University of Rajasthan
Jaipur

SYLLABUS

M.Sc.
CHEMISTRY

(ANNUAL SCHEME)

2015-2017

Asstt. Registrar (Acad.-I)
University of Rajasthan
Jaipur
M.Sc. (CHEMISTRY)  
(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 the theory part as well as in practical part (wherever prescribed) of a subject/paper separately.  

2. A candidate for a pass at each of the Previous and the Final Examinations shall be required to obtain :  
   1) Atleast 36% marks in the aggregate of all the papers prescribed for the examination, and  
   2) Atleast 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 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 that examination. No division will be awarded at the Previous and the Final Examination. Division shall be awarded at the end of the Final Examination on the combined marks obtained at the Previous and the Final Examination taken together, as noted below :  

   First Division  
   Second Division  

   60% of the aggregate marks taken together of the  
   48% Previous and the Final Examination.  

   All the rest will be declared to have passed the examination.  

3. 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 required 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 make up the deficiency in the requisite minimum , aggregate.  

4. The Thesis/Dissertation/Survey Report/Field Work shall be typewritten and submitted in triplicate so as to reach the office of the Registrar atleast 3 weeks before the commencement of the theory examinations. 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 papers prescribed for the previous examination in the case of annual scheme irrespective of the number of papers in which a candidate actually appeared at the examination.  

N.B. Non-collegiate candidates are not eligible to offer dissertation as per provisions of O. 170-A
# M.Sc. CHEMISTRY

(Two Year Course)

Note: In each question paper 10 questions will be set. Candidates have to answer any 5 questions selecting at least one question from each unit.

### M.Sc. I Year (Previous)

<table>
<thead>
<tr>
<th>Paper</th>
<th>Course No.</th>
<th>Course</th>
<th>Duration Hours</th>
<th>Max. Marks</th>
<th>Min. Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper I</td>
<td>CH-401</td>
<td>Inorganic Chemistry</td>
<td>3</td>
<td>100</td>
<td>36</td>
</tr>
<tr>
<td>Paper II</td>
<td>CH-402</td>
<td>Organic Chemistry</td>
<td>3</td>
<td>100</td>
<td>36</td>
</tr>
<tr>
<td>Paper III</td>
<td>CH-403</td>
<td>Physical Chemistry</td>
<td>3</td>
<td>100</td>
<td>36</td>
</tr>
<tr>
<td>Paper IV</td>
<td>CH-404</td>
<td>Spectroscopy</td>
<td>3</td>
<td>75</td>
<td>27</td>
</tr>
<tr>
<td>Paper V</td>
<td>CH-405</td>
<td>Mathematics for Chemists*</td>
<td>3</td>
<td>25</td>
<td>9</td>
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<td></td>
<td>Or</td>
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<td></td>
<td></td>
<td>Biology for Chemists**</td>
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</tr>
<tr>
<td>Paper VI</td>
<td>CH-406</td>
<td>Computers for Chemists</td>
<td>3</td>
<td>50</td>
<td>18</td>
</tr>
<tr>
<td>Practical</td>
<td></td>
<td></td>
<td>18 hrs.</td>
<td>200</td>
<td>72</td>
</tr>
</tbody>
</table>

* For students without Mathematics in B.Sc.  
** For students without Biology in B.Sc.

Total Marks: 650

### M.Sc. II Year (Final)

<table>
<thead>
<tr>
<th>Paper</th>
<th>Course No.</th>
<th>Course</th>
<th>Duration</th>
<th>Max. Marks</th>
<th>Min. Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper I</td>
<td>CH-501</td>
<td>Applications of Spectroscopy, Photochemistry and Solid State Chemistry</td>
<td>3 hrs.</td>
<td>100</td>
<td>36</td>
</tr>
<tr>
<td>Paper II</td>
<td>CH-502</td>
<td>a) Bioinorganic Chemistry</td>
<td>3 hrs.</td>
<td>75</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) Bioorganic Chemistry</td>
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<tr>
<td></td>
<td></td>
<td>c) Biophysical Chemistry</td>
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<tr>
<td>Paper III</td>
<td>CH-503</td>
<td>Environmental Chemistry</td>
<td>3 hrs.</td>
<td>50</td>
<td>18</td>
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<tr>
<td>Paper IV</td>
<td>CH-504</td>
<td>Elective Paper</td>
<td>3 hrs.</td>
<td>50</td>
<td>18</td>
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<tr>
<td>Paper V</td>
<td>CH-505</td>
<td>Elective Paper</td>
<td>3 hrs.</td>
<td>50</td>
<td>18</td>
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<tr>
<td>Paper VI</td>
<td>CH-506</td>
<td>Elective Paper</td>
<td>3 hrs.</td>
<td>50</td>
<td>18</td>
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<tr>
<td>Paper VII</td>
<td>CH-507</td>
<td>Elective Paper</td>
<td>3 hrs.</td>
<td>50</td>
<td>18</td>
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<tr>
<td>Seminars</td>
<td>Internal</td>
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<td>25</td>
<td>9</td>
</tr>
<tr>
<td>Practical</td>
<td></td>
<td></td>
<td>18 hrs.</td>
<td>200</td>
<td>72</td>
</tr>
</tbody>
</table>

Total Marks: 650

Grand Total: M.Sc. I Yr (Previous) & II Yr (Final): 1300

The following alternative groups of elective paper are approved for M.Sc. II Yr course.

