) Instrumental methods of Chemical Analysis by B. K. Sharma, Goel Publish House, Meerut.
7) Instrumental methods of Chemical Analysis by H. Kaur, Pragati Prakasan, Meerut.

Learning Outcomes:

- ✓ The student will understand advantage of cheromatographic separation and application on various reactions.
- ✓ The studentwill understand the advantage of HPLC & GC techniques over conventional separation techniques.
- ✓ The student will know the exchange of ions taking place in ion exchange chromatography.
- ✓ The student will know the procedure of analysing the elements using AAS & ICP-OES.
- ✓ The students understand the working principles and advantages of the UV, IR, NMR, ESR, TEM, SEM- techniques.

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SEMESTER–II

PAPER-IV (Elective–A): INORGANIC CHEMISTRY-II (R23CH24A)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To know the Classification and Applications of Metal Clusters.
- ✓ To know the reactions of organo metallic compounds.
- ✓ To know the Anation Reactions and Trans effects.
- ✓ To know the Selection rules, Correlation diagrams and Orgel diagrams.
- ✓ To know the Cotton effect and Faraday effect, structures of Hemoglobin and Myoglobin, Vitamin B_{12}, Photo Chemical Laws.

UNIT-I **12H**

Metal Clusters Classification: LNCs and HNCs**,** Isoelectronic and Iso lobal relationships, electron counting rules: Wade's and Lauher's rules. M-M multiple bonding; Preparation, structure and bonding in di nuclear $[Re_2Cl_8]^{2-}$, tri nuclear $[Re_3Cl_9]$, tetra nuclear $[W_4OR_{16}]$and hexa nuclear $[Mo_6Cl_8]^{4+}$, $[Nb_6Cl_{12}]^{2+}$ cluster molecules and ions.

Poly atomic Zintle ions and Chevrel phases. Applications of clusters

Metal π-Complexes Preparation, structure and bonding in Nitrosyl, Dinitrogen and Dioxygen complexes.

UNIT-II **12H**

Organometallic Complexes of Transition Metals: Classification and electron counting rules. Metallocenes with four, five, six, seven and eight ($\square^4$ - $\square^8$) membered rings. Synthesis, structureand bonding of Ferrocene. Cyclopenta dienyl, Arene, Cyclohepta triene and Tropylium complexes of transition metals.

Reactions of organometallic compounds-oxidative addition, reductive elimination, insertion and elimination.

Applications of organometallic compounds-Catalytic hydrogenation, Hydroformylation and polymerization of olefin using Zeigler- Nutta catalyst.

UNIT-III **12H**

Reaction Mechanism in Transition Metal Complexes: Kinetics of octahedral substitution, acid hydrolysis, base hydrolysis-conjugate base (CB) mechanism. Direct and indirect evidences in favour of CB mechanism.

Anation Reactions: Reactions without metal-ligand bond cleavage. Factors affecting the substitution reactions in octahedral complexes. Trans effect on substitution reactions in square planar complexes.

Mechanism of redox reactions, outer sphere mechanism, cross reactions and Marcus –Hush equation, inner sphere mechanism, complementary and non - complementary reactions.

PAPER-IV (Elective–A): INORGANIC CHEMISTRY-II (R23CH24A)

Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-IV **12H**

Electronic Spectra of Transition Metal Complexes: Electronic configurations of metal ions and Spectroscopic terms. Selection rules, Breakdown of selection rules, Slator – Condon repulsion parameters, Racah parameters, Term separation energies for d^n electronic configurations.
Correlation diagrams and Orgel diagrams. Tanabe-Sugano diagrams for configurations from d^1 to d^9 octahedral and tetrahedral transition metal complexes of 3d series.
Calculations of Dq, B and β parameters. Charge transfer spectra.

UNIT-V **12H**

Magnetic Properties of Transition Complexes: Types of magnetism, anomalous magnetic moments - Orbital and spin contribution, spin - orbit coupling and magnetic moments. Chiroptical properties, Cotton effect and Faraday effect.
Biochemical Aspects of Iron and Cobalt: Binding, storage and transport of dioxygen by Hemoglobin and Myoglobin, Vitamin B_{12} and its importance.
Photo Inorganic Chemistry: Introduction, Photochemical laws, photo redox reactions and photo anation reactions. Photo chemical decomposition of water.

Reference Books:

1) Inorganic Chemistry, Huheey. Harper and Row.
2) Concise Inorganic Chemistry, J. D. Lee, ELBS.
3) Inorganic chemistry,K.F. Purcell and J.C. Kotz, Holt Saunders international
4) Organometallic chemistry, R.C. Mehrotra and A. Singh. New Age International.
5) Advanced Inorganic Chemistry, Cotton and Wilkinson, Wiley Eastern
6) Inorganic Reaction Mechanism, Basolo and Pearson, Wiley Eastern
7) Bioinorganic Chemistry, K. Hussan Reddy
8) Biological Aspects of inorganic chemistry, A. W. Addiso, W. R. Cullen, D. Dorphin and G. J. James. WelieyInterscience.
9) Photochemistry of coordination compounds, V.BalzaniandV.Carassiti. Academic Press.

Learning Outcomes:

- ✓ The student will understand the various metal clusters and metal **π** complexes.
- ✓ Understanding the reactions of organo metallic compounds and its applications.
- ✓ The Students are able to understanding the reaction mechanism in transition metal complexes, anation reactions, and complementary reactions.
- ✓ The Students are able to understand the orgel diagrams and electronic spectra of transition metal complexes.
- ✓ The study of magnetic properties and anamolous magnetic moments of transition complexes.
- ✓ The Students are able to understanding structure and functions of hemoglobin, myoglobin and vitamin B12, photochemical laws.

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SEMESTER–II

PAPER-IV (Elective–B): NANOSCIENCE AND TECHNOLOGY(R23CH24B)
Max. Marks: 100 **(Internal-30M & External-70M)**

SYLLABUS

Learning Objectives:

- ✓ To learn the types of nano structures and the binding forces.
- ✓ To learn the synthetic and characterization techniques for nanostructures.
- ✓ To learn the chemistry involved in various functional nanostructures.
- ✓ To learn about the role of nanostructures in improving energy efficiency.
- ✓ To learn about the various types of nanosensor devises for biomedical applications.

UNIT -I **12H**

Introduction to Nanoscience: Definition of Nano, emergence and challenges of nanoscience, influence of nano over micro/macro, Types of nanostructures : One dimensional, Two dimensional and Three dimensional nanostructured materials, Quantum Dots structures, metal oxides, semiconductors and composites. Nanoscience and Interface: Intermolecular Forces, Van der Waals forces. Kessorn, Debye, and London Interactions. Surface nanoscience and surface active agents.

UNIT-II **12H**

Synthesis and Characterization of Nanostructures: Fabrication techniques: Self assembly, self replication, sol- gels, Langmuir-Blodgett thin films, Nanolithography, Bio inspired synthesis, and chemical vapor deposition. Characterization techniques: Electron microscopy, Scanning probe microscopy, Near field microscopy, Micro- and near field Raman spectroscopy,Surface enhanced Raman spectroscopy and X-Ray photo electron spectroscopy.

UNIT-III **12H**

Chemistry of Nanostructures Carbon nanotubes (CNT): Structure of carbon nanotubes, synthesis and functionalization of Carbon nanotubes, electronic-vibrational- mechanical and optical properties of Carbon nanotubees; Graphene nanostructures. Carbon based nanomaterials in environment and biological systems. Biological aspects of Carbon Nanostructures, Fullerene and its derivatives. Environmental effects of nanostructures.

UNIT-IV **12H**

Applications of Nanostructured Materials: Nanostructures in Ferroelectric materials and coatings, polymer based applications, Hydrophilic - hydrophobic surface-cleaning materials, nanostructures in energy conversion and storage for renewable energy, semiconductor materials, solar cells, fuel cells, Carbon nanotubes for energy storage and hydrogen storage, as nanoscale catalysts to save energy. Nanostructures in waste reduction and improved energy efficiency, in water purification, sensors for bio-medical applications and Carbon nano-adsorbents for environmental purification.

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SEMESTER–II

PAPER-IV (Elective–B): NANOSCIENCE AND TECHNOLOGY(R23CH24B)

Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-V **12H**

Nanotechnology in Sensor Devices: Nanosensors: Introduction to sensors, fundamentals and terminology of sensors, static and dynamic characteristics and characterization of sensors. Micro and nano-sensors, biosensors and micro fluids and organic and inorganic nanosensors. Nanotechnology based devices: nanomaterials, nanostructured films, nanoscale electronic and ionic transport devises. Sensor for bio-medical applications. Biosensors: generation of biosensors and nanomaterial based biosensors.

Recommended Books:

1) Nanomaterials: Synthesis, properties and Applications, Edited by A.S.Adelstein.
2) Nanostructured carbon for advanced Applications, Edited by G.Benedek, Kluwer academic publishers, 1996.
3) Chemistry of nanomaterials : Synthesis, properties and applications CNR Rao et.al.
4) Nanoparticles: From theory to applications G. Schmidt, Wiley Weinheim (2004).
5) Processing & properties of structural nanomaterials - Leon L. Shaw
6) Nanochemistry: A Chemical Approach to Nanomaterials, Royal Soc. of Chemistry, Cambridge, UK (2005).
7) Environmental Chemistry for a Sustainable World, Volume -1: Nanotechnology and
8) Health Risk Editors: Lichtfouse, Schwarzbauer, Robert
9) Advances in Nanotechnology and the Environment, Juyoung Kim, CRC Press, Taylor and Francis Group.
10) Nanomaterials for Biosensors, Cs. Kumar, Wiley – VCH (2007).
11) Naostructures and Nanomaterials: Synthesis, properties and applications, G.Cao, ImperialCollege Press (2004).
12) The chemistry of nanomaterials: Synthesis, properties and applications, C.N.R.Rao, A.Muller, A.K.Cheetham (Eds), Wiley VCH Verlag Gmbh&Co, Weinheim, 2004.
13) Carbon Nanotubes: Properties and Applications- Michael J. O'Connell.
14) Nanotubes and Nanowires-CNR Rao and A Govindaraj,RCS Publishing.
15) Carbon Nanomaterials for Environmental and Biological Applications, Bergmann andMachado., Springer.

Learning Outcomes:

- ✓ The student is provided with basic theoretical background on nanoscienceand nanostructures.
- ✓ Understands various synthetic and characterization techniques fornanostructures.
- ✓ Equipped with necessary chemistry knowledge involved in variousfunctional nanostructures.
- ✓ Student is encouraged to pursue the development of new Nanostructures for energy efficiency.
- ✓ Understands the challenges of Nanoscience and its potential applications in biomedical and environmental fields.

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SEMESTER–II

PAPER-IV (Elective-C): MATERIAL SCIENCE (R23CH24C)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To learn the basic concepts involved in Material science and material structures.
- ✓ To learn about various types of conducting materials.
- ✓ To learn how testing and characterizations are done for materials.
- ✓ To learn about aerospace materials used in Cryogenic applications.
- ✓ To learn about the materials used in energy production and storage.

