

***SCHEME OF EXAMINATIONS
AND
SYLLABUS***

M.Sc. (Final) Chemistry

Effective from the Academic Session 2017-2018

**This syllabus is for the Courses running
under Annual Scheme
at the affiliated Colleges of the University**

**Master of Science (M.Sc.)
Chemistry**

Faculty of Science



UNIVERSITY OF KOTA

MBS Marg, KOTA (Rajasthan)-324 005

INDIA

M.Sc. (Final) CHEMISTRY Examination (Annual Scheme)

SCHEME OF EXAMINATION

Each Theory Paper

3 Hrs. duration

1. The number of papers and the maximum marks for each paper/Practical shall be shown in the syllabus for the subject concerned. It will be necessary for a candidate to pass in theory part as well as in the Practical part (Wherever prescribed) of a subject/paper separately.
2. A candidate for a pass at each of the Previous and the Final Examination shall be required to obtain (i) atleast 36% marks in the aggregate of all the papers prescribed for the examination and (ii) at least 36% marks in practical (s) wherever prescribed at the examination, provided that if a candidate fails to secure atleast 25% marks in each individual paper at the examination, and also in the test Dissertation /Survey report/Field Work, wherever prescribed, he shall be deemed to have failed at the examination notwithstanding his having obtained the minimum percentage of marks required in the aggregate for the examination. No division will be awarded at the Previous Examination. Division shall be awarded at the end of the Final Examination on the combined marks obtained at the Previous and the Final Examinations taken together, as noted below :

First Division 60 % } of the aggregate marks taken together of
Second Division 48% } the Previous and the Final Examinations.

3. All the rest will be declared to have passed the examination.
4. If a candidate clears any paper (s)/Practical (s) Dissertation prescribed at the Previous and/or Final examination after a continuous period of three years, then for the purpose of working out his division the minimum pass marks only viz. 25% (36%) in the case of practical) shall be taken into account in respect of such Paper (s) Practical(s)/Dissertation as are cleared after the expiry of the aforesaid period of three years : Provided that in case where a candidate requires more than 25% marks in order to reach the minimum aggregate as many marks out of those actually secured by him will be taken into account as would enable him to makeup the deficiency in the requisite minimum aggregate.
5. The Thesis/Dissertation/Serve Report/Field work shall be typewritten and submitted triplicate so as to reach the office of the Registrar at least 3 weeks before the commencement of the theory examination. Only such candidates shall be permitted to offer Dissertation/Field Work/Survey Report/Thesis (If provided in the scheme of Examination) in lieu of a paper as have secured atleast 55% marks in the aggregate of all the paper prescribed for the previous examination in the case of annual scheme irrespective of the number of paper in which a candidate actually appeared at the examination.

N.B.: Non-collegiate candidates are not eligible to offer dissertation as per provisions of 0.170-A.

M.Sc. (Final) CHEMISTRY Examination (Annual Scheme)

Distribution of Marks

Number of Paper	Code of Paper	Nomenclature of Paper	Duration of Exam.	Max. Marks	Min. Pass Marks
Paper-I	CH-501	(A) Applications of Spectroscopy	3 Hrs.	75	27
		(B) Photochemistry			
		(C) Solid State Chemistry			
Paper-II	CH-502	(A) Bioinorganic Chemistry	3 Hrs.	50	18
		(B) Bioorganic Chemistry			
		(C) Biophysical Chemistry			
Paper-III	CH-503	Environmental Chemistry	3 Hrs.	50	18
Paper-IV	CH-504	Elective Paper	3 Hrs.	50	18
Paper-V	CH-505	Elective Paper	3 Hrs.	50	18
Paper-VI	CH-506	Elective Paper	3 Hrs.	50	18
Paper-VII	CH-507	Elective Paper	3 Hrs.	50	18
Paper-VIII	CH-508	Practical	14 Hrs.	200	72
		Seminars (Internal)	-----	25	09
Total Marks :				600	216

M.Sc. (Final) Chemistry

The following alternative groups of elective papers are approved for M.Sc. final course.

Group-I: Inorganic Chemistry Specialization

Paper-IV : CH-504 : Elective Paper-I : Organotransition Metal Chemistry
Paper-V : CH-505 : Elective Paper-II : Bioinorganic and Supramolecular Chemistry
Paper-VI : CH-506 : Elective Paper-III : Photoinorganic Chemistry
Paper-VII : CH-507 : Elective Paper-IV : Polymers

Group-II: Organic Chemistry Specialization

Paper-IV : CH-504 : Elective Paper-I : Organic Synthesis-I
Paper-V : CH-505 : Elective Paper-II : Organic Synthesis-II
Paper-VI : CH-506 : Elective Paper-III : Heterocyclic Chemistry
Paper-VII : CH-507 : Elective Paper-IV : Chemistry of Natural Products

Group-III: Physical Chemistry Specialization

Paper-IV : CH-504 : Elective Paper-I : Analytical Chemistry
Paper-V : CH-505 : Elective Paper-II : Physical Organic Chemistry
Paper-VI : CH-506 : Elective Paper-III : Chemical Dynamics
Paper-VII : CH-507 : Elective Paper-IV : Electrochemistry

M.Sc. (Final) CHEMISTRY Examination (Annual Scheme)

Paper-I: Applications of Spectroscopy, Photochemistry & Solid State Chemistry

Duration : 3 Hrs.

Max. Marks : 75

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.

Total marks : 10

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.

Total marks : 35

Section-C : 04 questions (question may have sub division) covering all units but not more than one question from each unit, descriptive type, answer in about 500 words, 2 questions to be attempted.

Total marks : 30

Applications of Spectroscopy:

Unit-I Inorganic Chemistry:

Vibrational Spectroscopy:

Symmetry and shapes of AB₂, AB₃, AB₄, AB₅ and AB₆, mode of bonding of ambidentate ligands, ethylenediamine and diketonato complexes, application of resonance Raman spectroscopy particularly for the study of active sites of metalloproteins.

Electron Spin Resonance Spectroscopy:

Hyperfine coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensors, application to transition metal complexes (having one unpaired electron) including biological systems and to inorganic free radicals such as PH₄, F₂ and (BH₃).

Nuclear Magnetic Resonance of Paramagnetic Substances in Solution:

The contact and Pseudo contact shifts, factors affecting nuclear relaxation, some applications including biochemical systems, an overview of NMR of metal nuclide with emphasis on ¹⁹⁵P_t and ¹¹⁹S_n NMR.

Mossbauer Spectroscopy:

Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of Fe⁺² and Fe⁺³ compounds including those of intermediate spin, (2) Sn⁺² Sn⁺⁴ compounds nature of M-L bond, coordination number, structure and (3) detection of oxidation state and inequivalent MB atoms.

Unit-II Organic Chemistry:

Ultraviolet and Visible spectroscopy:

Various electronic transitions (185-800 nm) Beer-Lambert law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Fieser Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic compounds. Steric effect in biphenyls.

Infrared Spectroscopy Instrumentation and Sample Handling:

Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and fermi resonance.

Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD):

Definition, deduction of absolute configuration, octon rule for ketones.

Unit-III Organic Chemistry:

Nuclear Magnetic Resonance Spectroscopy:

General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, mechanism of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), chemical exchange, effect of deuteration, complex spin spin interaction between two, three, four and five nuclei (first order spectra) virtual coupling, Stereochemistry, hindered rotation, Karplus curve-variation of coupling constant with dihedral angle. Simplification of complex spectranuclear magnetic double resonance, NMR shift reagents, solvent effects. Fourier transform technique, nuclear overhauser effect (NOE).

Carbon-13 NMR Spectroscopy:

General considerations, chemical shift (aliphatic olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Two dimension NMR spectroscopy-COSY, NOESY, DEPT, INEPT, APT and INADEQUATE techniques.

Mass Spectrometry:

Introduction ion production EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak. McLafferty rearrangement. Nitrogen rule. High resolution mass spectrometry. Example of mass spectral fragmentation of organic compounds with respect to their structure determination.

Photo-chemistry

Unit-IV Photochemical Reactions:

Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

Determination of Reaction Mechanism:

Classification, rate constants and life times of reactive energy state determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions-photo dissociation, gas-phase photolysis.

Miscellaneous Photochemical Reactions:

Photo-Fries reactions of anilides, Photo-Fries rearrangement. Barton reaction. Singlet molecular Oxygen reaction. Photochemical formation of smog. Photodegradation of polymers. Photochemistry of vision.

Photochemistry of Alkenes:

Intramolecular reactions of the olefinic bond-geometrical isomerism, cyclisation reactions, rearrangement of 1,4- and 1,5-dienes.

Photochemistry of Carbonyl Compounds:

Intramolecular reactions of carbonyl compounds-saturated, cyclic and acyclic, β,γ -unsaturated and α,β -unsaturated compounds, cyclohexadienones. Intermolecular cycloaddition reactions-dimerisations and oxetane formation.

Photochemistry of Aromatic Compounds:

Isomerisations, additions and substitutions.

Solid State Chemistry

Unit-V Solid State Reactions:

General principles, experimental procedure, co-precipitation as a precursory to solid state reactions, kinetics of solid state reactions.