**Group-I**  
CH-504 Organotransition Metal Chemistry  
CH-505 Bioinorganic and Supramolecular Chemistry  
CH-506 Photoorganic Chemistry  
CH-507 Polymers

**Group-II**  
CH-504 Organic Synthesis-I  
CH-505 Organic Synthesis-II  
CH-506 Heterocyclic Chemistry  
CH-507 Chemistry of Natural Products

**Group-III**  
CH-504 Analytical Chemistry  
CH-505 Physical Organic Chemistry  
CH-506 Chemical Dynamics  
CH-507 Electrochemistry
M.Sc. I YEAR (PREVIOUS)

Paper I : CH - 401 Inorganic Chemistry

Duration : 3 hrs.  Max. Marks : 100

Unit-I

Symmetry and Group Theory in Chemistry
Symmetry elements and symmetry operation, definition of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Point symmetry group. Schönflies symbols, representations of groups by metrics (representation for the C_n, C_n, D_n, etc., groups to be worked out explicitly). Character of a representation. The great orthogonality theorem (without proof) and its importance. Character tables and their uses; spectroscopic derivation of character table for C_n and C_2 point group. Symmetry aspects of molecular vibrations of H2O molecule.

Unit-II

Stereochemistry and Bonding in Main Group Element Compounds
VSEPR, Walsh diagram [tri-atomic (AH_2 type) and penta-atomic (CH_2I) molecules]. da-pr bond. Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules.

Metal-Ligand bonding
Limitations of crystal field theory. Molecular orbital theory: octahedral, tetrahedral and square planar complexes and π-bonding complexes.

Unit-III

Electronic Spectra and Magnetic Properties of Transition Metal Complexes
Spectroscopic ground states, correlation. Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), calculations of Dq, B and β parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

Metal-Ligand Equilibria in Solution
Stepwise and overall formation constants and their interactions, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry.

Unit-IV

Reaction Mechanism of Transition Metal Complexes
Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anion reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, trans effect, mechanism of the substitution reaction. Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions.

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[Signature]
UNIT V

Metal π-Complexes
Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand.

Metal Clusters
Higher boranes, carbones, metallaboranes and metalloboranes, compounds with metal-metal multiple bonds.

Isopoly and Heteropoly Acids and Salts.

Books Suggested:

PAPER II: CH-402 Organic Chemistry

Duration: 3 hrs. Max. Marks: 100

UNIT I

Nature of Bonding in Organic Molecules
Delocalized chemical bonding - conjugation, cross conjugation, resonance, hyperconjugation, bonding in fullerenes, tautomerism.
Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons. Hückel's rule, energy level of π-molecular orbitals. Annulenes, anti-aromaticity, homo-aromaticity. PMO approach. Bonds weaker than covalent - addition compounds, crown ether complexes and cryptands, inclusion compounds, catenanes and rotaxanes.

Stereochemistry
Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, strain due to unavoidable crowding. Elements of symmetry, chirality, molecules with more than one chiral centre, three and erythro isomers, methods of resolution, optical purity. Enantiomeric and diastereotopic atoms, groups and faces. Stereospecific and stereoselective synthesis. Asymmetric synthesis. Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape. Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.
Unit-II

Reaction Mechanism: Structure and Reactivity
Effect of structure on reactivity, resonance and field effects, steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants, Taft equation.

Aliphatic Nucleophilic Substitution
The S_N2, S_N1, mixed S_N1-S_N2 and S_E T mechanisms.
The neighbouring group mechanism, neighbouring group participation by π and σ bonds, anchimeric assistance. Classical and nonclassical carboxations, phenonium ions, norbornyl system, common carboxation rearrangements. Application of NMR spectroscopy in the detection of carboxation. The S_N1 mechanism. Nucleophilic substitution at the allylic, aliphatic trisolvation and a vinylic carbon.
Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound. Ambident nucleophile, regioselectivity.

Unit-III

Aliphatic Electrophilic Substitution
Bimolecular mechanisms - S_E2 and S_E1. The S_E1 mechanism - electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Aromatic Electrophilic Substitution
The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeier reaction, Gattermann-Koch reaction.