UNIT-I **12H**

Material Science: Introduction, Condensed states of matter- crystalline and amorphous states. Ionic, covalent, metallic and molecular bindings- Bond angle, bond length and bond energy. Hybridisation - Delocalised chemical bonding. Basics in crystal morphology, Lattice energy - Madelung constant. Inert gas crystals - van der Waals interaction - Lennard Jones' potential. Simple crystal structures - Sodium Chloride, Cesium Chloride, Diamond and Zinc sulphide structures. Close packed structures - packing efficiency and density of materials.

UNIT-II **12H**

Conducting Materials: Metals, Alloys, Semiconductors-Definition, electrical properties, optical properties, mechanical properties and thermal properties. Specific examples of metals-Copper, Aluminium, Iron, Gold, Silver. Uses of metals. Drawbacks of metals. Alloys-advantages of alloying. Examples-Brass, Bronze, Steel, Stainless steel, Gold alloys, silver alloys and their uses. Semiconductors: Elemental semiconductors- Silicon, Germanium. Doping-n-type and p-type semiconductors, p-n junctions. Qualitative ideas of devices- diodes to Integrated circuits (ICs).

UNIT-III **12H**

Materials Testing and Characterization Vacuum Techniques: Vacuum pumps: Rotary, Vapour diffusion, Turbomolecular and Cryogenic pumps. Vacuum measurement: Thermal conductivity gauges and Pirani and thermocouple gauges. Ionisation gauges: Hot and cold cathode ionisation gauges. Non- Destructive Testing of Materials: X-Ray and Neutron Radiography. Mechanical Testing of Materials: Tensile, Compression and Hardness tests, B-V-R hardness numbers. Impact and Fatigue tests. Materials Characterisation: Electron Microscopy,Transmission Microscopy (TEM)-Scanning Microscopy (SEM) - Atomic Absorption, IR, Raman, Low Energy Electron Diffraction (LEED) and X-ray Photoelectron Spectroscopy (XPS).

PAPER-IV (Elective-C): MATERIAL SCIENCE (R23CH24C)

Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-IV **12H**

Aerospace Materials,Super Alloys and Smart Materials: Aerospace materials-Evaluation of materials for space environment. Materials for Cryogenic applications: Metals for low temperature applications, Austenitic stainless steel, Nitrogen containing steel, Al-Li alloys, Titanium alloys and cryoinsulation materials. Materials for space environment: Radiation shielding materials, Space suit materials and materials for life support system. Metallic materials, super alloys and Smart Materials: Iron based-nickel based–cobalt based super alloys-applications. Smart materials-shape memory effect (SME). Ti-Ni(SM) alloys, Cu based alloys and applications.

UNIT-V **12H**

Materials in Energy Production: Global Energy Scene, Forms of energy, Conservation of energy, Solar Cells, Types of Solar cells. Solar Cell Fabrication Technology. Hydrogen energy-merits as a fuel-Hydrogen storage, sea as source of deuterium. Fuel cells-components, working and performance of fuel cells, Types of fuel cells-Solid oxide fuel cells (SOFC), Molten carbonate fuel cells (MCFC), Phosphoric acid fuel cells (PAFC) Polymer Electrolyte fuel cells and applications. Superconductors: Types - high Tc superconductors - applications of Superconductors.

Recommended Books

1) Elements of Materials Science and Engineering–Lawrence H van Vlack, AddisionWesley(1975).
2) Materials Science and Engineering, V. Raghavan, Prentice Hall India (1993).
3) The Structure and Properties of Materials, Rose, Shepard and Wulff, Vol.I-IV Wiley eastern, (1987).
4) X-Ray Crystallography, M .J Buerger, John Wiley (1942).
5) Introduction to Solids, A J Dekker, McMillan India (1981).
6) Electronic Processes in Materials, L. V Azaroff and J.J. Brophy.McGraw Hill (1963).
7) Materials Science and Technology–A comprehensive treatment, R.W Cahn, P Haasen & E J Kramer.
8) Electronic and Magnetic Properties of Metals and Ceramics: Part I Materials Science andTechnology : A Comprehensive Treatment, **Vol.** 3, R. W. Cahn, P. Haasen, 1991, John Wiley.
9) High performance materials in Aerospace, H.M.Flower, Ist ed, Chapman & Hall (1995).
10) Advanced Aerospace materials, B.Horst, B.Ilschner, K.C.Russel, Springer-verlag,Berlin (1992).

Learning Outcomes:

- ✓ The student is provided with basic theoretical background on Material Science and molecular structures.
- ✓ Understands various types of widely used conducting materials.
- ✓ Gains necessary knowledgeabout material testing and characterization.
- ✓ Understands properties of materials used to protect severe environmentsand extreme stress levels in space crafts.
- ✓ Understands global energy scenario and the role played by materials inenergy storage and conservation.

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SEMESTER–II

PRACTICAL–I: INORGANIC & PHYSICAL CHEMISTRY(R23CH25)

Max. Marks: 100 **(Internal-30M & External-70M)**

A total Six (6) Experiments must be carryout taking minimum of '3' in each section

LIST OF EXPERIMETNS:

SECTION-I: INORGANIC CHEMISTRY

Semimicro analysis of six radical mixtures containing one interfering radical and one less familiar cation each.

Interfering Anions : Oxalate, tartrate, phosphate, chromate.

Less familiar Cations : Thallium, molybdenum, thorium, zirconium,vanadium, uranium.
(Minimum three Mixtures)

SECTION-II: PHYSICAL CHEMISTRY

1) Potentiometric determination of Fe(II) with Cr(VI)
2) pH-metric determination of strong acid with strong base.
3) Conductometric titration of strong acid with strong base
4) Verification of Beers Law using potassium permanganate.

Reference Books:

1) Vogels Text Books of Qualitative analysis, Revised. J. asset, R.C. Denny, G.H. Jeffery and J. Mendhan. ELBS.
2) Synthesis and Characterisation of Inorganic Compounds, W.L.Jolly. Prentice Hall.
3) Practical Inorganic chemistry by G. Pass and H. Sutcliffe Chapman and Hall.
4) Practical Inorganic Chemistry by. K. Somasekhar Rao and K.N.K. Vani.

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SEMESTER–II

PRACTICAL–II: ORGANIC CHEMISTRY(R23CH26)

Max. Marks: 100 **(Internal-30M & External-70M)**

(Minimum Five Experiments must be carryout)

1) **Identification Functional Groups in Organic Compounds:** Phenol, bases, organic acid, ketone, aldehyde, amide and carbohydrate with preparation of two solid derivatives.
   i) Identification of given two compounds with preparation of two solid derivatives and
   ii) Reporting of the melting points for derivatives.

2) **Purification of Derivatives**: The student has to do recryastallization to final derivatives(s) and submit the sample. If the sample is impure liquid must carryout distillation process.

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SEMESTER–II

PRACTICAL–III: COMPREHENSIVE VIVA-VOCE (R23CH27)

Max. Marks: 50

1) The students will be analyzed with questions covering 1st & 2nd semester topics.

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SEMESTER–II

PAPER-VIII: COMMUNICATIVE ENGLISH (R23CH28)

Max. Marks: 50

Learning Objectives:

- ✓ The course helps to improve easy and fluent communication skill among the students.
- ✓ This English Communication Skill based course mainly focuses on to improve the Linguistic Listening, Communicative Competence and Presentation Skills of the students.
- ✓ Activities in the English Communication Skill based course will simulate actual discourses that students will engage in their interaction with their peers, teachers or strangers in their day-to-day situations.
- ✓ To learn the employability skills and descriptions.
- ✓ To learn the extempore and presentaions.

Unit-I: Communication Skills **6H**

a) Verbal: a) Types of Communication; b) Barriers to Communication.
b) Strategies for effective communication.
Nonverbal Skills - a) Body Language-Voluntary and Involuntary;
b) Kinesics Facial Expressions;
c) Proxemics;
d) Oculesics;
e) Haptics and Chronemics.

Unit-II: Advanced Vocabulary **6H**

a) Synonyms & Antonyms; b) Phrasal verbs; c) Idioms; d) One word Substitutes.

Unit-III: Employability Skills & Descriptions **6H**

Employability Skills:

a) Interview Skills; b) Group Discussion c) Resume Writing.

Descriptions:

a) Process Description; b) Picture Description; c) Narration; d) Email etiquette.

Unit-IV: Role Play/Dialogue Writing **6H**

a) Introducing oneself & others;
b) Asking for & giving permissions;
c) Asking for and responding to give directions;
d) Seeking request;
e) Inviting and responding invitations;
f) Apologizing.

Unit-V: Presentation Skills **6H**

Extempore (JAM) Sessions; Paper Presentation.

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SEMESTER–II

PAPER-VIII: COMMUNICATIVE ENGLISH (R23CH28)

Max. Marks: 50

Learning Outcomes:

- ✓ To realize the importance of communication skills in job arena.
- ✓ To enhance the students ability to communicate.
- ✓ Able to describe procedures and improves analytical thinking.
- ✓ Capable to make the students communicate in Daily life situations.
- ✓ Capable to participate in all recruitment procedures.
- ✓ Able to communicate confidently in oral presentations.

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SEMESTER–III
PAPER–I: APPLIED INORGANIC ANALYSIS (R23AC31)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To get knowledge about the industrial valuable minerals and ores.
- ✓ To know about the various constituents and their determinations present in Lime stone, phosphate rock, pyrolusite, feldspar etc.
- ✓ To know about the various constituents and their determinations present in ferrous and non-ferrous alloys.
- ✓ To know about the various constituents and their determinations present in non-ferrous alloys.
- ✓ To know about the various constituents and their determinations present in complex materials like cement and glass.

UNIT-I **12H**

Analysis of Limestone: Moisture, loss on ignition, insoluble matter (silica), determination of combined oxides (R2O3), calcium, magnesium, carbon dioxide.
Analysis of Hematite - Moisture, volatile matter, silica, iron, oxide iron,
Analysis of Pyrolusite - Moisture, volatile matter, silica, manganese, combined oxides
Analysis of Clay Materials: Moisture, volatile matter, silica, R_2O_3, Fe_2O_3.

UNIT-II **12H**

Analysis of Phosphate Rock: Moisture, loss on ignition, SiO_2, allumina, Fe_2O_3, toal CaO, magnesium. **Analysis of Feldspar:** Silica, sodium, potassium, sulphate.
Analysis of Monozite: Oxides of calcium, magnesium, iron, aluminum, sulphur, silica.
Analysis of Arsenic ores, Barium ores, Chrome ores, Vanadium ores.

UNIT-III **12H**

Analysis of Ferrous Alloys: Analysis of Steels - types of steels- digestion methods for different types of steels - determination of contents of carbon, silicon, sulphur, phosphorous, manganese, nickel magnesium, vanadium, molybdenum, nickel, aluminum, chromium and tungsten in steel samples.