Crystal Defects and Non-Stoichiometry:

Perfect and imperfect crystals, intrinsic and extrinsic defects-point defects, line and plane defects, vacancies-Schottky defects and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation, colour centres, non-stoichiometry and defects.

Electronic Properties and Band Theory:

Metals, insulators and semiconductors, electronic structure of solidsband theory, band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, super conductors. Optical properties-Application of optical and electron microscopy. Magnetic Properties-Classification of materials: Effect of temperature calculation of magnetic moment, mechanism of ferro and anti ferromagnetic ordering super exchange.

Organic Solids:

Electrically conducting solids. organic charge transfer complex, organic metals, new superconductors.

Books Suggested:

- *Physical Methods for Chemistry*, R.S. Drago, Saunders Compnay.
- *Structural Methods in Inorganic Chemistry*, E.A.V. Ebsworth, D.W.H. Rankin and S. Cradock, ELBS.
- *Infrared and Raman Spectral: Inorganic and Coordination Compounds* K. Nakamoto, Wiley.
- *Progress in Inorganic Chemistry* vol., 8, ed., F.A. Cotton, vol., 15 ed. S.J. Lippard, Wiley.
- *Transition Metal Chemistry* ed. R.L. Carlin vol. 3 Dekker.
- *Inorganic Electronic Spectroscopy*, A.P.B. Lever, Elsevier.
- *NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry*, .V. Parish, Ellis Haywood.
- *Practical NMR Spectroscopy*, M.L. Martin. J.J. Deepish and G.J. Martin, Heyden.
- *Spectrometric Identification of Organic Compounds*, R.M. Silverstein, G.C. Bassler adn T.C. Morrill
- *Introduction to NMR spectroscopy*, R.J. Abraham, J. Fisher and P. Loftus, Wiley.
- *Application of Spectroscopy of Organic Compounds*, J.R. Dyer Prentice Hall.
- *Spectroscopic Methods in Organic Chemistry* D.H. Williams, I. Fleming, Tata McGraw-Hill.
- *Fundamentals of photochemistry*, K.K. Rothagi-Mukheriji, Wiley-Eastern.
- *Essentials of Molecular Photochemistry*, A Gilbert and J. Baggott, Blackwell Scientific Publication.
- *Molecular Photochemistry*, N.J. Turro, W.A. Benjamin.
- *Introductory Photochemistry*, A. Cox and t. Camp, McGraw Hill.
- *Organic Photochemistry*, J. Coxon and B.halton, Cambridge University Press.
- *Solid state chemistry and its applications*, A.R. West. Peenum.
- *Principles of the Solid State*, H.V. Keer, Wiley Eastern.
- *Solid State Chemistry*, D.K. Chakrabarty, New Wiley Eastern.

Paper-II: Bio-inorganic, Bio-organic & Bio-physical Chemistry

Duration : 3 Hrs.

Max. Marks : 50

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.

Total marks : 05

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.

Total marks : 25

Section-C : 04 questions (question may have sub division) covering all units but not more than one question from each unit, descriptive type, answer in about 500 words, 2 questions to be attempted.

Total marks : 20

Unit-I Metal Ions in Biological Systems:

Bulk and trace metals with special reference to Na, K, Mg, Ca, Fe, Cu, Zn, Co, and K^+ , Na^+ pump.

Bioenergetics and ATP Cycle:

DNA polymerisation, glucose storage, metal complexes in transmission of energy; chlorophylls, photosystem-I and photosystem-II in cleavage of water.

Nitrogen fixation:

Biological nitrogen fixation, and its mechanism, nitrogenase, Chemical nitrogen fixation.

Transport and Storage of Dioxygen:

Haem proteins and oxygen uptake structure and function of haemoglobin, myoglobin, haemocyanin and hemerythrin, model synthetic complexes of iron, cobalt and copper.

Electron Transfer in Biology:

Structure and function of metal of proteins in electron transport, processes cytochromes and iron-sulphur proteins, synthetic models.

Unit-II Introduction:

Basic considerations, Proximity effects and molecular adaptation.

Enzymes:

Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labelling and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michaelis-Menten and Lineweaver Burk plots, reversible and irreversible inhibition.

Mechanism of Enzyme Action:

Transition-state theory, orientation and Steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase.

Unit-III Kinds of Reactions Catalysed by Enzymes:

Nucleophilic displacement on a phosphorus atom, multiple displacement reactions and the coupling of ATP cleavage to endergonic processes. Transfer of sulphate,

addition and elimination reactions, enolic intermediates in isomerisation reactions, β -cleavage and condensation, some isomerization and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation. Mechanism of enzyme action of Isomerase and Synthetase.

Enzyme Models:

Host-guest chemistry, chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality. Biometric chemistry, crown ether, cryptates. Cyclodextrins, cyclodextrin-based enzyme models, clixarenes, ionospheres, micelles synthetic enzymes or synzymes.

Unit IV Co-enzyme Chemistry:

Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD^+ , NADP^+ , FMN, FAD, lipoic acid, vitamin B_{12} . Mechanisms of reactions catalyzed by the above cofactors.

Biotechnological Applications of Enzymes large-scale production and purification of enzymes, techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, application of immobilized enzymes, use of enzymes in food and drink industry-brewing and cheese-making, syrups from corn starch, enzymes as targets for drug design. Clinical uses of enzymes, enzyme therapy, enzymes and recombinant DNA Technology.

Biopolymer Interactions Forces involved in biopolymer interactions. Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions. Multiple equilibrium and various types of binding processes in biological systems. Hydrogen ion titration curves.

Unit-V Biological Cell and its Constituents:

Biological cell, structure and functions of proteins, enzymes, DNA and RNA in living systems. Helix coil transition.

Bioenergetics:

Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP.

Cell Membrane and Transport of Ions:

Structure and functions of cell membrane, ion transport through cell membrane, Irreversible thermodynamic treatment of membrane transport. Nerve conduction.

Statistical Mechanics in Biopolymers:

Chain configuration of macromolecules, statistical distribution end to end dimensions, calculation of average dimensions for various chain structures. Polypeptide and protein structures, introduction to protein folding problem.

Thermodynamics of Biopolymers Solutions:

Thermodynamics of biopolymer solutions, osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanochemical system.

Books Suggested:

- *Bioorganic Chemistry : A Chemical Approach to Enzyme Action*, Hermann Dugas and C. Penny, Springer Verlag.
- *Understanding Enzymes*, Trevor Palmer, Prentice Hall.
- *Enzyme Chemistry : Impact and Applications*, Ed. Collin J Suckling, Royal Society of Chemistry.
- *Enzyme Mechanisms* Ed. M.I. Page and A Williams, Royal Society of Chemistry.
- *Fundamentals of Enzymology*, N.C. Price and L. Stevens. Oxford University Press.
- *Immobilized Enzymes : An Introduction and Applications in Biotechnology*, Michael ID. Trevan
- *Enzymatic Reaction Mechanisms*. C. Walsh. W.H. Freeman.

- *Enzyme Structure and Mechanism*, A Fersht, W.H. Freeman.
- *Biochemistry: The Chemical Reactions of Living Cells*, D.E. Metzler, Academic Press.
- *Principles of Bioinorganic Chemistry*, S.J. Lippard and J.M. Berg, University Science Books.
- *Bioinorganic Chemistry*, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.
- *Inorganic Biochemistry* vol. I and II ed. G.L. Eichhorn, Elsevier.
- *Progress in Inorganic Chemistry*, Vol 18 and 38 ed J.J. Lippard, Wiley.
- *Macromolecules Structure and Function*, F.Wold, Prentice Hall.

Paper-III: Environmental Chemistry

Duration : 3 Hrs.

Max. Marks : 50

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.

Total marks : 05

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.

Total marks : 25

Section-C : 04 questions (question may have sub division) covering all units but not more than one question from each unit, descriptive type, answer in about 500 words, 2 questions to be attempted.

Total marks : 20

Unit-I Atmosphere:

Atmospheric layers, Vertical temperature profile, heat/radiation budget of the earth atmosphere systems. Biogeochemical cycles of carbon, nitrogen, sulphur, phosphorus oxygen. Residence times.

Atmospheric Chemistry Sources of trace atmospheric constituents : Nitrogen oxides, Sulphur dioxide and other sulphur compounds, carbon dioxides, chlorofluorocarbons and other halogen compounds, methane and other hydrocarbons. Mechanism of photochemical decomposition of NO₂ and formation of ozone atoms, hydroxyl, hydroperoxy and organic radicals and hydrogen peroxide and their reactions

Unit-II Air Pollution:

Air pollutants and their classifications. Aerosols-sources, size distribution and effect on visibility, climate and health.

Acid Rain Definition, Acid rain precursors and their aqueous and gas phase atmospheric oxidation reactions. Damaging effects on aquatic life, plants, buildings and health. Monitoring of SO₂ and NO_x. Acid rain control strategies.

Stratospheric Ozone Depletion Mechanism of Ozone formation, Mechanism of catalytic Ozone depletion, Discovery of Antarctic Ozone hole and Role of chemistry and meteorology. Control Strategies.

Green House Effect Terrestrial and solar radiation Spectra, Major green house gases and their sources and Global warming potentials. Climate change and consequences.

Urban Air Pollution Exhaust emissions, damaging effects of carbon monoxide. Monitoring of CO. Control strategies.

Unit-III Aquatic Chemistry and Water Pollution:

Redox chemistry in natural waters. Dissolved oxygen, biological oxygen demand, chemical oxygen demand, determination of DO, BOD and COD. Aerobic and

anaerobic reactions of organic sulphur and nitrogen compounds in water. Acid-base chemistry of fresh water and sea water. Aluminum, nitrate and fluoride in water. Eutrophication . Sources of water pollution. Treatment of waste and sewage. Purification of drinking water, techniques of purification and disinfection.

Unit-IV Soil and Environmental Disasters:

Composition, micro and macronutrients, soil pollution by fertilizers, plastic and metals. Methods of re-mediation of soil. Bhopal gas tragedy, Chernobyl, three mile island, Minimata Disease, Seveso (Italy), London smog.

Unit-V Industrial Pollution:

Cement, sugar, distillery, drug, paper and pulp, thermal power plants, nuclear power plants. Metallurgy, polymers, etc.. radionuclide analysis, disposal of wastes and their managements.

Books Suggested:

- *Environmental Chemistry*, Colin Baird, W.H. Freeman Co. New York, 1998.
- *Chemistry of Atmospheres*, R.P. Wayne, Oxford.
- *Environment Chemistry*, A.K. De, Wiley Eastern, 2004.
- *Environmental Chemistry*, S.E. Manahan, Lewis Publishers.
- *Introduction to Atmospheric Chemistry*, P.V. Hobbs, Cambridge.

ELECTIVE PAPERS

Group-I: Inorganic Chemistry Specialization

Paper-IV	: CH-504	: Elective Paper-I	: Organotransition Metal Chemistry
Paper-V	: CH-505	: Elective Paper-II	: Bioinorganic and Supramolecular Chemistry
Paper-VI	: CH-506	: Elective Paper-III	: Photoinorganic Chemistry
Paper-VII	: CH-507	: Elective Paper-IV	: Polymers

Group-II: Organic Chemistry Specialization

Paper-IV	: CH-504	: Elective Paper-I	: Organic Synthesis-I
Paper-V	: CH-505	: Elective Paper-II	: Organic Synthesis-II
Paper-VI	: CH-506	: Elective Paper-III	: Heterocyclic Chemistry
Paper-VII	: CH-507	: Elective Paper-IV	: Chemistry of Natural Products

Group-III: Physical Chemistry Specialization

Paper-IV	: CH-504	: Elective Paper-I	: Analytical Chemistry
Paper-V	: CH-505	: Elective Paper-II	: Physical Organic Chemistry
Paper-VI	: CH-506	: Elective Paper-III	: Chemical Dynamics
Paper-VII	: CH-507	: Elective Paper-IV	: Electrochemistry

Paper-IV: Elective Paper-I (Group-I): Organotransition Metal Chemistry

Duration : 3 Hrs.

Max. Marks : 50

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.

Total marks : 05

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.

Total marks : 25

Section-C : 04 questions (question may have sub division) covering all units but not more than one question from each unit, descriptive type, answer in about 500 words, 2 questions to be attempted.

Total marks : 20

Unit-I Alkyls and Aryls of Transition Metals:

Types, routes of synthesis, stability and decomposition pathways organocopper in organic synthesis. Transition metal compounds with bonds to hydrogen.

Unit-II Compounds of Transition Metal-Carbon Multiple Bonds:

Alkylidenes, alkylidynes, low valent carbenes and carbynes-synthesis, nature of bond, structural characteristics, nucleophilic and electrophilic reactions on the ligands, role in organic synthesis.

Unit-III Transition Metal π -Complexes:

Transition metal π -Complexes with unsaturated organic molecules, alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes, preparation, properties, nature of bonding and structural features. Important reactions relating to nucleophilic and electrophilic attack on ligands and to organic synthesis.

Unit-IV Homogeneous Catalysis:

Stoichiometric reactions for catalysis, homogeneous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydrocarbonylation of olefins (oxoreaction), oxopalladation reactions, activation of C-H bond.

Unit-V Fluxional Organometallic Compounds:

Fluxionality and dynamic equilibrium in compounds such as η^2 -olefine, η^3 -allyl and dienyl complexes.

Books Suggested

- *Principles and Application of Organotransition Metal Chemistry*, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
- *The Organometallic Chemistry of the Transition Metals*, R.H. Crabtree. John Wiley.
- *Metallo-organic Chemistry*, A.J. Pearson, Wiley.
- *Organometallic Chemistry*, R.C. Mehrotra and A. Singh New Age International.

Paper-V: Elective Paper-II (Group-I): Bioinorganic and Supramolecular Chemistry

Duration : 3 Hrs.

Max. Marks : 50

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.

Total marks : 05

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.

Total marks : 25

Section-C : 04 questions (question may have sub division) covering all units but not more than one question from each unit, descriptive type, answer in about 500 words, 2 questions to be attempted.

Total marks : 20

Unit-I Metal Storage and Transport and Biomineralization:

Ferritin transferrin, and siderophores.

Calcium in Biology Calcium in living cells, transport and regulation, molecular, aspects of intramolecular processes, extracellular binding proteins.

Unit-II Metalloenzymes:

Zinc enzymes: carboxypeptidase and carbonic anhydrase. Iron enzymes-catalase, peroxidase and cytochrome P-450.

Metallo enzyme-II:

Copper enzymes-superoxide dismutase. Molybdenum oxatransferase enzymes-xanthine oxidase. Coenzyme vitamin B₁₂.

Unit-III Metals in Medicine:

Metal deficiency and disease, toxic effects of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs.

Metal-Nucleic Acid Complexes:

Metal ions and metal complex interactions. Metal complex nucleic acids.

Unit-IV Supramolecular Chemistry-I:

Molecular recognition: Molecular receptors for different types of molecules including arisonic substrates, design and synthesis of co receptor molecules and multiple recognition. Supramolecular reactivity and catalysis.

Unit -V: Supramolecular Chemistry-II:

Transport processes and carrier design. Supramolecular devices. Supramolecular photochemistry, supramolecular electronic, ionic and switching devices.

Books Suggested

1. *Principles of Bioinorganic Chemistry*. S.J. Lippard and J.M. Berg University Science Books.
2. *Bioinorganic Chemistry*, I Bertini, H.B. Gray. S.J. Lippard and J.S. Valentine, University Science Books.
3. *Inorganic Biochemistry Vols I and II* Ed.G.L. Eichhorn, Elsevier.
4. *Progress in Inorganic Chemistry Vols. 18 G.L. Eichhorn, Elsevier and 38 Ed J.J. Lippard Wiley.*
5. *Supramolecular Chemistry*, J.M Lehn, VCH

Paper-VI: Elective Paper-III (Group-I): **Photoinorganic Chemistry**

Duration : 3 Hrs.

Max. Marks : 50

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.

Total marks : 05

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.

Total marks : 25

Section-C : 04 questions (question may have sub division) covering all units but not more than one question from each unit, descriptive type, answer in about 500 words, 2 questions to be attempted.

Total marks : 20

Unit-I Basic of Photochemistry:

Absorption, excitation, photochemical laws, quantum yield, electronically excited states-life times-measurements of the times. Flash photolysis, stopped flow techniques Energy dissipation by radiative and non-radiative processes, absorption spectra, Frank-Condon principle, photochemical stages-primary and secondary processes.

Unit-II Properties of Excited States:

Structure, dipole moment, acid-base strengths, reactivity. Photochemical kinetics-calculation of rates of radiative processes. Bimolecular deactivation-quenching.

Unit-III Excited States of Metal Complexes:

Excited states of metal complexes: Comparison with organic compounds, electronically excited states of metal complexes, charge transfer spectra, charge transfer excitations.

Metal Complex Sensitizers:

Metal complex sensitizer, electron relay, metal colloid systems, semiconductor supported metal or oxide systems, water photolysis, nitrogen fixation and carbon dioxide reduction.

Unit-IV Ligand Field Photochemistry:

Photosubstitution, photooxidation and photoreduction, lability and selectivity, zero vibrational levels of ground state and excited state, energy content of excited state, zero-zero spectroscopic energy, development of the equations for redox potentials of the excited states.

Unit-V Redox Reactions by Excited Metal Complexes:

Energy transfer under conditions of weak interaction and strong interaction-excimer formation; condition of the excited states to be useful as redox reactants, excited electron transfer, metal complexes as attractive candidates, (2,2-bipyridine and 1,10-phenanthroline complexes), illustration of reducing and oxidising character of Ruthenium⁺² (bipyridal complex, comparison with Fe (bipy)₃; role of spin-orbit coupling-life time of these complexes. Application of redox processes of electronically excited states for catalytic purposes, transformation of low energy reactants into high energy products, chemical energy into light.

Books Suggested:

- *Concepts of Inorganic Photochemistry*, A.W. Adamson and P.D. Fleischauer, Wiley.
- *Inorganic Photochemistry*, J.Chem. Educ. vol. 60 No. 10, 1983.
- *Progress in Inorganic Chemistry*, Vol. 30ed. S.J. Lippard. Wiley.
- *Coordination Chem. Revs.* 1981, vol. 39, 121, 131; 1975, 15, 321; 1990 97, 313.
- *Photochemistry of Coordination Compounds*, V. Balzari and V. Carassiti, Academic Press.
- *Elements in Inorganic Photochemistry*, G.J. Ferraudi, Wiley.