UNIT-IV **12H**

Analysis of Non - Ferrous Alloys: Brass, bronze and solder. Compositions of different alloys-digestion procedures of alloys - Procedures for the determination of contents like tin, copper, lead, zinc and iron, aluminum, manganese, antimony.

Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-V **12H**

Analysis of Complex Materials: Analysis of cement - loss on ignition, insoluble residue, total silica, sesqui oxides, lime, magnesia, ferric oxide.

Analysis of Glasses: Determination of silica, sulphur, barium, arsinic, antimony, total R_2O_3, calcium, magnesium, total alkalies, aluminum, chloride, fluoride colouring agents in glass-chromium, cobalt, copper, total iron, manganese, nickel, titanium, lead, barium, sodium, potassium, cerium, zirconium, arsenic.

Reference Books:

1) F.J.Welcher-Standard methods of analysis
2) I.M.Kolthoff-Volumetric analysis V.A. Strenger Vols I to III,
3) A.I.Vogel - A text Book of quantitative Inorganic analysis - ELBS,
4) H.P.Walton- Principles and methods of chemical analysis-Prentice Hall,
5) Laitnen & Harris -Chemical Analysis,
6) C.W.Wilson and D.W.Wilson-Comprehensive analytical Chemistry,
7) F.D.Snell & F.M.Biffen-Commercial methods of analysis-D.B. Taraporavala & sons,
8) Manual of procedures for Chemical and instrumental analysis of Ores, Minerals and Ore Dressing Products Published by Indian Bureau of Mines, Ministry of Steel and Mines, Nagpur.

Learning Outcomes:

- ✓ The student will understand the methods of analysis of ores and minerals in industries.
- ✓ Understanding the methods of analysis of various industrial products.
- ✓ Students are able to understand the methods of analysis of various constituents and their determinations present in the ferrous and non-ferrous alloys.
- ✓ Students are able to understand the methods of analysis of various constituents and their determinations present in the non-ferrous alloys.
- ✓ Students know about types of various constituents and their determinations present in the cement and glasses.

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SEMESTER–III

PAPER–II: ANALYSIS OF APPLIED INDUSTRIAL PRODUCTS (R23AC32)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To get knowledge about the analysis of pesticides present in the food samples by using chromatography methods.
- ✓ Provides knowledge on analysis of oils.
- ✓ Having an idea about analysis of different industrial solvents and determination of methoxyl and
  N-methyl groups.
- ✓ To know about the analysis of fertilizers, pesticides and other materials starch, sugars, cellulose and paper.
- ✓ To get knowledge about the analysis of gases, gaseous fuels and coal.

UNIT-I **12H**

Pesticide analysis of Food Products: Purification of food samples,
Gas chromatography for organophosphates in food,
Thin layer chromatography for chlorinated pesticides in food products,
Microscopic examination food.

UNIT-II **10H**

Analysis of Oils: Saponification value, iodine value, acid value, ester value, bromine value, acetyl value

UNIT-III **12H**

Analysis of industrial solvents like benzene, acetone, methanol and acetic acid,
Determination of methoxyl and N-methyl groups.

UNIT-IV **14H**

Analysis of Fertilizers: Urea, NPK fertilizer, super phosphate,
Analysis of DDT, BHC, endrin, endosulfone, malathion, parathion,
Analysis of starch, sugars, cellulose and paper.

UNIT-V **12H**

Gas Analysis: Carbon dioxide, carbon monoxide, oxygen, hydrogen, saturated hydro carbon, unsaturated hydrocarbons, nitrogen, octane number, cetane number.
Analysis of Fuel Gases like: Water gas, producer gas, kerosene (oil) gas.
Ultimate Analysis: Carbon, hydrogen, nitrogen, oxygen, phosphorus and sulfur.

PAPER–II: ANALYSIS OF APPLIED INDUSTRIAL PRODUCTS (R23AC32)

Max. Marks: 100 **(Internal-30M & External-70M)**

Reference Books:

1) F.J.Welcher - Standard methods of analysis,
2) A.I.Vogel - A text book of quantitative Inorganic analysis – ELBS.
3) H.H.Willard and H.Deal - Advanced quantitative analysis - Van Nostrand Co.
4) F.D.Snell & F.M.Biffen - Commercial methods of analysis - D.B.Taraporavala & sons.
5) J.J.Elving and I.M.Kolthoff - Chemical analysis - A series of monographs on analytical chemistry and its applications - Inter Science- Vol. I to VII.
6) G.Z.Weig - Analytical methods for pesticides, plant growth regulators and food additives – Vol. I to VII.
7) Analytical Agricultural Chemistry by S.L.Chopra & J.S.Kanwar - Kalyani Publishers.
8) Manual of soil, plant, water and fertilizer analysis, R.M. Upadhyay and N.L Sharma, Kalyani Publishers, New Delhi.
9) Analytical Chemistry, H. Kaur – A Pragathi Edition.

Learning Outcomes:

- ✓ Imparts students with the core skills to assess measures and interpret data extracted from real life applications.
- ✓ By applying this knowledge they can establish numerical value in order to determine the various components present in an oil samples.
- ✓ Can analyze the different solvent for the industrial purpose.
- ✓ Can identify different chemical compound used as fertilizers and also can analyze those fertilizers.
- ✓ It explores various methods and techniques to analyze different gas that are present in the fuels.

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SEMESTER–III

PAPER–III (Elective–A): OPTICAL THERMAL & RADIOCHEMICAL METHODS OF ANALYSIS (R23AC33A)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To gain knowledge about spectroscopic techniques like IR, Raman etc.
- ✓ Provide knowledge about Nephelometry & Turbidimetry and Flourimetry & Phosphorimetry.
- ✓ Have an idea about basic analytical techniques like flame photometer, AAS etc.
- ✓ To know about thermal analysis.
- ✓ Must have basic idea about radio chemical methods of analysis.

UNIT-I **12H**

Infrared Spectroscopy: Theory – Molecular Vibrations – Instrumentation- Limitations – Structure determination – Quantitative Analysis: Base line techniques.
Raman Spectroscopy: Theory – Properties of Raman lines – Differences between Raman & IR Spectra – Rayleigh Scattering – Mechanism of Raman effect – Instrumentation – Applications.

UNIT-II **12H**

Nephelometry & Turbidimetry: Theory – Instrumentation – Difference between Nephelometry & Turbidimetric titrations – Applications.
Flourimetry & Phosphorimetry: Theory – Flourescence & Phosphorescence – factors effecting Flourescence & Concentration – Limitations – Comparison of Flourimetry & Phosphorimetry – Applications.

UNIT-III **12H**

Emission Spectroscopy: Principle – Theory – Instrumentation – Types responsible for Line Spectra – Merits & Demerits – Applications.
Flame Photometry: Principle – Theory – Instrumentation – Experimental Procedures – errors in Flame Photometry – Applications.

UNIT-IV **12H**

Atomic Absorption Spectroscopy: Principle – Theory – Limitations – Relation between Atomic absorption& Flame emission – Instrumentation Estimation of cation & anions – Applications.
Inductively Coupled Spectrometer: Principles – Instrumentation – Advantages over Atomic Absorption Spectroscopy – Applications with specific examples like Chromium, Molybdenum, Zirconium and Aluminium.

PAPER–III (Elective–A): OPTICAL THERMAL & RADIOCHEMICAL METHODS OF ANALYSIS (R23AC33A)

Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-V **12H**

Thermal Analysis Techniques: Thermogravimetric Analysis – Types of Thermal balances. **Differential Thermal Analysis:** Differential scanning calorimetry-Thermometric Titrations.

Radio Chemical Methods: Objectives, introduction, principles and theoretical aspects, technique/ method, gas counter, scintillation counter, errors and correction, liquid scintillation counting, sample preparation, applications.

Reference Books:

1) B.K.Sharma - Instrumental methods of chemical analysis, Goel Publishers.
2) G.Chatwal and S.Anand --Instrumental methods of chemical analysis.
3) A.I.Vogel - A text Book of Quantitative Inorganic Analysis-ELBS.
4) H.H.Willard, LL Merrit and JA Dean -- Instrumental Methods of Analysis.
5) Peace-Instrumental Methods of Analysis.
6) J.W. Robbinson- Under graduate Instrumental Analysis.
7) G.W Eving- Instrumental Methods of Chemical Analysis.
8) D.A.Skoog, D.M.West and F.J.Holler -Fundamentals of Analytical Chemistry.
9) H.Kaur-Instrumental methods of chemical analysis, Pragathi Prakasan.
10) D.A.Skoog, F.J.Holler and Nieman-Instrumental Methods of Analysis.

Learning Outcomes:

- ✓ Students able to understand vibrational spectroscopic techniques.
- ✓ Understand the principles of Nephelometer and Turbidity meter.
- ✓ Student gets knowledge about emission spectroscopic methods.
- ✓ Student gets knowledge about principle & instrumental techniques of AAS, ICP-MS.
- ✓ To get the knowledge about Thermal analysis techniques and radio chemical methods.

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SEMESTER–III

PAPER–III (Elective–B): APPLICATIONS OF SYNTHETIC PRODUCTS (R23AC33B)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To know the basics of dyes, drugs and also their importance.
- ✓ To know about the production and working of soaps, detergents and formulations of cosmetics.
- ✓ To know about flavours, sweeteners, insecticides, and their applications.
- ✓ To know about explosions and polymer types.
- ✓ To know about the biodegradable and non-biodegradable polymers and their industrial importance**.**

UNIT-I **12H**

Dyes: Colour and constitution, classification, dyeing method, and their industrial importance.

Drugs: Basic concepts, classification, sources, the requirement of an ideal drug.

UNIT-II **12H**

Synthetic Drugs: Structure and medicinal properties.

Sulphanilamide: An example of sulpha drug - paracetamol, aspirin, oil of wintergreen; Mephensin.

A muscle relaxant; Ibuprofen – an anti-inflammatory drug; L-dopa-cures Parkinson’s disease;

UNIT-III **12H**

Soaps and Detergents: Production and their cleansing action.

Liquid crystals and their applications. Surfactants

Cosmetics: Detailed study of formulations and manufacturing of cream and lotions, lipstick and nail polish, shampoos, hair dyes, and toothpastes.

Flavours: Natural flavouring materials and classification.

UNIT-IV **12H**

Sweeteners: Natural and Synthetic sweeteners.

Pesticides: Introduction, Classification, Applications and their effect on the environment.

Insecticides: Introduction, Classification, Applications and their effect on the environment.

Explosives: Introduction, RDX, Gun Powder.

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SEMESTER–III

PAPER–III (Elective–B): APPLICATIONS OF SYNTHETIC PRODUCTS (R23AC33B)

Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-V **12H**

Polymers: Introduction, biodegradable and non-biodegradable polymers and their industrial importance, plastics (uses and effects on environment), natural and synthetic rubbers, polyamides, and polyesters like nylon, decron, terelyne. Thermoplastics–Poly carbonates, Poly acrylates in lens applications, Polyurethanes, and conducting polymers.