Paper-VII: Elective Paper-IV (Group-I): Polymers

Duration : 3 Hrs.

Max. Marks : 50

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.

Total marks : 05

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.

Total marks : 25

Section-C : 04 questions (question may have sub division) covering all units but not more than one question from each unit, descriptive type, answer in about 500 words, 2 questions to be attempted.

Total marks : 20

Unit-I Polymers:

Importance of polymers. Basic concepts : Monomers, repeat units, degree of polymerization Linear, branched and network polymers. Classification of polymers. Polymerization: condensation, addition/radical chain-ionic and co-ordination and copolymerization. Polymerization conditions and polymer reactions. Polymerization in homogeneous and heterogeneous systems.

Unit-II Polymer Characterization:

Polydispersion-average molecular weight concept. Number, weight and viscosity average molecular weights. Polydispersity and molecular weight distribution. The practical significance of molecular weight. Measurement of molecular-weights, end-group, viscosity, light scattering, osmotic and ultracentrifugation methods.

Analysis and testing of polymers Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study. Microscopy.

Thermal analysis and physical testing tensile strength. Fatigue, impact. Tear resistance, hardness and abrasion resistance.

Unit-III Inorganic Polymers:

A general survey and scope of Inorganic Polymers special characteristics, classification, homo and hetero atomic polymers.

Unit-IV Structure, Properties and Applications of

- Polymers based on Phosphorous-Phosphazenes, Polyphosphates
- Polymers based on Sulphure-Tetrasulphur tetranitride and related compounds.

Structure, Properties and Applications of

- Polymers based on boron-borazines, boranes and carboranes.

- Polymers based on Silicon, silicones, polymetalloxanes and polymetallosiloxanes, silazanes.

Unit-V Structure, Properties and Applications of
Metal clusters.

Co-ordination and metal chelate polymers.

Books Suggested

- *Inorganic Chemistry*, J.E. Huheey, Harper Row.
- *Developments in Inorganic polymer Chemistry*, M.F. Lappert and G.J. Leigh.
- *Inorganic polymers*- N.H. Ray.
- *Inorganic polymers*, Graham and Stone.
- *Inorganic Rings and Cages* : D.A. Armitage.
- *Textbook of Polymers Science*, F.W. Billmeyer Jr. Wiley.
- *Contemporary Polymer Chemistry*, H.R. Alcock and F.W. Lambe, Prentice Hall.
- *Polymer science*, V.R.Gowariker, N.V.Viswanthan and J.Shreedhar Wiley-Eastern.

Paper-IV: Elective Paper-I (Group-II): Organic Synthesis-I

Duration : 3 Hrs.

Max. Marks : 50

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.

Total marks : 05

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.

Total marks : 25

Section-C : 04 questions (question may have sub division) covering all units but not more than one question from each unit, descriptive type, answer in about 500 words, 2 questions to be attempted.

Total marks : 20

Unit-I Organometallic Reagents:

Principle, preparations, properties and applications of the following in organic synthesis with mechanistic details.

Group I and II metal organic compounds:

Li, Mg, Hg, Cd, Zn and Ce Compounds.

Transition metals:

Cu, Pd, Ni, Fe, Co, Rh, Cr, and Ti compounds.

Other elements:

S, Si, B and I compounds.

Unit-II Oxidation:

Introduction, Different oxidative processes. Hydrocarbons-alkenes, aromatic rings, saturated C-H groups (activated and unactivated) alcohols, diols, aldehydes, ketones, ketals and carboxylic acids. Amines, hydrazines, and sulphides. Oxidations with ruthenium tetroxide, iodobenzene diacetate and thallium. (III) Nitrate.

Unit-III Reduction:

Introduction, Different reductive processes. Alkanes, alkenes, alkynes, and aromatic rings. Carbonyl compounds-aldehydes, ketones, acids and their derivatives. Epoxides. Nitro, nitroso, azo and oxime groups. Hydrogenolysis.

Unit-IV Rearrangements:

General mechanistic considerations-nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangements: Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid. Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hoffmann, Curtius, Schmidt, Baeyer-Villiger, Shapiro reaction.

Unit-V Metallocenes, Nonbenzenoid Aromatics and Polycyclic Aromatic Compounds:

General consideration. Synthesis and reactions of some representative compounds. (Tropone, tropolone, azulene, ferrocene, phenanthrene and fluorine).

Books Suggested

- *Modern Synthetic Reactions.* H.O. House, W.A. Benjamin.
- *Some Modern Methods of Organic Synthesis,* W. Carruthers, Cambridge Univ. Press.
- *Advanced Organic Chemistry, Reactions Mechanisms and Structure,* J. March. John Wiley.
- *Principles of Organic synthesis,* R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
- *Advanced Organic Chemistry Part B.F.A.* Carey and R.J. Sundberg Plenum Press.
- *Rodd's Chemistry of Carbon Compounds.* Ed. S. Coffey, Elsevier.

Paper-V: Elective Paper-II (Group-II): Organic Synthesis-II

Duration : 3 Hrs.

Max. Marks : 50

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.

Total marks : 05

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.

Total marks : 25

Section-C : 04 questions (question may have sub division) covering all units but not more than one question from each unit, descriptive type, answer in about 500 words, 2 questions to be attempted.

Total marks : 20

Unit-I Disconnection Approach:

An introduction to synthons and synthetic equivalents. Disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reaction, amine synthesis.

Unit-II Protecting Groups:

Principle of protection of alcohol, amine, carbonyl and carboxyl groups.

One Group C-C Disconnections:

Alcohols and carbonyl compounds, regioselectivity. Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.

Unit-III Two Group C-C Disconnections:

Diels-Alder Reaction, 1,3-difunctionalised compounds, α - β - unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalised compounds. Micheal addition and Robinson annelation.

Unit-IV Ring Synthesis:

Saturated heterocycles, synthesis of 3-, 4-, 5- and 6- membered rings aromatic heterocycles in organic synthesis.

Unit-V Synthesis of Some Complex Molecules:

Application of the above in the synthesis of following compounds : Camphor, Longifoline, Cortsone, Reserpine, Vitamin D, Juvabione, Aphidicolin and Fredericamycin A.

Books Suggested

- *Designing Organic Synthesis*, S. Warren. Wiley.
- *Organic Synthesis-Concept, Methods and Starting Materials*, J. Fuhrhop.
- *Some Modern Methods of Organic Synthesis*. W. Carruthers, Cambridge Univ. Press.
- *Modern Synthetic Reactions* H.O. House, W.A Benjamin.
- *Advanced Organic Chemistry : Reactions, Mechanisms and Structure*, J. March. Wiley.
- *Principles, of Organic Chemistry Part B*, F.A. Carey and R.J. Sundberg, Plenum Press.
- *Disconnection Approach: Ameta, Punjabi, Ameta, Jain, Sadguru Publications*

Paper-VI: Elective Paper-III (Group-II): Heterocyclic Chemistry

Duration : 3 Hrs.

Max. Marks : 50

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.

Total marks : 05

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.

Total marks : 25

Section-C : 04 questions (question may have sub division) covering all units but not more than one question from each unit, descriptive type, answer in about 500 words, 2 questions to be attempted.

Total marks : 20

Unit-I Nomenclature of Heterocycles:

Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic fused and bridged heterocycles.

Aromatic Heterocycles:

General chemical behaviour of aromatic heterocycles, classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in ^1H NMR-spectra. Empirical resonance energy, delocalization energy and dewar resonance energy, diamagnetic susceptibility escalations). Heteroaromatic reactivity and tautomerism in aromatic heterocycles.

Unit-II Non-aromatic Heterocycles:

Strain-bond angle and torsional strains and their consequences in small ring heterocycles. Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interaction stereo-electronic effects, anomeric and related effects, Attractive interactions-hydrogen bonding and intermolecular nucleophilic electrophilic interactions.

Heterocyclic Synthesis:

Principles of heterocyclic synthesis involving cyclization reactions and cycloaddition reactions.

Unit-III Small Ring Heterocycles:

Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, oxiranes, thiranes, azetidines, oxetanes and thietanes.

Benzo-Fused Five-Membered Heterocycles:

Synthesis and reactions including medicinal applications of benzopyrroles, bezofurans and benzothiophenes.

Unit-IV Meso-ionic Heterocycles:

General classification, chemistry of some important meso-ionic heterocycles of type-A and B and their applications.

Six-Membered Heterocycles with one Heteroatom:

Synthesis and reactions of pyrylium salts and pyrones and their comparison with pyridinium & thiopyrylium salts and pyridones. Synthesis and reactions of quinolizinium and benzopyrylium salts, coumarins and chromones.

Unit-V Six Membered Heterocycles with Two or More Heteroatoms:

Synthesis and reactions of diazoles, triazines, tetrazines and thiazines.

Seven-and Large-Membered Heterocycles:

Synthesis and reactions of azepines, oxepines, thiepinines, diazepines thiazepines, azocines, diazocines, dioxocines and dithiocines.

Heterocyclic Systems Containing P, As, Sb and B:

Heterocyclic rings containing phosphorus : introduction, nomenclature, synthesis and characteristics of 5- and 6-membered ring systems phosphorinanes, phosphorines, phospholanes and phospholes.

Books Suggested :

- *Heterocyclic Chemistry Vol. 1-3, R.R. Gupta, M. Kumar and V.Gupta, Springer Verlag.*
- *The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.*
- *Heterocyclic Chemistry J.A. Joule, K. Mills and G.F. Smith, Chapman and Hall.*
- *Heterocyclic Chemistry, T.L. Gilchrist, Longman Scietific Techinal.*
- *Contemporary Hetrocyclic Chemistry, G.,R. Newkome and W.W. Paudler, Wiley-Inter Science.*
- *An Introductiion to the Heterocyclic Compounds, R.M. Acheson, John Wiley.*
- *Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, eds. Pergamon Press.*

Paper-VII: Elective Paper-IV (Group-II): **Chemistry of Natural Products**

Duration : 3 Hrs.

Max. Marks : 50

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.

Total marks : 05

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.

Total marks : 25

Section-C : 04 questions (question may have sub division) covering all units but not more than one question from each unit, descriptive type, answer in about 500 words, 2 questions to be attempted.

Total marks : 20

Unit-I Terpenoids and Carotenoids:

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules : Citral, Gerniol α -Terpeneol, Menthol, Farnesol, Zingiberene, Santonin, Phytol, Abietic acid and β -Carotene.

Unit-II Alkaloids:

Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants. Structure, stereochemistry, synthesis and biosynthesis of the following : Ephedrine , (+)- Conine, Nicotine, Atropine, Quinine and Morphine.

Unit-III Steroids:

Occurrence, nomenclature, basic skeleton, Diels hydrocarbon and stereochemistry, Isolation, Structure determination and synthesis of Cholesterol, Bile acids, Androsterone, Testosterone, Estrone, Progesterone, Aldosterone, Biosynthesis of Steroids.

Unit-IV Plant Pigments:

Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of Apigenin, Luteolin Quercetin, Myrcetin, Quercetin 3-glucoside, Vitexin, Diadzein, Butein, Aureusin, Cyanidin-7arabinoside, Cyanidin, Hirsutidin,

Biosynthesis of flavonoids: Acetate pathway and Shikimic acid pathway.

Porphyrins Structure and synthesis of Haemoglobin and Chlorophyll.

Unit-V Prostaglandins:

Occurrence, nomenclature, classification, biogenesis and physiological effects. Synthesis of PGE₂ and PGF_{2 α} .

Pyrethroids and Rotenones:

Synthesis and reactions of Pyrethroids and Rotenones. (For structure elucidation, emphasis is to be placed on the use of spectral parameters wherever possible).

Books Suggested

- *Natural Products : Chemistry and Biological Significance*, J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrophe and J.B. Harborne, Longman, Essex.
- *Organic Chemistry : Vol. 2 IL. Finar, ELBS*

- *Stereoselective Synthesis : A Practical Approach*, M. Ngoradi, VCH.
- *Rodd's Chemistry of Carbon Compounds*, Ed. S. Coffey, Elsevier.
- *Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas*, Ed. Kurt Hostettmann, M.P. Gupta and A. Marston. Harwood Academic Publishers.
- *Introduction to Flavonoids*, B.A. Bohm. Harwood Academic Publishers.
- *New Trends in Natural Product Chemistry*, Ata-ur-Rahman and M.L. Choudhary, Harwood Academic Publishers.
- *Insecticides of Natural Origin*, Sukh Dev, Harwood Academic Publishers.
- *Chemistry of Natural Products*: B. C. Joshi, S. C. Ameta, Himanshu Publication

Paper-IV: Elective Paper-I (Group-III): Analytical Chemistry

Duration : 3 Hrs.

Max. Marks : 50

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.

Total marks : 05

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.

Total marks : 25

Section-C : 04 questions (question may have sub division) covering all units but not more than one question from each unit, descriptive type, answer in about 500 words, 2 questions to be attempted.

Total marks : 20

Unit-I Introduction:

Role of analytical chemistry. Classification of analytical methods classical and instrumental. Types of instrumental analysis. Selecting an analytical method. Neatness and cleanliness. laboratory operations and practices. Analytical balance. Techniques of weighing, errors. Volumetric glassware cleaning and calibration of glassware. Sample preparation-dissolution and decompositions. Gravimetric techniques. Selecting and handling of reagents. Laboratory notebooks. Safety in the analytical laboratory.

Unit-II Errors and Evaluation:

Definition of terms in mean and median. Precision-standard deviation, relative standard deviation. Accuracy-absolute error, relative error. Types of error in experimental data determinate (systematic), indeterminate (or random) and gross. Sources of error and the effects upon the analytical results. Methods for reporting analytical data. Statistical evaluation of data-indeterminate errors. The uses of statistics.

Unit-III Food Analysis:

Moisture, ash, crude protein, fat crude fiber, carbohydrates, calcium, potassium, sodium and phosphate. Food adulteration-common adulterants in food, contamination of foods stuffs. Microscopic examination of foods for adulterants. Pesticide analysis in food products. Extraction and purification of sample. HPLC. Gas chromatography for organophosphates. Thin-layer chromatography for identification of chlorinated pesticides in food products.

Unit-IV Analysis of Water Pollution:

Origin of Waste water, types, water pollutants and their effects. Sources of water pollution-domestic, industrial, agricultural soil and radioactive wastes as sources of pollution. Objectives of analysis-parameter for analysis-colour, turbidity, total solids, conductivity, acidity, alkalinity, hardness, chloride, sulphate, fluoride, silica, phosphates and different forms of nitrogen, Heavy metal pollution-public health significance of cadmium, chromium, copper, lead, zinc, manganese, mercury and arsenic. General survey of instrumental technique for the analysis of heavy metals in aqueous systems. Measurements of DO, BOD, and COD. Pesticides as water pollutants and analysis.

Unit-V Analysis of Soil:

Moisture pH total nitrogen, phosphorus, silica, lime, magnesia, manganese, sulphur and alkali salts.

Fuel Analysis: liquid and gas. Ultimate and proximate analysis-heating values-grading of coal. Liquid fuels-flash point, aniline point, octane number and carbon residue. Gaseous fuels-produced gas and water gas-calorific value.

Clinical Chemistry: Composition of blood-collection and preservation of samples.

Clinical Analysis: Serum electrolytes, blood glucose, blood urea nitrogen, uric acid, albumin, globulins, barbiturates, acid and alkaline phosphates.

Immunoassay: principles of radio immunoassay (RIA) and applications. The blood gas analysis trace elements in the body.

Drug Analysis: Narcotics and dangerous drug. Classification of drugs. Screening by gas and thin-layer chromatography and spectrophotometric measurements.

Book Suggested

- *Analytical Chemistry, G.D. Christian, J.Wiley.*
- *Fundamentals of Analytical Chemistry. D.A. Skoog. D.M. West and F.J. Hooler, W.B. Saunders.*
- *Analytical Chemistry-Principles. J.H. Kennedy. W.B. Saunders.*
- *Analytical Chemistry-Principles and Techniques. L.G. Hargis. Prentice Hall.*
- *Principles of Instrumental analysis D.A. Skoog and J.L. Loary, W.B. Saunders.*
- *Principles of Instrumental Analysis D.A. Skoog W.B. Saunders.*
- *Quantitative Analysis, R.A. Day, Jr. and A.L. Underwood, Prentice Hall.*
- *Environmental Solution, S.M. Khopkar, Wiley Eastern.*
- *Basic Concepts of Analyticals Chemistry, S.M. Khopkar, Wiley Eastern.*
- *Handbook of Instrumental Techniques for Analytical Chemistry, F. Settle, Prentice Hall.*

Paper-V: Elective Paper-II (Group-III): **Physical Organic Chemistry**

Duration : 3 Hrs.

Max. Marks : 50

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.

Total marks : 05

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.

Total marks : 25

Section-C : 04 questions (question may have sub division) covering all units but not more than one question from each unit, descriptive type, answer in about 500 words, 2 questions to be attempted.

Total marks : 20

Unit-I Concepts in Molecular Orbital (MO) and Valence Bond (VB) Theory:

Introduction to Huckel molecular orbital (MO) method as a mean to explain modern theoretical methods. Advanced techniques in PMO and FMO theory. Molecular mechanics, semi empirical methods and *ab initio* and density functional methods. Scope and limitations of several computational programmes.

Quantitative MO Theory:

Hückel molecular orbital (HMO) method as applied to ethene, ally and butadiene. Qualitative MO theory ionisation potential. Electron affinities. MO energy levels. Orbital symmetry. Orbital interaction diagrams. MO of simple organic systems such as ethene, ally, butadiene, methane and methyl group. Conjugation and hyperconjugation. Aromaticity. Valence bond (B) configuration mixing diagrams. Relationship between VB configuration mixing and resonance theory. Reaction profiles. Potential energy diagrams.

Curve-crossing Model-nature of activation barrier in chemical reactions.