Reference Books:

1) I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.742.
2) K. Albert, L Lehninger, D. L. Nelson, M.M. Cox, Principles of Biochemistry, CBZ Publishers, 1st Edition, New Delhi, 1993.
3) Harper's Biochemistry, Ed. R. Harper, 22nd Edition, Prentice Hall Press, New York, 1990.
4) Encyclopedia of Chemical Technology – Kirck – Othmer Series.
5) Harper's Review of Biochemistry – P.W. Martin, P.A. Mayer & V.W. Rodfwell, 15th Edition, Maurzen Asian Edition, California, 1981.
6) Polymer Science, Gowarikar.
7) Industrial Chemistry, B.K. Sharma.

Learning Outcomes:

- ✓ The students able to understand dyes and their industrial importance.
- ✓ The students understand the cleansing action of soaps, manufacture of cosmetics and use of flavours and sweetness.
- ✓ The students able to understand effects of pesticides and insectides to the environment.
- ✓ The students understand about explosive materials and preparation & use of polymers in industries.
- ✓ Students can understand the biodegradable and non-biodegradable polymers and their industrial importance**.**

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SEMESTER–III

PAPER–III (Elective–C): BASICS OF BIOTECHNOLOGY (R23AC33C)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ Learn the fundamentals of cell biology such as structure and functions of cell and subcellular organelles in eukaryote
- ✓ To understand the basic concept of metabolic processes in microorganisms, plants and animals
- ✓ To get knowledge on biology in the computer age, information processing challenges in biotechnology
- ✓ To get knowledge on biodegradation and genetically modified organisms in the environmental management.
- ✓ To get knowledge about the different food processing methods.

Unit-I: **12H**

Biology of Cell (Cell Biology), Diversity of cell size and shape, Ultra structure, Cell theory, Cell isolation, Cell disruption, Centrifugation for separation of cell contents, Biochemical methods for the identification of Cell organelles (Marker enzytmes) Ultra structure, Composition and functions of organells in eukaryotes. Nucleus, Endoplasmicreticulam, Mitochondria, Chloroplast, Golgi complex, Ribosomes, Lysosomes and Microbodies (Peroxisomes and Glyoxysomes) Vacuoles, Gap junctions and Plasmodesmata and Cell cycle.

Unit-II: **12H**

Basic concepts of metabolism (Biochemistry). Diversity of metabolic processes in microorganisms, plants and animals; Autotrophs and heterotrophs; Glycolysis, Gluconeogenesis and Glycogen metabolism, cori cycle,Citric acid cycle, Electron transport system and oxidative phosphorylation, Pentose phosphate pathway.

Unit-III: **12H**

Biology in the Computer age, information processing challenges in Biotechnology, Introduction and Scope of Bioinformatics, Biological Database Classification: Sequence, Structure and Integrated Databases.

Unit-IV: **12H**

Bioremediation, Bioaugmentation, Biodegradation of recalcitrant compounds and the role of genetically engineered microbes and genetically modified organisms in the ssss environmental management. Bioplastics and Biocompatible materials.

Unit-V: **12H**

Food preservation – Different food processing methods, High temperature, Pasteurization, Sterilization, Cold storage, Chill temperature, Freezing, Drying, Concentration, Chemical preservation, Radiation and novel methods like high pressure, microwave, dielectric methods.

Reference Books:

1) The Cell: A Molecular Approach, 4th edition, Geoffrey M. Cooper and Robert E. Hausman, 2006, *ASM Press and Sinauer Associates, Inc.*
2) Cell and Molecular Biology: Concepts and Experiments, 4th edition, Gerald Karp, Wiley Publishers, New York
3) Nelson, David L., Cox, Michael M. Lehninger Principles of Biochemistry 4/e, 2005, W.H. Freeman, Madison avenue, New York.
4) Alexander, R. (1999) Compost markets grow with environmental applications, BioCycle, April, p. 48.
5) D. Rao, SciTech Publications, Chennai, India, 2009
6) Gorden, G.Brich, food science, pergamon press headington Hill hall, 1986.
7) John.A, Troller, Sanitation in food processing, Academic press, IN.

Learning Outcomes:

- ✓ Student able to understand the fundamentals of cell biology such as structure and functions of cell and subcellular organelles in eukaryote
- ✓ Students able to understand the basic concept of metabolic processes in microorganisms, plants and animals
- ✓ Student able to understand the biology in the computer age, information processing challenges in biotechnology
- ✓ Student able to understand the biodegradation and genetically modified organisms in the environmental management.
- ✓ Students able to understand the different food processing methods.

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SEMESTER–III

PAPER–IV (Elective–A): PRINCIPLES AND TECHNIQUES IN CLASSICAL ANALYSIS (R23AC34A)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To get knowledge about acid-base titration and titrations of non-aqueous solvents.
- ✓ To get knowledge about the various types of oxidants, reductants, and redox titrations.
- ✓ To get knowledge on Complexometric Titrations and Precipitation Titrations.
- ✓ To get knowledge on Gravimetric analysis and Complexing agents.
- ✓ To get knowledge on enzymatic catalyzed and uncatalyzed reactions.

UNIT-I **10H**

Theory and Principles of Titrimetric Analysis:

Acid - Base Titrations: Titrimetric procedures involved in the neutralisation of acids and bases; Acid base indicators-indicator action-preparation of indicator solutions-mixed and universal indicators.

Precipitation Equilibria, Types of precipitates, Surface absorption, optimum conditions for precipitation.

Titration in Non-Aqueous Solvents: Choice of solvents for non-aqueous titrations. End point detection - Applications of non-aqueous titrations using glacial acetic acid as titre.

UNIT-II **14H**

Redox Titrations: Theoretical principles - redox indicators - Indicator action.

Analytical chemistry of some selected oxidants / reductants, selection of suitable indicators for various oxidant / reductant titration systems.

Oxidants: Mn(III), Mn(VII), Ce(IV), Cr(VI), V(V), Ti(III), Iodimetry and iodometry,

Reductants: Cr(II), V(II), Ti(III, Sn(II),

Use of Karl-Fisher reagent in the estimation of moisturecontent.

UNIT-III **12H**

Complexometric Titrations: Theoretical principles involved in complexometric titrations - role of indicators, EDTA titrations, Silver cyanide titration, Direct titration, back titration, substitution titration, total hardness of water, fluoride ion as demasking agent- analysis of nickel alloy.

Precipitation Titrations: Theoretical principles involved in argentometric titrations-use of normal and adsorption indicators -Indicator action.

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SEMESTER–III

PAPER–IV (Elective–A): PRINCIPLES AND TECHNIQUES IN CLASSICAL ANALYSIS (R23AC34A)

Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-IV **12H**

Gravimetric Analysis: Role of organic precipitants in Gravimetric Analysis.

Analytical Applications of organic precipitants in gravimetric analysis - Structural requirements of an organic precipitant - Specificity, selectivity, sensitivity, masking.

Complexing precipitants like DMG, Oxine, Salicylaldoxime, α-Benzoinoxime. Ion association precipitants: Benzidene, Sodium tetra phenyl boron, arsonium salts.

UNIT-V **12H**

Catalysed and Induced Reactions and Kinetic Methods of Analysis:

Kinetic aspects of the analytical use of chemical reactions-Kinetics of chemical reactions-Kinetic effects in oxidation reduction reactions

Application of Kinetic Methods: Catalytic reactions.

Uncatalysed Reactions: determination of components, determination of the rate with change of concentration, Types of kinetic methods: single point method, Differential method, Integral method, Rate determination by complex decomposition, by steady state condition, Kinetics of enzyme catalysed reactions- Factor effecting- activators, inhibitors, hydrogen ion concentration, temperature-Principles of the analytical use of enzyme reactions.

Reference Books:

1) I.M.Kolthoff - Volumetric analysis V.A. Strenger Volume I to III,
2) A.I.Vogel - A text Book of quantitative Inorganic analysis - ELBS,
3) H.P.Walton - Principles and methods of chemical analysis-Prentice Hall,
4) Laitnen-Chemical Analysis,
5) C.W.Wilson and D.W.Wilson-Comprehensive analytical Chemistry,
6) R.A.Day Jr and A.L.Underwood-Quantitative analysis-Prentice Hall,
7) K.B.Yarstimiskii - Kinetic Methods of Analysis,
8) D.A.Skoog, D.M.West and F.J.Holler - Fundamentals of Analytical Chemistry,
9) A Textbook of Analytical Chemistry. Y. Anjaneyulu - Published by PharmaMed Press.

Learning Outcomes:

- ✓ Student able to understand acid-base titration and non-aqueous solvents.
- ✓ Students able to understand role of the various types of oxidants, reductants, and redox titrations.
- ✓ Student able to understand the complexometric and precipitation titrations.
- ✓ Student able to understand the gravimetric analysis and role of complexing precipitants.
- ✓ Students able to understand enzymatic catalysed and uncatalyzed reactions.

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SEMESTER–III

PAPER–IV (Elective–B): FOOD CHEMISTRY & ANALYSIS (R23AC34B)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To learning the principles underlying and methods of food analysis in order to enable the students
- ✓ To get knowledge about the functions and importance to food quality.
- ✓ To get knowledge on types of sugars, raw materials and their roles.
- ✓ To learning about the structure, sources, functions and also their role as cofactors in metabolism of minerals and vitamins.
- ✓ To get knowledge on proteins, amino acids and nucleic acids.

UNIT-I **12H**

Starch Chemistry: Types of starches, properties of different starches. methods of extraction of starches and reducing sugars and non-reducing sugars determination. Crude fibre and fibre fractions determination.

Lipid Chemistry: Nature and types of fats, Plant, and animal foods. physical, chemical structures and properties of different fats and oils, Principles, and methods of determination of Saponification number, Iodine number, free fatty acid number, and richert-meisel number. Chemical changes in fatty acids. Chemical changes on Rancidity and heating, hydrogenation, inter-esterification, and acetylation, shortening power of fat.

UNIT-II **12H**

Food enzymes: Types of enzymes in foods, functions, and their importance to food quality.

Methods of determination of total ash. Vitamins and Minerals - Ca. phosphorus. iron. Vitamin A, Beta carotene. Riboflavin and Vitamin C.

UNIT-III **12H**

Sugars and Fats: Sugars, sugar crystals and Confections: Types of sugars and sugar syrups, Sugar cookery, Crystallization of sugars, Confectionery-Types, raw materials and their role, Indian confectionery.

Fats and oils: Sources. Composition, Absorption, Functional properties of fat, Rancidity.

Food and Drug interactions: Risk factors for food and drug interactions. Effect of food on drug therapy. Effect of drug on food and nutrition. Modifications of drug action by food and nutrition. Effect of drug on nutritional status.