Unit-II Principles of Reactivity:

Mechanistic significance of entropy, enthalpy and Gibbs free energy. Arrhenius equation. Transition state theory. Uses of activation parameters, Hammond's postulate, Bell-Evans-Polanyi Principle. Potential energy surface model. Marcus theory of electron transfer. Reactivity and selectivity principles.

Kinetic Isotope Effect:

Theory of isotope effects. Primary and secondary kinetic isotope effects. Heavy atom isotope effects. Tunneling effect. Solvent effects.

Solvation and Solvent Effects:

Qualitative understanding of solvent-solute effects on reactivity. Thermodynamic measure of solvation. Effects of solvation on reaction rates and equilibria. Various empirical indexes of solvation based on physical properties, solvent-sensitive reaction rates, spectroscopic properties and scales for specific solvation. Use of solvation scales in mechanistic studies. Solvent effects from the curve-crossing model.

Unit-III Structural Effects on Reactivity:

Linear free energy relationships (LFER). The Hammett equation, substituent constants, theories of substituent effects. Interpretation of values. Reaction constant. Deviations from Hammett equation. Dual parameter correlation, inductive substituent constant. The Taft model, σ_i and σ_R scales.

Acids, Bases, Electrophiles, Nucleophiles and Catalysis:

Acid-base dissociation, Electronic and structural effects, acidity and basicity. Acidity functions and their application. Hard and soft acids and bases. Nucleophilicity scales. Nucleofugacity. The α -effect. Ambivalent nucleophiles. Acid-base catalysis-specific and general catalysis. Brønsted catalysis, Nucleophilic and electrophilic catalysis. Catalysis by noncovalent binding-micellar catalysis.

Steric and Conformation Properties:

Various type of steric strain and their influence on reactivity. Steric acceleration. Molecular measurements of steric effects upon rates. Steric LFER, Conformational barrier to bond rotation-spectroscopic detection of individual conformers. Acyclic and

monocyclic systems. Rotation around partial double bonds. Winstein-Holness and Curtin-Hammett principle.

Unit-IV Nucleophilic and Electrophilic Reactivity:

Structural and electronic effects on S_N^1 and S_N^2 reactivity. Solvent effect. Kinetic isotope effects. Intramolecular assistance. Electron transfer nature of S_N^2 reaction. Nucleophilicity and S_N^2 reactivity based on curvecrossing mode. Relationship between polar and electron transfer reactions S_{RN}^1 mechanism. Electrophilic reactivity, general mechanism. Kinetic of S_E^2 Ar reaction. Structural effects on rates and selectivity. Curve-crossing approach to electrophilic reactivity.

Radical and Pericyclic Reactivity Radical stability, polar influences, solvent and steric effects. A curve crossing approach to radical addition, factors affecting barrier heights in addition, regioselectivity in radical reactions. Reactivity, specificity and periselectivity in pericyclic reactions.

Unit-V Supramolecular Chemistry:

Properties of covalent bonds-bond length, inter-bond angles, force constant, bond and molecular dipole moments. Molecular and bond polarizability, bond dissociation enthalpy, entropy. Intermolecular forces, hydrophobic effects. Electrostatic, induction, dispersion and resonance energy, magnetic interactions, magnitude of interaction energy, forces between macroscopic bodies, medium effects. Hydrogen bond. Principles of molecular association and organization as exemplified in biological macromolecules like enzymes, nucleic acids, membranes and model system like micelles and vesicles. Molecular receptors and design principles. Cryptands, cyclophanes, calixerenes, cyclodextrines. Supramolecular reactivity and catalysis. Molecular channels and transport processes, Molecular devices and nanotechnology.

Book Suggested :

- *Molecular Mechanics*, U. Burkrt and N.L. Allinger, ACS Monograph 177, 1982.
- *Organic Chemists, Book of Orbitals* : L. Salem and W.L. Jorgensen, Academic Press.
- *Mechanism and Theory in Organic Chemistry*, T.H. Lowry and K.C. Richardson, Harper and Row.
- *Introduction to Theoretical Organic Chemistry and Molecular Modeling*.
- *Physical Organic Chemistry* : N.S. Isaacs, ELBS/Longman.
- *Supramolecular Chemistry : Concepts and Perspective*, J.M. Lehn, VCH.
- *The Physical Basis of Organic Chemistry* : H. Maskill, Oxford University Press.

Paper-VI: Elective Paper-III (Group-III): Chemical Dynamics

Duration : 3 Hrs.

Max. Marks : 50

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.

Total marks : 05

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.

Total marks : 25

Section-C : 04 questions (question may have sub division) covering all units but not more than one question from each unit, descriptive type, answer in about 500 words, 2 questions to be attempted.

Total marks : 20

Unit-I Atmospheric Reactions:

Physical structure of the atmosphere, chemical composition of the atmosphere, Kinetics and mechanism of NO_x , ClO_x cycles and $\text{H}_2 + \text{O}_2$ reaction. Mechanism of general methane oxidation. Kinetics and mechanism of low temperature oxidation of methane. Concept of global warming.

Unit-II Enzymes and Inhibitions:

Kinetics of one enzymes-Two substrate systems and their experimental characteristics. Enzyme inhibitors and their experimental characteristics. Kinetics of enzyme inhibited reactions.

Micelles catalysis and inhibition:

Kinetics and mechanism of micelle catalyzed reactions (1^{st} order and second order) Various type of micelle catalyzed reactions. Micelle inhibited reactions.

Transition State:

A brief aspect of statistical mechanics and transition state theory. Application in calculation of second order rate constant for reactions involving collision of (1) atom+atom (2) atom+molecule (3) molecule+molecule reactions. Static solvent effects and thermodynamics formulations. Adiabatic electron transfer reactions, energy surfaces.

Unit-III Radiation Chemistry:

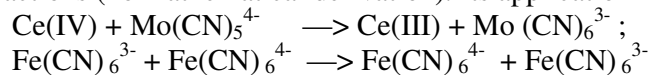
Radiation chemistry and photochemistry. Radiation chemistry of water and aqueous solutions. Hydrogen atom and hydroxyl radical-oxidizing and reducing conditions. Kinetics and mechanism of photochemical and photosensitized reactions (One example in each case). Stern-Volmer equation and its application. Hole-concept in the presence of semiconductor type photocatalysts. Kinetics and mechanism of electron transfer reaction in the presence of visible light. Kinetics of exchange reactions (Mathematical analysis)

Dynamics of Gas-surface Reactions:

Adsorption/desorption kinetics and transition state theory. Dissociative adsorption and precursor state. Mechanism of Langmuir's adsorption of the oxidation of carbon monoxide to carbon dioxide. True and apparent activation energies. Industrial importance of heterogeneous catalysis.

Unit-IV Substitution Reactions:

Substitution reactions. Classification of ligand substitution mechanism. Anation and base catalyzed kinetics of anation reactions. Aquation and acid catalyzed kinetics of aquation reactions (octahedral complexes). Inner-sphere electron transfer reactions and mechanism. Various types of inner sphere bridges, adjustment and remote attack. Linkage isomerism. Chemical and resonance mechanism. Marcus-Cross relation in outersphere reactions (no mathematical derivation). Its application in reactions



Bridged outer-sphere electron transfer mechanism. Kinetics of reactions in the presence of cyclodextrines. Considering one full case study, Nucleophilic and electrophilic catalyst and their mode of action.

Unit-V Metal ion Catalysis and Induced Phenomena:

Metal ion catalyzed reactions, their kinetics and reaction mechanism in solutions. Induced reactions, their characteristics. Mechanism of (i) Fe(II) induced oxidation of iodine by Cr(VI). (ii) As(III) induced oxidation of Mn(II) by chromate in acid solutions. Kinetics and mechanism of induced reactions in metal complexes (octahedral complexes of Cobalt (III) only).

Oscillatory Reactions:

Autocatalysis and oscillatory reactions, Kinetics and mechanism of Belousov-Zhabotinski (B-Z) reactions.

Books Suggested :

- *Progress in Inorganic Chemistry*, Vol. 30.
- *R. Lumry and R.W. Raymond, Electron Transfer Reactions, Interscience.*
- *N.L. Bender, Mechanism of Homogeneous Catalysis from protein to protein, Wiley.*
- *A.G. Sykes, Kinetics of Inorganic reactions, Pergamon.*
- *S.W. Benson, Mechanism of Inorganic Reactions, Academic Press.*
- *Physical Chemistry Vol. 2, Ed. Prof Ya Grasimov, Mir publisher.*
- *Inorganic Reaction Mechanism, Basolo and Pearson, J. Wiley .*
- *Electron Transfer Reactions, H. Taube, Oxford Press.*

Paper-VII: Elective Paper-IV (Group-III): Electrochemistry

Duration : 3 Hrs.

Max. Marks : 50

Note : The question paper will contain three sections as under –

Section-A : One compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part.

Total marks : 05

Section-B : 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit, answer approximately in 250 words.

Total marks : 25

Section-C : 04 questions (question may have sub division) covering all units but not more than one question from each unit, descriptive type, answer in about 500 words, 2 questions to be attempted.