PAPER–IV (Elective–B): FOOD CHEMISTRY & ANALYSIS (R23AC34B)

Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-IV **12H**

Minerals: An overview of structure, sources, functions (also their role as co factors in metabolism) deficiency states factors influencing bioavailability and requirements of Calcium, Phosphorus, Iron, Iodine, Zinc, Sodium, Potassium, Chloride and Fluorine Metabolism of Calcium and Phosphorus.

Vitamins: Sources. functions (also their role as cofactors in metabolism) deficiency states. factors influencing bioavailability and requirements'.

UNIT-V **12H**

Proteins and Amino Acids: Sources, structure, functions, digestion, and absorption of proteins.Classification of amino acids - peptides and proteins, Metabolism of amino acids - Amino Acid decarboxylation, Tran's peptidation.

Formation and disposal of ammonia- Hepatic coma, creatine and Creatinine -biosynthesis.

Nucleic acid - DNA, RNA, Bases- Purines and Pyrimidines, synthesis of Nucleic Acids- Steps of replication-Initiation, Elongation and Termination. Protein biosynthesis.

Reference Books:

1) Clipton. E. Meloan. Food analysis 3rd edition (Theory & Practice).
2) Dennis. D, Muller., Food chemistry, a Laboratory Manual by inter science publication, John Willey & Sons Inc.
3) N. Shakuntula Manay & M. Shadaksharswamy (2001). Foods- Facts and Principles. second edition. New Age International Publishers, New Delhi.
4) Keith Wilson and John Walker (2000). Practical Biochemistry Principles and Techniques, 5th edition, Cambridge University Press.
5) Satyanarayana, U, 2001. Biochemistry, Calcutta: Books & Allied (P) Ltd, 8/I -Chintharnani Das Lane.
6) Nath R.L. (1996). Text book of Medicinal Biochemistry, New age International (P) Limited Publishers, New Delhi.

Learning Outcomes:

- ✓ Student able to understand the principles underlying and methods of food analysis in order to enable the students
- ✓ Students able to understand the functions and importance to food quality.
- ✓ Student able to understand the types of sugars, raw materials and their roles
- ✓ Student able to understand the structure, sources, functions and also their role as cofactors in metabolism of minerals and vitamins**.**
- ✓ Students able to understand the proteins, amino acids and nucleic acids.

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SEMESTER–III

PAPER–IV (Elective–C): GREEN CEMISTRY (R23AC34C)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To learn the principles and importance of Green chemistry.
- ✓ To learn the use of biocatalysts in chemical reactions.
- ✓ To learn about the solvent free techniques in chemical reactions.
- ✓ To learn the synthesis and applications of ionic liquids.
- ✓ To learn about the Ultrasound and Microwave assisted green synthesis.

UNIT-I **14H**

Fundamentals and significance of Green Chemistry:

Discussion of the current state of chemistry and the environment and the definition of Green chemistry. Assessment of the impact of chemistry in the environment and definition of risk hazard. An introduction to the tools of green chemistry and its fundamental principles. Principles of Green Chemistry: Prevention of waste / by-products , Hazardous products- Designing of safer chemicals- Selection of appropriate solvents and starting materials- Use of protecting groups and catalysis- Designing of biodegradable products.

UNIT-II **10H**

Catalysis for Green Chemistry:

Use of biocatalysts- Biochemical Oxidation, Biochemical Reduction, Enzyme Catalyzed Hydrolytic Process, Modified biocatalysis- transition metal catalysis- Reformatsky reaction, Wurtz reaction, Pinacol coupling, Simmons-Smith reaction, Mukaiyama reaction, Heak reaction, Ullmann's coupling.

UNIT-III **12H**

Solvent Free Reactions:

Solvent free techniques- Reactions on solid mineral supports, Phase Transfer Catalysis- C-alkylation, N-alkylation, S-alkylation, Darzen's reaction, Wittig reaction. Green synthesis- Oxidation, Reduction, Hydroboration, Bouveault reaction, Strecker reaction, Green synthesis- Biginelli reaction, Aza-Michael reaction, Suzuki reaction, Stille reaction, Sonogashira reaction.

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SEMESTER–III

PAPER–IV (Elective–C): GREEN CEMISTRY (R23AC34C)

Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-IV **12H**

Ionic liquids:

Definition- Types of Ionic Liquids-Synthesis of Ionic Liquids- Selection of ionic liquids- physical properties- Application in organic synthesis- alkylation, allylation, oxidation, reduction, polymerization, hydrogenation, hydroformylation, alkoxycarbonylation, carbon-carbon bond forming reactions, alkene metathesis. **P**hase transfer catalysis in green synthesis: Introduction, mechanism of phase transfer catalyst reactions, types and advantages of phase transfer catalyst reactions.

UNIT-V **12H**

ULTRASOUND AND MICROWAVE ASSISTED GREEN SYNTHESIS Ultrasound:

Introduction, instrumentation and the phenomenon of cavitation. Chemical reactions: Sonochemical esterification, substitution, addition, alkylation, oxidation, reduction and coupling reactions. Microwave: Introduction, concept, reaction vessel/ medium, specific effects, atom efficiency (% atom utilization) and advantages and limitations. Chemical reactions: N-alkylation and alkylation of active methylene compounds and Diels –Alder reactions. Reactions in water and reactions in organic solvents. Solvent free reactions and deprotection of esters.

Recommended Books

1) Green Chemistry theory and Practice, P. T. Anastas and J. C. Warner Oxford Univ. Press., Oxford (1988).
2) Green Chemistry and Introductory text, Mike Lancaster, II Edition 39.
3) New Trends in Green Chemistry, V.K. Ahluwalia, M. Kidwai.
4) Green Chemistry: Environment Friendly Alternatives, Rashmi Sanghi, M M Srivastava, Narosa, New Delhi (2003).
5) Green Solvents for Organic Synthesis, V.K. Ahluwalia, Rajender S. Varma.
6) Green Analytical Chemistry, Mihkel Koel and Mihkel Kaljuran.
7) Green Chemistry – an introduction text, Royal Society of Chemistry, UK(2002).
8) Phase Transfer Catalysis in Organic Synthesis, W. B. Weber, G. W. Gokel, Springer (1977).
9) Phase Transfer Catalysis, E. V. Dehmlov, S. S. Dehmlov, 2nd Edn., Verlagchemie, Wienhein, (1983).

Learning Outcomes:

- ✓ The student is provided with theoretical background Green chemistry.
- ✓ Understands various techniques used for environmental friendly Green synthesis.
- ✓ Equipped with necessary knowledge to design and develop new solvent free chemical reactions.
- ✓ Develop biocatalysts for Green synthesis in the field of catalysis.
- ✓ Familiarized with Ultrasound and Microwave assisted green synthesis.

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SEMESTER–III

PRACTICAL–I: CLASSICAL METHODS OF ANALYSIS (R23AC35)

Max. Marks: 100 **(Internal-30M & External-70M)**

(Minimum Five Experiments must be carryout)

1) Analysis of iron ore.
2) Analysis of pyrolusite.
3) Analysis of synthetic mixture copper and nickel.
4) Analysis of synthetic mixture of iron and zinc.
5) Analysis of cement.
6) Analysis of total hardness in waters.
7) Analysis of chloride in water samples.

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SEMESTER–III

PRACTICAL–II: INSTRUMENTAL METHODS OF ANALYSIS (R23AC36)

Max. Marks: 100 **(Internal-30M & External-70M)**

(Minimum Five Experiments must be carryout)

1) Determination of alkalinity in industrial or environmental samples using pH metric procedures.
2) Assay of commercial acids by pH metric titrations using suitable base.
3) Conductometric titrations with individual acids and mixtures of acids.
4) Potentiometric titration of Fe(II) with Cr(VI).
5) Estimation of mixture of Mn(VII) and V(V) with Fe(II) using potentiometric techniques.
6) Mixture analysis of Ce(IV) and V(V) with Fe(II) by a potentiometric method.
7) Estimation of potassium thiocyanate with silver nitrate by potentiometric method.

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SEMESTER–IV

PAPER–I: ADVANCED METHODS OF ANALYSIS (R23AC41)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To provide knowledge about interpretation of Mass spectrum.
- ✓ To know about principle, theory X-RAY Spectroscopy as well as identification of substances.
- ✓ To understand about principle, theory, instrumentation and applications of EPR.
- ✓ To understand about principle, theory, instrumentation and applications of Mossbauer Spectroscopy.
- ✓ To know about principle, theory, instrumentation and applications of NMR Spectroscopy.

UNIT-I **12H**

Mass Spectrometry: Principle - Theory - Instrumentation - Interpretation of spectra of metal compounds-identification of compounds of metal compounds from fragmentation pattern.
Types of Ions produced in mass spectrometer - Nitrogen rule, thermodynamic studies-molecular structure Analytical aspects of the mass spectrometry, applications.

UNIT-II **12H**

X-RAY Spectroscopy: Principles - Theory, X-ray diffraction – Instrumentation - X-ray fluorescence - applications-identification of substances by the powder diffraction method-applications.

UNIT-III **12H**

Electron Paramagnetic Resonance Spectroscopy (EPR): Principle-Theory-Instrumentation - hyperfine interactions-determination of 'g' value - endor and eldor, applications - Study of free radicals,
Determination of Manganese, Determination of Vanadium.

UNIT-IV **10H**

Mossbauer Spectroscopy: Principle, Instrumentation and Mossbauer Spectra, Applications.

UNIT-V **14H**

Nuclear Magnetic Resonance Spectroscopy (NMR): Principles-theory-instrumentation-differences between NMR and EPR-chemical shift-spin-spin coupling effect of chemical exchange on spin-spin interactions-spin decoupling-limitations of NMR-cause of chemical shift and shielding-applications-qualitative and quantitative analysis-kinetic studies.

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SEMESTER–IV

PAPER–I: ADVANCED METHODS OF ANALYSIS (R23AC41)

Max. Marks: 100 **(Internal-30M & External-70M)**

Reference Books:

1) Becky - Ionization mass spectrometry.
2) Physical methods of Analytical Chemistry Vol. I - III,
3) J.Roilly and W.N.Ray -Physical Chemical Methods.
4) Advances in Analytical Chemistry and Instrumentation. Vol. I – IV.
5) T.H.Gouw- Guide to modern methods of instrumental analysis,
6) A.I.Vogel - A text Book of Quantitative Inorganic Analysis-ELBS.
7) P.Delahay -New instrumental methods in Analytical Chemistry.
8) H.H.Willard, LL Merrit and JA Dean -- Instrumental Methods of Analysis.
9) Banwell- Fundamentals of molecular spectroscopy.
10) D.M.Willium and I.Fleming - Spectroscopic methods of Inorganic Chemistry.
11) J.Charalambous - Mass spectrometry of metal compounds.
12) J.W.Robbinson- Under graduate Instrumental Analysis.
13) D.A.Skoog, F.J.Holler and Neman-- Instrumental Methods of Analysis.
14) Instrumental Methods of Chemical Analysis: Analytical Chemistry.
15) Gurdeep R.Chatwal and Sham K. Anand, 5th edn.

Learning Outcomes:

- ✓ Be able to use the mass spectrum of a compound to find the molecular mass & to help identify the structure of a compound
- ✓ Students learn the principles of different X-ray spectroscopic method's and application.
- ✓ Make Students aware of the fine structure of ESR absorption, Hyperfine structure, Double resonance in ESR, Techniques of ESR spectroscopy.
- ✓ Be able to use NMR spectra to determine the structures of compounds, given other information such as a molecular formula.
- ✓ Understand Principles and Applications of Mossbauer spectroscopy.

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SEMESTER–IV

PAPER–II: ANALYSIS OF DRUGS, FOODS, DAIRY PRODUCTS & BIOCHEMICAL ANALYSIS (R23AC42)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To know the different drugs used for anlgesic, antipyretics and infections.
- ✓ Provides the basic knowledge about antihistamine and sedative drugs.
- ✓ Having an idea of anti-epileptic, anticonvulsant and cardiovascular drugs.
- ✓ To know the various dairy products, preservatives, flavoring agents and food adulterants.
- ✓ Provides the knowledge about biochemical and clinical analysis of blood.

UNIT-I **12H**

Analysis of the following Drugs and Pharmaceuticals Preparations: (Knowledge of molecular formula, structure and analysis) Analysis of analgesics and antipyretics like aspirin and paracetamol Analysis of antimalerials like choloroquine. Analysis of drugs in the treatment of infections and infestations: Amoxycillin., chloramphenicol, metronidazole, penicillin, tetracycline. Anti tuberculous drug- isoniazid.

UNIT-II **12H**

Analysis of the following Drugs and Pharmaceuticals Preparations: (Knowledge of molecular formula, structure and analysis) Analysis of antihistamine drugs and sedatives like: allegra, zyrtec(citirizine), alprazolam, trazodone, lorazepem.

UNIT-III **12H**

Analysis of anti epileptic and anti convulsant drugs like phenobarbital and phenacemide. Analysis of drugs used in case of cardiovascular drugs:atenolol, norvasc (amlodipine), Analysis of Lipitor (atorvastatin) a drug for the preventin of productin of cholesterol.
Analysis of diuretics like: furosemide (Lasix), triamterene Analysis of prevacid (lansoprazole) a drug used for the prevention of production of acids in stomach.

UNIT-IV **12H**

Analysis of Milk and Milk Products: Acidity, total solids, fat, total nitrogen, protenines, lactose, phosphate activity, casein, chloride Analysis of food materials.
Preservatives: Sodium carbonate, sodium benzoate sorbic acid Flavoring agents - Vanilla, diacetyl, isoamyl acetate, limonene, ethylpropionate, allyl hexanoate and Adulterants in rice and wheat, wheat flour, sago, coconut oil, coffee powder, tea powder, milk.

UNIT-V **12H**

Clinical Analysis of Blood: Composition of blood, clinical analysis, trace elements in the body. Estimation of blood cholesterol, glucose, enzymes, RBC & WBC, Blood gas analyser.

PAPER–II: ANALYSIS OF DRUGS, FOODS, DAIRY PRODUCTS & BIOCHEMICAL ANALYSIS (R23AC42)

Max. Marks: 100 **(Internal-30M & External-70M)**

Reference Books:

1) F.J.Welcher-Standard methods of analysis,
2) A.I.Vogel-A text book of quantitative Inorganic analysis-ELBS,
3) F.D.Snell & F.M.Biffen-Commercial methods of analysis-D.B.Taraporavala & sons,
4) J.J.Elving and I.M.Kolthoff- Chemical analysis - A series of monographs on
5) Analytical chemistry and its applications -- Inter Science- Vol I to VII.,
6) Aanalytical Agricultrual Chemistry by S.L.Chopra & J.S.Kanwar - Kalyani Publishers
7) Quantitative analysis of drugs in pharmaceutical formulations by P.D.Sethi, CBS Publishers and Distributors, New Delhi.
8) G.Ingram- Methods of organic elemental micro analysis- Chapman and Hall.
9) H.Wincciam and Bobbles (Henry J)-Instrumental methods of analysis of food additives.,
10) H.Edward-The Chemical analysis of foods; Practical treatise on the examination of food stuffs and the detection of adulterants,
11) The quantitative analysis of drugs- D.C.Garratt-Chapman & Hall,
12) A text book of pharmaceutical analysis by K.A.Connors-Wiley- International, Comprehensive medicinal chemistry-Ed Corwin Hansch Vol 5, Pergamon Press.

Learning Outcomes:

- ✓ Imparts students with the core skills to interpret in real life applications.
- ✓ Gives the knowledge about pharmaceutical preparation of various sedative drugs and some other drugs.
- ✓ By applying this knowledge they can analyze and utilize various drugs.
- ✓ It explores various methods and techniques to asses and identify matter.
- ✓ Can detect the core analytes that are existing in the sample.

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SEMESTER–IV
PAPER–III (Elective–A): SEPARATION TECHNIQUES AND ELECTRO ANALYTICAL TECHNIQUES (R23AC43A)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To get knowledge on Separation Techniques in Chemical Analysis.
- ✓ To know basic concepts of chromatography.
- ✓ To get knowledge on advance chromatography techniques.
- ✓ To get knowledge on electro separation techniques.
- ✓ To get knowledge on electro analytical techniques.

UNIT-I **12H**

Separation Techniques in Chemical Analysis:

Solvent Extraction: Introduction, principle, techniques, factors affecting solvent extraction, quantitative treatment of solvent extraction Equilibria - chelate and ion association systems-synergism,

ION EXCHANGE: Introduction, action of ion exchange resins, separation of inorganic mixtures, applications.

UNIT-II **12H**

Chromatography-I: Basics of chromatography, methods of development-Elution development, Gradient elution development. Principles of chromatography, adsorption, partition coefficient. Terms: retention time and volume, resolution, Separation Factor.

Dynamics of chromatography- High Equivalent Theoretical Plate (HETP), Van Deempter equation. Introduction, equipment and applications of Column, paper chromatography and Thin layer chromatography.

UNIT-III **12H**

Chromatography -II:

Introduction, instrumentation and applications: HPLC and Gas chromatography.

Size Exclusion Chromatography – Principles of gel – filtration Chromatography, Instrumentation, retention behavior, resolution, selection of gel type, applications, Ion exclusion – Principle and applications.

Supercritical fluid chromatography (SFC) – Instrumentation of SFC, stationary and mobile phases used in SFC, Detectors, Advantages of SFC. Technique and applications of SFC.

UNIT-IV **12H**

Electrogravimetry:

Theory of electro analysis–Polarisation–Over voltage–Principles involved in electrogravimetric analysis–current–voltage curves – separation of metals by electrolysis – constant current – controlled potential electrolysis.

Coulometry: Coulometry at controlled potential – separation of Nickel and Cobalt – coulometres – types of coulometric analysis –
constant current coulometry of coulometric titrations.

UNIT-V **12H**

Voltametry, Polarography and Amperometric Titrations:

Voltametry – Principle of Polarography – dropping mercury electrode; working; factors effecting the limiting current; residual current, migration current – diffusion current – kinetic current – polarographic maximum – Half wave potential – Organic Polarography, Rapid Scan polarography – cyclic voltametry – qualitative and quantitative polarographic analysis – Amperometric titrations – its advantages and disadvantages – Bi Amperometric titrations – Chrono potentiometry.

Reference Books:

1) B.K.Sharma - Instrumental methods of chemical analysis, Goel Publishers,
2) G.Chatwal and S.Anand -Instrumental methods of chemical analysis,
3) J.J.Lingane- Electroanalytical Chemistry - Inter Science,
4) A.I.Vogel - A text Book of Quantitative Inorganic Analysis-ELBS,
5) H.H.Willard, LL Merrit and JA Dean - Instrumental Methods of Analysis,
6) Peace-Instrumental Methods of Analysis,
7) J.W. Robbinson- Under graduate Instrumental Analysis,
8) R.A.Day and A.L. Underwood- Quantitative Analysis,
9) G.W Eving- Instrumental Methods of Chemical Analysis,
10) D.A.Skoog,D.M.West and F.J.Holler--Fundamentals of Analytical Chemistry,
11) H.Kaur- Instrumental methods of chemical analysis, Pragathi Prakasan,
12) D.A.Skoog, F.J.Holler and Neman-- Instrumental Methods of Analysis,
13) G.H.Morrison and H.Frieser- Solvent extraction in Analytical Chemistry,
14) Chemical Separation methods- JA Dean, D.Vannostrand Company, New York,
15) Physical and Chemical Methods of Separation by E.W.Berg, MC Graw Hill Book Company, New York.

Learning Outcomes:

- ✓ Student able to understand Solvent Extraction and Ion Exchange separation methods.
- ✓ Students know about basics and fundamental concepts of chromatography.
- ✓ Understand the basic principles, procedure, instrumentation and applications of advance chromatographic techniques.
- ✓ Students able to understand separation and quantification of ions of a substance through Electrogravimetry and Coulometry.

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SEMESTER–IV

PAPER–III (Elective–B): ANALYTICAL CHEMISTRY OF OILS & FATS (R23AC43B)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To get knowledge about Elementary methods of analysis of Oils, Fats & Fatty acids.
- ✓ To get knowledge on Separation Techniques in Fatty acids.
- ✓ To get knowledge about chromatography techniques of Oils & Fats.
- ✓ To get knowledge about principles and spectroscopy techniques of Oils & fats.
- ✓ To get knowledge about the analysis of special quality control methods for Oils and Fats.

Unit-I: **12H**

Elementary methods of analysis of oil seeds, Oils, Fats & Fatty acids including BIS methods, Identification of Oils & Fats: Methods for detection of adulteration in Oils & Fats, Method's for evaluation of stability of Oils & Fats. BIS & AG mark specifications for Oils and Fats.

Unit-II: **12H**

Techniques of separations of Fatty acids Esterification, Low temp, Crystallization, Urea adduct, counter current Distribution.

Unit-III: **12H**

Chromatographic methods of separation for Oils and Fats with special reference to TLC & GLC techniques.

Unit-IV: **12H**

Principles and uses of modern Physico chemical analysis techniques such as UV, IR, NMR, MS etc. in Oils and Fats, their products analysis.

Unit-V: **12H**

Dilatometric measurement and its significance. Wet bulb temp & Measurement of humidity, special quality control methods for Oils and Fats like detection of Nickel etc.

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SEMESTER–IV

PAPER–III (Elective–B): ANALYTICAL CHEMISTRY OF OILS & FATS (R23AC43B)

Max. Marks: 100 **(Internal-30M & External-70M)**

Reference Books:

1) Analytical methods in Oils & Fats by cocks.
2) Laborary Hand book for chromatographic methods by O.Milkes.
3) Treatise on Fats, Fatty Acids, Oleo chemicals by O.P.Narula.
4) Instrumentation by Eckmen.