Total marks : 20

Unit-I Conversion and Storage of Electrochemical Energy:

Present status of energy consumption : Pollution problem. History of fuel cells, Direct energy conversion by electrochemical means. Maximum intrinsic efficiency of an electrochemical converter. Physical interpretation of the Carnot efficiency factor in Electrochemical energy converters. Power outputs. Electrochemical generators (Fuel Cells) : Hydrogen oxygen cells, Hydrogen Air cell, Hydrocarbon air cell, Alkaline fuel cell, Phosphoric and fuel cell, direct NaOH fuel cells, applications of fuel cells.

Electrochemical Energy Storage : Properties of Electrochemical energy stores : Measure of battery performance, Charging and discharging of a battery, Storage Density, Energy Density.

Unit-II Classical Batteries:

(i) Lead Acid (ii) Nickel-Cadmium, (iii) Zinc-Manganese dioxide.

Modern Batteries:

(i) Zinc-Air (ii) Nickel-Metal Hydride, (iii) Lithium Battery, Future

Electricity storers:

Storage in (i) Hydrogen, (ii) Alkali Metals, (iii) Non aqueous solutions.

Bioelectrochemistry:

Bioelectrodes, Membrane Potentials, Simplistic theory, Modern theory, Electrical conductance in biological organism: Electronic, Protonic electrochemical mechanism of nervous systems, enzymes as electrodes.

Unit-III Corrosion and Stability of Metals:

Civilization and surface mechanism of the corrosion of the metals; Thermodynamics and the stability of metals, Potential -pH (or Pourbaix) Diagrams; Corrosion current and corrosion potential -Evans diagrams. Measurement of corrosion rate : (i) Weight Loss method, (ii) Electrochemical Method.

Inhibiting Corrosion:

Cathodic and Anodic Protection. Inhibition(i) by addition of substrates to the electrolyte environment, (ii) by charging the corroding metal from external source, anodic protection. Organic inhibitors. The fuller Story. Green inhibitors.

Passivation:

Structure of Passivation films, Mechanism of Passivation, Spontaneous Passivation Nature's method for stabilizing surfaces.

Unit-IV Kinetics of Electrode Processes:

Essentials of Electrode reaction. Current Density, Over potential, Tafel Equation, Butler-Volmer equation. Standard rate constant (K^0) and Transfer coefficient, Exchange Current.

Irreversible Electrode processes:

Criteria of irreversibility, information from irreversible wave.

Methods of determining kinetic parameters for quasi-reversible and irreversible waves : Koutecky's methods, Meites Israel method, Gelling's method.

Electrocatalysis:

Chemical catalysts and Electrochemical catalysts with special reference to porphyrins, porphyrin oxides of rare earths. Electrocatalysis in simple redox reactions, in reaction involving adsorbed species. Influence of various parameters.

Unit-V Potential Sweep Method:

Linear sweep Voltammetry, Cyclic Voltammetry, theory and applications. Diagnostic criteria of cyclic voltammetry. Controlled current microelectrode techniques: comparison with controlled potential methods, chronopotentiometry, theory and applications.

Bulk Electrolysis Methods: Controlled potential coulometry, controlled coulometry. Electro-organic synthesis and its important applications. **Stripping analysis :** anodic and cathodic modes, pre electrolysis and stripping steps. Applications of stripping analysis.

Books Suggested :

- *Modern Electrochemistry Vol. I, IIA, Vol. IIB J'OM Bockris and A.K.N. Reddy, Plenum Publication, New York.*
- *Polarographic Techniques by L. Meites, Interscience.*
- *"Fuel Cells : Their electrochemistry". McGraw Hill Book Company, New York.*
- *Modern Polarographic Methods by A.M. Bond, Marcell Dekker.*
- *Polarography and Allied techniques by K. Zutshi, New age International publicatin. New Delhi.*
- *Electroanalytical Chemistry by Basil H. Vessor & Galen W. ; Wiley Interscience.*
- *Topics in Pure and Applied Chemistry, Ed. S. K. Rangrajan, SAEST Publication, Karaikudi (India)*

M.Sc. (Final) CHEMISTRY Practical (Annual Scheme)

Contact Hrs.: 18 Hrs./Week

Max. Marks : 200

Inorganic Chemistry:

Preparations:

Preparation of selected inorganic compounds and their study by IR, electronic, Mossbauer, ESR and magnetic susceptibility measurements. Handling of air and moisture sensitive compounds involving vacuum lines. Selection can be made from the following:

- Sodium amide. *Inorg. Synth.*, 1946, 2, 128.
- Synthesis and thermal analysis of group II metal oxalate hydrate. *J. Chem. Ed.*, 1988, 65, 1024.
- Atomic absorption analysis of Mg and Ca.
- Trialkoxyboranes-IR and NMR spectra.
- PhBce Dichlorophenylborane - Synthesis in vacuum line.
- Preparation of Tin (IV) iodide, Tin (IV) chloride and Tin (II) iodide, *Inorg. Synth.*, 1953, 4, 119.
- Relative Stability of Tin (IV) and Pb (IV). Preparation of ammonium hexachlorostannate $(\text{NH}_4)_2 \text{SnCl}_6$ ammonium hexachlorophlumbate $(\text{NH}_4)_2 \text{PbCl}_6$.
- Hexa-bis (4,nitrophenoxy) cyclotriphosphazene.
- Synthesis of trichlorodiphenylantimony (V) hydrate. *Inorg. Synths.*, 1985, 23, 194
- Sodium tetrathionate $\text{Na}_2\text{S}_4\text{O}_6$.
- Metal complexes of dimethyl sulfoxide (IR) : $\text{CuCl}_2 \cdot 2\text{DMSO}$, $\text{PdCl}_2 \cdot 2\text{DMSO}$, $\text{RuCl}_2 \cdot 4\text{DMSO}$. *J. Chem. Edu.*, 1982, 59, 57.
- Synthesis of metal acetylacetonate: Magnetic moment, IR, NMR, *Inorg. Synths*, 1957, 5, 130, 1963, 1, 183.
- Bromination of $\text{Cr}(\text{acac})_3$. *J. Chem. Edu.*, 1986, 63, 90.
- Magnetic moment of $\text{Cu}(\text{acac})_2 \cdot \text{H}_2\text{O}$.
- Cis and Trns $[\text{Co}(\text{en})_2\text{Cl}_2]^+$.
- Separation of optical isomer of cis- $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$. *J. Chem. Soc.*, 1960. 4369.
- Ion exchange separation of oxidation state of vanadium. *J. Chem. Edu.*, 1980, 57, 316; 1978, 55, 55.
- Determination of Cr(III) complexes. $[\text{Cr}(\text{H}_2\text{O})_6]\text{NO}_3 \cdot 3\text{H}_2\text{O}$, $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot 2\text{H}_2\text{O}$, $[\text{Cr}(\text{en})_3]\text{Cl}_3$, $\text{Cr}(\text{acac})_3$. *Inorg. Synths.*, 1972, 13, 184.
- Preparation of N, N bis (salicylaldehyde) ethylenediamine, silane H_2 . $\text{Co}(\text{Silane})$ *J. Chem. Edu.*, 1977, 54, 443; 1973, 50, 670.
- Preparation of Fe(II) chloride (use it as Friedel-Craft chlorination source) *J. Org. Chem.*, 1978, 43, 2423; *J. Chem. Edu.*, 1984, 61, 645; 1986, 63, 361.
- Reaction of Cr(III) with a multidentate ligand: a kinetics experiment (visible spectra Cr-EDTA complex) *J. Am. Chem. Soc.*, 1953, 75, 6570.
- Preparation and use of Ferrocene. *J. Chem. Edu.* 1966, 43, 73; 1976, 53, 730.

- Preparation of copper glycine complex-cis and trans bis (glycinato Copper (II). J. Chem. Soc. Dalton, 1979, 1901, *J. Chem. Edu.*, 1982, 59, 1052.
- Preparation of phosphine Ph_3P and its transition metal complexes.
- Preparation of $[\text{Co}(\text{phenanthroline}-5,6 \text{ quinone})]$.
- Any other experiment such as conversion of p-xylene to terephthalic acid catalyzed by CoBr_2 (homogeneous catalysis).

Spectrophotometric Determinations:

- Manganese / Chromium / Vanadium in steel sample.
- Nickel / molybdenum / tungsten / vanadium / uranium by extractive spectrophotometric method.
- Fluoride/nitrite/phosphate.
- Zirconium-alizarin Red-S complex : Mole-ratio method.
- Copper-Ethylene diamine complex : Slope-ratio method.
- Iron-phenanthroline complex : Job's method of continuous variations.

Flame Photometric Determinations:

- Sodium and potassium when present together.
- Lithium/Calcium/barium/strontium.
- Cadmium and magnesium in tap water.

Quantitative Determinations of a Three Component Mixture:

One Volumetrically and two gravimetrically :

- Cu^{+2} , Ni^{+2} , Zn^{+2}
- Cu^{+2} , Ni^{+2} , Mg^{+2}

Chromatographic Separations:

- Cadmium and zinc
- Zinc and magnesium.
- Thin-layer chromatography-separation of nickel, manganese, cobalt and zinc. Determination of R_f values.
- Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of R_f values.

Organic Chemistry:

Qualitative Analysis:

Separation, purification and identification of the components of a mixture of three organic compounds (three solids or two liquids and one solid or two solids and one liquid), using TLC for checking the purity of the separated compounds, chemical analysis, IR, PMR and mass spectral data.

Multi-step Synthesis of Organic Compounds:

The exercise should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques.

- **Photochemical reaction**
 $\text{Benzophenone} \rightarrow \text{Benzpinacol} \rightarrow \text{Benzpinacolone}$
- **Beckmann rearrangement** : Benzanilide from benzene
 $\text{Benzene} \rightarrow \text{Benzophenone} \rightarrow \text{Benzophenone oxime} \rightarrow \text{Benzanilide}$
- **Benzilic acid rearrangement** : Benzilic acid from benzoin
- $\text{Benzoin} \rightarrow \text{Benzil} \rightarrow \text{Benzilic acid}$

- **Synthesis of heterocyclic compounds**
 - Skraup synthesis : Preparation of quinoline from aniline
 - Fisher Indole synthesis: Preparation of 2-phenylindole from phenylhydrazine.
- **Enzymatic synthesis**
Enzymatic reduction: reduction of ethyl acetoacetate using Baker's yeast to yield enantiomeric excess of S(+) ethyl-3-hydroxybutanoate and determine its optical purity.
- **Biosynthesis:** ethanol from sucrose.
- **Synthesis using microwave:** Alkylation of diethyl malonate with benzyl chloride.
- **Synthesis using phase transfer catalyst :** Alkylation of diethyl malonate or ethyl acetoacetate with an alkylhalide.

Extraction of Organic Compounds from Natural Sources:

- Isolation of caffeine from tea leaves.
- Isolation of casein from milk (the students are required to try some typical colour reactions of proteins).
- Isolation of lactose from milk (purity of sugar should be checked by LC and PC and R_f values reported).
- Isolation of nicotine dipicrate from tobacco.
- Isolation of cinchonine from cinchona bark.
- Isolation of piperine from black pepper.
- Isolation of lycopene from tomatoes.
- Isolation of β -carotene from carrots.
- Isolation of oleic acid from olive oil (involving the preparation of complex with urea and separation of linoleic acid).
- Isolation of eugenol from clove.
- Isolation of (+) limonine from citrus rind.

Paper Chromatography:

Separation of identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of R_f values.

Spectroscopy:

Identification of organic compounds by the analysis of their spectral data (UV, IR, PMR, CMR & MS) Spectrophotometric (UV/VIS) Estimations

- Amino acids
- Proteins
- Carbohydrates
- Cholesterol
- Ascorbic acid
- Aspirin
- Caffeine

Physical Chemistry:

Number of hours for each experiment : 3-4 hours. a list of experiments under different headings are given below. Typical experiments are to be selected from teach type.

Thermodynamics

- Determination of partial molar volume of solute (e.g. KCl) and solvent in a binary mixture.
- Determination of the temperature dependence of the solubility of a compound in two solvents having similar intramolecular interactions (benzoic acid in water and in DMSO-Water mixture and calculate the partial molar heat of solution.

Spectroscopy

- Determination of pK_a of an indicator (e.g. methyl red) in (a) aqueous and (b) micellar media.
- Determination of stoichiometry and stability constant of Ferricisothiocyanate complex ion in solution.
- Determination of rate constant of alkaline bleaching of Malachite green and effect of ionic strength on the rate of reaction.

Polarography

- Identification and estimation of metal ions such as Cd²⁺, Pb²⁺, Zn²⁺, and Ni²⁺ etc. polarographically.
- Study of a metal ligand complex polarographically (using Lingane's Method).

Chemical Kinetics

- Determination of rate constant and formation constant of an intermediate complex in the reaction of Ce(IV) and Hypophosphorous acid at ambient temperature.
- Determination of energy and enthalpy of activation in the reaction of KMnO₄ and benzyl alcohol in acid medium.
- Determination of energy of activation and entropy of activation from a single kinetic run.
- Kinetics of an enzyme catalyzed reaction.

Electronics

This lab course will have theory as well as practical and the lectures shall be delivered during lab hours.

Basic Electronics

Notations used in the electronic circuit, study of electronic compounds and colour codes. Conversion of chemical quantities into electronic quantities. Transducer, illustration with electrodes, thermocouples and thermistors. Passive components : Resistors, capacitors and inductors with some emphasis on solid state properties of materials. Networks of resistors. Thevenin's theorem, superposition theorem, loop analysis, RC circuits, LR Circuits, LCR circuits. Illustration of the use of circuits in NMR spectroscopy, Mössbauer spectroscopy, cyclic voltammetry and in power supplies as filter circuits.

Active components

Introduction to ordinary diodes and Zener diode with some emphasis on p-n junction as a solid state property. Use of diode as rectifiers, clipping and clamping circuits. Power supplies. Transistors : An extension of p-n-p and n-p-n transistors. Characteristics of transistors, hybrid parameters; transistor circuits as amplifiers, high impedance (preamplifier) circuits. Darlington pairs, differential amplifiers.

Operational Amplifiers

Ideal characteristics; inverter, summer, integrator, differentiator, voltage follower, illustrative use of operational amplifiers. Introduction to Fourier transformation in instrumentation. List of Experiments in electronics (Do at least five experiments from this section):

1. (a) To plot the diode characteristics and find its dynamic resistance and cut in voltage.
(b) To plot the characteristics of transistor used as a diode and compare the results with those of (a)
2. (a) To plot the diode characteristics and find its dynamic resistance and cut in voltage.
(b) To plot the characteristics of transistor used as a diode and compare the results with those of (a) wave form.
3. To implement a diode damper circuit which damps the positive peak of the input voltage to (a) Zero voltage and (b) a given voltage. Verify the performance.
4. (a) To plot the characteristics of an NPN transistor in CE configuration.
(b) To find the h-parameter of the transistor from the characteristics.
5. (a) To plot the characteristics of an NPN transistor in CB configuration.
(b) To find the h-parameter of the transistor from the characteristics and compare it with the results of experiment No. 6.
6. (a) To plot the drain and transfer characteristics of a JEET in CS configuration.
(b) To find out the pinch off voltage, maximum drain to source saturation current and the transconductance.
7. To obtain the frequency response of an RC coupled amplifier and estimate the bandwidth.
8. (a) To plot the characteristics of Zener diode and find its dynamic resistance under reverse biased condition. To use zener diode for a voltage regulation.
(i) Plot the line regulation curve.
(ii) Plot the load Regulation curve.
9. (a) To wire a Half wave Rectifier circuit using diode and measure the rms voltage, dc voltage and to find Ripple factor.
(b) To study the performance of half wave and full wave doubler circuits.
10. To plot the characteristics of UJT and find the peak voltage, peak current and valley voltage and use as a relaxation oscillator.

Note : A sheet containing 20 questions/diagrams/circuits will be provided to the students to reply. These question based on basic electronics will cover both theory and practical as provided in the syllabi. They will be of objective type for duration of 20 minutes with maximum scoring of 10 marks

Books Suggested

- *Inorganic Experiments*, J. Derek Woolings, VCH.
- *Microscale Inorganic Chemistry*, Z. Szafran, R.M. Pike and M.M. Singh, Wiley.
- *Practical Inorganic Chemistry*, G. Marr and B. W. Rockett, Van Nostrad.
- *The systematic Identification of Organic Compounds*, R.L. Shriner and D.Y. curlin.

M.Sc. (Final) CHEMISTRY Practical Examination (Annual Scheme)

Distribution of Maximum Marks

Duration of Examination: 14 Hrs. (Spread over 2 days)

Max. Marks : 200

S. No.	Exp. No.	Details of Experiment	Marks Alloted
1.	Inorganic Chemistry		
	(i)	Preparation of selected inorganic compounds and their study by IR, electronic spectra, Mossbauer. ESR and magnetic susceptibility measurements. Handling of air and moisture sensitive compounds involving vacuum lines	20
	(ii)	Spectrophotometric determinations of one of the 5 exercises given in the syllabus	15
	(iii)	Flame photometric determinations	15
		or	
		Chromatographic separations and determination of R_f values of Cadmium and Zinc or Zinc and Magnesium or Nickel and Manganese or Cobalt and Zinc or Mixture of glucose, fructose and sucrose.	
		Total Marks (Inorganic Chemistry)	50
2.	Organic Chemistry		
	(i)	Qualitative Analysis: Separation, purification and identification of the components of a mixture of three organic compounds (three solids or two liquids and one solid or two solids and one liquid), using tc for checking the purity of the separated compounds, chemical analysis, IR, PMR and mass spectral data.	20
	(ii)	Multi-step Synthesis of Organic Compounds Perform one of the 7 types multi-step synthesis of organic compounds in examination	15
	(iii)	Extraction of Organic Compounds from Natural Sources perform one of the 11 exercises as mentioned in the syllabus	15
		or	
		Spectroscopy: Identification of organic compounds by the analysis of their spectral data (UV, IR, PMR, CMR & MS)	
		Total Marks (Organic Chemistry)	50
3.	Physical Chemistry		
	(i)	Perform any one physical experiments	25
	(ii)	Perform any one physical experiments	25
		A list of experiments are to be selected from each topic.	
		Total Marks (Physical Chemistry)	50
4.	Viva-voce		30
5.	Practical Record		20
	Grand Total of Maximum Marks		200

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