Learning Outcomes:

- ✓ Students able to understand Elementary methods of analysis of Oils, Fats & Fatty acids.
- ✓ A student gets knowledge about the Separation Techniques in Fatty acids.
- ✓ A student gets knowledge about the chromatography techniques of Oils & Fats.
- ✓ A Student gets knowledge about the principles and spectroscopy techniques of Oils & fats.
- ✓ To get the knowledge about the analysis of special quality control methods for Oils and Fats.

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SEMESTER–IV

PAPER–III (Elective–C): QUALITY CONTROL & QUALITY ASSURANCE IN PHARMA INDUSTRY (R23AC43C)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To know about the basics of quality audit like SOP, ICH, ISO etc.
- ✓ To understand the various documentation processes and handling of materials.
- ✓ To understand the organizational responsibilities and personal responsibilities in the pharma sector.
- ✓ To acquire basic knowledge about the regulatory aspects and quality control.
- ✓ To know about the Basic concepts of Quality Assurance

UNIT-I: **12H**

Pharmaceuticals Concept of drug, lead compound and lead modification, prodrugs and soft drugs. Importance of quality control, drugs and pharmaceuticals, sources of impurities in pharmaceutical chemicals, analytical quality control in finished/final products, common methods of assay.

UNIT-II: **12H**

Quality Audit, Documentation Quality audit. Standard operating procedure (SOP); international conference harmonization (ICH); ISO-9000; ISO-14000, WHO specifications, USFDA guidelines and ICMR. Documentation and Handling: Manufacturing documents, Master Formula, batch formula, Record, Distribution of records, Handling of returned goods, Recovered materials and Reprocessing.

UNIT-III: **12H**

Organization and Personnel Responsibilities Training, Hygiene, Premises: Location, Design, Plant layout, Construction, Maintenance and Sanitations. Environmental control, sterile areas, control of contamination.

UNIT-IV: **12H**

Regulatory Aspects and Quality Control Regulatory aspects. Validation f Personnel, Equipment and cleaning methods, regulatory aspects of pharmaceutics. Quality Control. In-process quality Control on various dosage forms, Sterile and non-sterile operations.

UNIT-V: **12H**

Basic concepts of Quality Assurance Basic concepts, principles or prescription, Needs, requirements and expectations, characteristics of quality, Achieving, sustaining and improving quality, Quality dimensions and costs of quality. Elements of quality Assurance, Quality Management System, Quality management concepts and principles: ISO 9001:2000, QMS Case studies on ISO 9001: 2000 in chemical industries.

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SEMESTER–IV

PAPER–III (Elective–C): QUALITY CONTROL & QUALITY ASSURANCE IN PHARMA INDUSTRY (R23AC43C)

Max. Marks: 100 **(Internal-30M & External-70M)**

Reference Books:

1) R. Pannerselvam, Production and Operations Management, Prentice Hall India Learning Pvt. Ltd 3rd Ed., 2012.
2) M. Savsar, Quality Assurance and Management, InTech-Croatia, 2012, ISBN 978-953-51-0378-3.
3) D.C. Montgomery, Statistical Quality Control, John Wiley & Sons, 5th Ed., 2005.
4) M. K. Starr, Production and Operations Management, Biztantra, Delhi, 2004.
5) D.H. Shah, QA Manual, Business Horizons, 2000.
6) D.H. Besterfield, C. Besterfield-Michna, G.H. Besterfield, M. Besterfield Sacre, Total Quality Management, Pearson Education, Inc., 3rd Ed., 2003.
7) P. Konieczka, J. Namiesnik, Quality Assurance and Quality Control in the Analytical Chemical Laboratory: A Practical Approach, 1st Ed., CRC press 2009.
8) D. Hoyle, ISO 9000 Quality Systems Handbook, 5th Ed., Butterworth Heinemann-Elsevier, New York, 2006.
9) E. Prichard, V. Barwick, Quality Assurance in Analytical Chemistry, John Wiley & Sons, 2007.

Learning Outcomes: On the successful completion of the course, student will be able:

- ✓ To learn the preliminary issues of standard operating procedure, international conference harmonization, ISO-9000, ISO-14000 etc.
- ✓ To get awareness about the methods of documentation and handling of materials.
- ✓ To gain detailed knowledge on organizational responsibilities and personal responsibilities in the maintenance of Pharma industry.
- ✓ To develop knowledge validation procedures and regulatory aspects of and quality control aspects.
- ✓ To understand the basics of Quality Assurance.

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SEMESTER–IV

PAPER–IV (Elective–A): ENVIRONMENTAL CHEMISTRY AND ANALYSIS (R23AC44A)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ To get knowledge about soil formation, properties and constituents.
- ✓ To know about the various pollutants causing water pollution and their effects.
- ✓ To know about the various pollutants causing air pollution and their effects. And also methods of waste water treatment.
- ✓ To know about the waste water treatment methods.
- ✓ To know about the various constituents present in air and water samples and their analysis.

UNIT-I **12H**

Significance of basic segments of Environment: Nomenclature in the study of Environmental Chemistry. Soil Chemistry & Pollution Studies: Principles of weathering - effect of temperature, water, air, plants and animals on weathering., Soil formation / development-factors affecting soil development - physical properties of soil; soil colloids-ion exchange properties. Soil fertility, productivity - Soil nutrients-micro and macro.

UNIT-II **12H**

Study of Water Pollution and Monitoring and Treatment Methods of Water Pollutants: Hydrosphere-water resources-hydrological cycle-unique properties of water- water quality parameters., Pollution from Domestic water, industrial, agricultural, solid waste, shipping, radioactive waste & thermal pollution.

UNIT-III **12H**

Effect of specific pollutants like mercury, lead, arsenic, selenium, nitrates, oil., Effects of soaps, detergents, pesticides, hydrocarbon with regard to water pollution., Techniques of water treatment-Primary, secondary and tertiary methods-use of coagulants-flash distillation-solar stills, ion exchange reverse osmosis, electro dialysis.

UNIT-IV **12H**

Study of Air Pollution and Monitoring and Treatment Methods in case of Air Pollution: Atmospheric sources and emission of air pollutants-carbon monoxide-sulphur, oxides-oxides of nitrogen, organic pollutants and photo chemical smog-particulates-acid rain and radioactive substances. Continuous monitoring of air pollutants - Principles, Monitoring instruments, monitoring of sulphur dioxide, hydrogen sulphide, oxides of nitrogen, oxides of carbon, hydrocarbons, ozone and suspended particulate matter and radioactive substances.

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SEMESTER–IV

PAPER–IV (Elective–A): ENVIRONMENTAL CHEMISTRY AND ANALYSIS (R23AC44A)

Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-V **12H**

Environmental Chemical Analysis:

Analysis of Soil: Sampling, determination of moisture, total nitrogen, phosphorus, silicon, lime, humus, nitrogen, alkali salts.

Analysis of Water Samples: Dissolved oxygen, Chemical oxygen demand, Biological oxygen demand, Phosphates, nitrogen compounds.

Analysis of metallic constituents,

Analysis of Air Samples: Carbon mono oxide, carbon dioxide, sulphur dioxide, hydrogen sulphide, oxides of nitrogen, ammonia, ozone, hydrocarbons and aromatic hydrocarbons.

Reference Books:

1) Environmental Chemistry by A.K.De, Wiley Eastern Limited, New Delhi
2) A Text Book of Environmental Chemistry by O.D.Tyagia and M.Mehra-Anmol Publicaitons,
3) Environmental Pollution Control and Engineering by C.S.Rao , Wiley Eastern Limited,
4) Environmental Chemistry by P.S. Sindhu -New Age International Publishers
5) A Text Book of Environmental Chemistry and Pollution Control by S.S.Dara, S.Chand & Co.,
6) Environmental Pollution Analysis by S.M. Khopkar, Wiley Eastern Limited, New Delhi
7) Analytical Agricultural Chemistry by S.L.Chopra & J.S.Kanwar - Kalyani Publishers
8) Manual of soil, plant, water and fertilizer analysis, R.M. Upadhyay and N.L 5harma, Kalyani Publishers, New Delhi.
9) Environmental Chemistry by B.K.Sharma - Goel Publishing House, Meerut.
10) Soil Chemical Analysis by M.L. Jackson, Prentice-Hall India Pvt. Ltd., New Delhi.

Learning Outcomes:

- ✓ The student will understand the soil development and various nutrients present in the soil.
- ✓ Understanding the water quality parameters and various pollutants causing water pollution.
- ✓ Students are able to understand effects of specific pollutants.
- ✓ Students are able to understand waste water treatment methods.
- ✓ Understanding the methods for analysis of soil, air and water samples.

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SEMESTER–IV

PAPER–IV (Elective–B): FORENSIC SCIENCE IN SOLVING CRIME (R23AC44B)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives:

- ✓ The significance of Forensic science to human society.
- ✓ The fundamental principles and functions of Forensic science.
- ✓ The divisions in a Forensic science laboratory.
- ✓ The various steps to be taken to thoroughly record the crime scene.
- ✓ The legal importance of chain of custody.

UNIT-I **12H**

Introduction to Forensic Science: Need and functions of Forensic science. Historical aspects of Forensic science. Development of Forensic Science Laboratories. Definitions and concepts in Forensic science. Basic principles of Forensic science. Scope of Forensic science. Governing principals of Forensic Science. Forensic Science in Indian scenario. Admissibility in Indian Courts. Frye standard and Daubert standard.

Unit-II **12H**

Divisions of Forensic Science

Branches of Forensic science and their importance. Hierarchical set up of various Government Forensic Science Laboratories.

Forensic Evidences: Concise of Forensic Physical, Biological, Chemical and Psychological evidences, Medico-Legal Cases. Legal and Scientific problems. Forensic intelligence and Interviews.

UNIT-III **12H**

Crime Scene

Types of crime scenes. Safety measures at crime scenes. Role of First Responding Officer. Coordination between police personnel and Forensic scientists at crime scenes. The evaluation of 5Ws (who? what? when? where? why?) and 1H (how?)

Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-IV **12H**

Police and Forensic Science

Relationship between police and forensic expert, Role of Police at the Crime scene, scientific help at crime scene, Importance of Chain of custody, handling of various types of crime scenes by police, forensic teaching of police personals, forensic case documentation by Police, Technological Advance and Police, Mobile device forensics, Role of Media, Human Rights Commission & Criminal Justice System.

UNIT-V **12H**

Administration and Organizational Setup:

DFSS, CFSL, GEQD, SFSL, RFSL, MFSL, FPB, NICFS, CDTS, NCRB, BPR&D, Qualifications and duties of Forensic Scientists Academic centres of education and research: Indian and Academy of Forensic Science, American Board of Forensic Science, American Board of Forensic Odontology, Bureau of Alcohol Tobacco and Firearms, Interpol and FBI, Australian Academy of Forensic Sciences. Forensic Science in India: Teaching Courses and Research fields in Forensic Science, Scope and jobs in Forensic Science.

Reference Books:

1) Max. M. Houck, Forensic Science: Modern Methods of Solving Crime.
2) U.S. Attroney's Bulletion: Forensic Science & Forensic Evidence.
3) Ross M. Gardeneer and Tom Bevel: Practical Crime scene analysis and reconstruction.
4) Dr. Karanam Satyanarayana: Step by step in police investigation and ground realities, Ist edition.

Learning Outcomes:

- ✓ The definition and difference between Forensic Science and Criminalists.
- ✓ The major contributors to the development of Forensic Science.
- ✓ Importance of physical evidence.
- ✓ To Learn Forensic Technology solving crimes with advanced technology
- ✓ Explain the steps typically required to maintain appropriate health and safety standards at the crime scene.

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SEMESTER–IV

PAPER–IV (Elective–C): ENGINEERING CHEMISTRY (R23AC44C)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Objectives: The student should be conversant with the:

- ✓ Chemistry of engineering materials and their applications.
- ✓ Principles of polymer chemistry and engineering applications of polymers.
- ✓ Principles of electro chemistry, electrochemical cells, Reference electrodes, Solar and fuel cells, Energy Storage Devices.
- ✓ Mechanism of corrosion and Principles of corrosion control.
- ✓ Analytical techniques and their importance.

UNIT-I: Engineering Materials **12H**

Refractories: Classification – Acidic, Basic and Neutral refractories; Properties: refractoriness, refractoriness under load, dimensional stability, porosity, thermal spalling; Preparation, Properties and applications of alumina, magnesite and zirconia bricks,

Composites: Introduction Constituents of Composites, types- Fibre reinforced Particulate and Layered composites and their applications.

Lubricants: Mechanism of lubrication, Liquid lubricants - properties: viscosity index, flash and fire points, cloud and pour points, oiliness; Solid lubricants - graphite and molybdenum sulphide.

UNIT-II: Polymer Chemistry: **12H**

Introduction, polymerization: types – addition and condensation polymerization; Mechanism of free radical addition polymerization with suitable example; Polymer Tacticity and Ziegler Natta polymerization (mechanism).

Plastics: Classification (Thermoplastic and thermosetting); Preparation, properties and uses of PVC, Teflon, Bakelite, Nylon-6,6.

Rubbers: Natural rubber**,** drawbacks of raw rubber**,** Vulcanization of rubber; Synthetic rubbers: Buna-S, Buna-N and Poly urethane.

UNIT-III: Electro Chemistry: **12H**

Electrode potential, Determination of single electrode potential; Nernst equation (problems); Electrochemical series – significance; Electro chemical cells, Reversible and irreversible cells, Reference electrodes – Standard Hydrogen electrode, Calomel electrode, Ion selective electrode (glass electrode) – measurement of pH;

Solar cells: Introduction, Solar Panels, Applications;
Fuel Cells: Hydrogen – Oxygen Fuel Cell;
Batteries: Lead – acid, NiCad and Lithium Batteries.

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SEMESTER–IV

PAPER–IV (Elective–C): ENGINEERING CHEMISTRY (R23AC44C)

Max. Marks: 100 **(Internal-30M & External-70M)**

UNIT-IV: Corrosion and Corrosion Control:
12H

Corrosion: Types of corrosion - Chemical or dry corrosion, Pilling – Bedworth rule; Electrochemical or wet corrosion; Galvanic corrosion, pitting, stress and differential aeration corrosion; factors influencing corrosion;

Corrosion control – sacrificial anodic method and impressed current cathodic methods, corrosion inhibitors; Protective coatings: Metallic coatings – electro plating (Au) and electroless plating (Ni). Paints – constituents and functions.

UNIT-V: Analytical Techniques: **12H**

Beer-Lambert's law; **Colorimetry**: principle, instrumentation (with block diagram) and Estimation of iron, **Flame photometry**: principle, instrumentation (with block diagram) and estimation of sodium; **A**tomic **A**bsorption **S**pectroscopy: principle, instrumentation (with block diagram) and estimation of nickel.

Conductometric titrations (Acid-Base) and Potentiometric titrations (Redox titrations–Fe^{2+} *vs* dichromate).

Reference Books:

1) P.C. Jain and Monica Jain, "Engineering Chemistry" Dhanpat Rai Pub, Co., New Delhi 15^{th} edition (2010).
2) S.S. Dara & Mukkanti K. "A text book of engineering chemistry" S. Chand & Co. Ltd., New Delhi (2006).
3) B. Sivasankar "Engineering Chemistry" Tata McGraw Hills co., New Delhi (2008).
4) Dr. B. K. Sharma, Instrumental methods of analysis, Krishna Prakashan Media, 2000.
5) Text Book of Engineering Chemistry by C.P. Murthy, C.V. Agarwal, A. Naidu B.S. Publications, Hyderabad (2006).
6) Engineering Chemistry by K. Maheswaramma, Pearson publishers 2015.

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SEMESTER–IV

PAPER–IV (Elective–C): ENGINEERING CHEMISTRY (R23AC44C)

Max. Marks: 100 **(Internal-30M & External-70M)**

Learning Outcomes: To impart a sound knowledge on the principles of Engineering Chemistry involving the different application oriented topics required for all chemistry courses. After studying this course, students will be able to:

- ✓ Apply their knowledge in designing and preparing different materials and their utility at various needs to overcome all the problems that commonly arise in construction, automobile, metallurgical industries etc.
- ✓ Design economically new synthetic methods of polymers, their usages, and substitute metals with Cheaper, durable & light weight polymer materials.
- ✓ Have the capacity of applying energy sources efficiently and economically for various needs with knowledge of construction of energy devices.
- ✓ Understand corrosion methods and able to develop methods to prevent corrosion of metals and also to protect the environment by designing safer chemical techniques.
- ✓ Apply their knowledge in analyzing the structure of organic compounds and estimations of elements in various samples by using different instrumental techniques.

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SEMESTER–IV

PRACTICAL-I: CLASSICAL & INSTRUMENTAL METHODS OF ANALYSIS (R23AC45)

Max. Marks: 100 **(Internal-30M & External-70M)**

(Minimum Five Experiments must be carryout)

1) Estimation of total iron with different procedures using various reductants.
2) Analysis of zinc in zinc containing alloy using EDTA.
3) Analysis of nickel by EDTA.
4) Estimation of glucose.
5) Analysis of oil for the determination of saponification value, acid value and iodine value.
6) Estimation of chloride and iodide in a mixture by potentiometric method.
7) Determination of Fe(III) colorimetrically using potassium thiocyanate.
8) Estimation of amount of manganese by colorimetric procedure.

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SEMESTER–IV

PRACTICAL-II: PROJECT WORK / SPECTRAL PROBLEMS (R23AC46)

Max. Marks: 100 **(Internal-30M & External-70M)**

(Minimum Five Experiments must be carryout)

Title Selection: 1) Project Work / 2) Spectral Problems

1) **Project Work:** For University students- Project Work / Internship is compulsory and have to submit a dissertation containing Back ground of the work, Experimental, Results and Discussion and Summary.
   ***In respect of Affiliated Colleges*-**Project work is optional for only colleges having doctorate degree faculty and students may opt for project work and others have to select *Spectral Problems paper*.
2) **Spectral Problems:** For students who selected spectral problems will be given spectra of two different compounds for structural elucidation along with Viva-voce. (A minimum of 10 representative examples should be studied in regular practical hours).

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SEMESTER–IV

PRACTICAL-III: COMPREHENSIVE VIVA-VOCE (R23AC47)

Max. Marks: 50M

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1) The students will be analyzed with questions covering 3rd & 4th semester topics.

MODELPAPER

ANDHRA KESARI UNIVERSITY

M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-I: Paper-I. Inorganic Chemistry (R23CH11)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

1.
2.
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9.
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SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)

MODELPAPER

ANDHRA KESARI UNIVERSITY

M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-I: Paper-II. Organic Chemistry (R23CH12)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

1.
2.
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SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)

MODELPAPER

ANDHRA KESARI UNIVERSITY

M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-I: Paper-III. Foundation for Chemistry (R23CH13)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

1.
2.
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10.

SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)

MODELPAPER

ANDHRA KESARI UNIVERSITY

M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-I: Paper-IV. Physical Chemistry (R23CH14A)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

1.
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SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)

MODEL PAPER

ANDHRA KESARI UNIVERSITY
M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-II: Paper-I Physical Chemistry-II (R23CH21)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

1.
2.
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SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)

MODEL PAPER

ANDHRA KESARI UNIVERSITY
M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-II: Paper-II Organic Chemistry-II (R23CH22)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

1.
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SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)

MODEL PAPER

ANDHRA KESARI UNIVERSITY
M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-II: Paper-III Essential Lab Techniques for Industry (R23CH23)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

1.
2.
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SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)

MODEL PAPER

ANDHRA KESARI UNIVERSITY
M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-II: Paper-IV Inorganic Chemistry-II (R23CH24A)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

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SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)

MODEL PAPER

ANDHRA KESARI UNIVERSITY
M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-III: Paper-I Applied Inorganic Analysis (R23AC31)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

1.
2.
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SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)

MODEL PAPER

ANDHRA KESARI UNIVERSITY
M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-III: Paper-II Analysis of Applied Industrial Products (R23AC32)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

1.
2.
3.
4.
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SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)

MODEL PAPER

ANDHRA KESARI UNIVERSITY
M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-III: Paper-III Optical Thermal & Radiochemical Methods of Analysis (R23AC33A)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

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2.
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10.

SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)

MODEL PAPER

ANDHRA KESARI UNIVERSITY
M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-III: Paper-IV Principles and Techniques in Classical Analysis (R23AC34A)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)

MODEL PAPER

ANDHRA KESARI UNIVERSITY
M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-IV: Paper-I Advanced Methods of Analysis (R23AC41)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)

MODEL PAPER

ANDHRA KESARI UNIVERSITY
M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-IV: Paper-II Analysis of Drugs, Foods, Diary Products & Biochemical Analysis (R23AC42)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)

MODEL PAPER

ANDHRA KESARI UNIVERSITY
M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-IV: Paper-III Separation Techniques & Electro Analytical Techniques (R23AC43A)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)

MODEL PAPER

ANDHRA KESARI UNIVERSITY
M.Sc. Analytical/Inorganic/Physical Chemistry

Semester-IV: Paper-IV Environmental Chemistry & Analysis
(R23AC44A)

Time:3 Hours **Maximum Marks: 70**

SECTION-A

(Answer any five questions, each question carries 4 marks) (5X4=20 Marks)

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

SECTION-B

(Answer all questions each question carries 10 marks) (5X10= 50 Marks)

11. (a.) (10M)

(or)

(b)

12. (a) (10M)

(or)

(b)

13. (a) (10M)

(or)

(b)

14. (a) (10M)

(or)

(b)

15. (a) (10M)

(or)

(b)