Aromatic Nucleophilic Substitution
The S_NAr, S_N1, benzylene and S_N1 mechanisms. Reactivity - effect of substrate structure, leaving group and attacking nucleophile. The von Richte, Sommelet-Hauser and Smiles rearrangements.

Free Radical Reactions
Unit-IV

Addition to Carbon-Carbon Multiple Bonds

Addition to Carbon-Hetero Multiple Bonds
Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction. Mechanism of condensation reactions involving enolates - aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

Elimination Reactions
The E2, E1 and E1cB mechanisms and their spectrum. Orientation of the double bond. Reactivity - effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.

Unit-V

Pericyclic Reactions
Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions - conrotatory and disrotatory motions. 4n, 4n+2 and allyl systems. Cycloadditions - antarafacial and suprafacial additions. 4n and 4n+2 systems, 2+2 addition of ketenes. 1,3-dipolar cycloadditions and chelotropic reactions. Sigmatropic rearrangements - Suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties. 3,3- and 5,5-sigmatropic rearrangements. Claisen, Cope and aza-Cope rearrangements. Fluxional tautomerism. Ene reaction.

Books Suggested
Paper III : CH 403 Physical Chemistry

Duration : 3 hrs.  
Max. Marks : 100

Unit-I

Quantum Chemistry

Introduction to Exact Quantum Mechanical Results : The Schrodinger equation and the postulates of quantum mechanics. Discussion of the solutions of the Schrodinger equation to some model systems viz., particle in a box, the harmonic oscillator, the rigid rotor, the hydrogen atom.


Angular Momentum : Ordinary angular momentum, generalized angular momentum, eigen functions for angular momentum, eigen values of angular momentum, operator using ladder operators, addition of angular momenta, spin, antisymmetry and Pauli's exclusion principle.

Molecular Orbital Theory : Hückel theory of conjugated systems, bond and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene etc. Introduction to extended Hückel theory.

Unit-II

Thermodynamics

Classical Thermodynamics : Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Partial molar properties, partial molar free energy, partial molar volume and partial molar heat content and their significances. Determinations of these quantities. Concept of fugacity and determination of fugacity.


Non Equilibrium Thermodynamics : Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equations for different irreversible processes (e.g., heat flow, chemical reaction etc) transformations of the generalized fluxes and forces, non equilibrium stationary states, phenomenological equations, microscopic reversibility and Onsager's reciprocity relations, electrokinetic phenomena, diffusion, electric conduction.
Unit-III

Chemical Dynamics

Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory; ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions, treatment of unimolecular reactions.

Dynamic chain reactions (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical reactions (hydrogen-bromine and hydrogen-chlorine) and homogeneous catalysis, kinetics of enzyme reactions, general features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method, dynamics of unimolecular reactions (Lindemann Hinshelwood and Rice-Ramsperger-Kassel-Marcus [RRKM] theories of unimolecular reactions).

Unit-IV

Surface Chemistry

Adsorption: Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation). Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electro-kinetic phenomenon).

Micelles: Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization-phase separation and mass action models, solubilization, micro emulsion, reverse micelles.

Macromolecules

Polymer - definition, types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetics of polymerization, mechanism of polymerization.

Molecular mass, number and mass average molecular mass, molecular mass determination (osmometry, viscometry, diffusion and light scattering methods), sedimentation, chain configuration of macromolecules, calculation of average dimension of various chain structures.

Unit-V

Electrochemistry


Quantum aspects of charge transfer at electrodes-solution interfaces, quantization of charge transfer, tunneling.

Semiconductor interfaces - theory of double layer at semiconductor, electrolyte solution interfaces, structure of double layer interfaces. Effect of light at semiconductor solution interface.

Polarography theory, Ilkovic equation, half wave potential and its significance.
Books Suggested
1. Physical Chemistry. P.W. Atkins, ELBS.
2. Introduction to Quantum Chemistry, A.K. Chandra, Tata Mcgraw Hill.
4. Coulson's Valence. R. McWeeny, ELBS.

Paper IV: CH 404 - Spectroscopy and Diffraction Methods
Duration : 3 hrs. Max. Marks : 75

Unit-I
Unifying Principles
Electromagnetic radiation, interaction of electromagnetic radiation with matter - absorption, emission, transmission, reflection, refraction, dispersion, polarisation and scattering. Uncertainty relation and natural line width and natural line broadening, transition probability, results of the time dependent perturbation theory, transition moment, selection rules, intensity of spectral lines.

Microwave Spectroscopy
Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor, Stark effect, nuclear and electron spin interaction and effect of external field. Applications.

Unit-II
Vibrational Spectroscopy
Infrared Spectroscopy: Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero point energy, force constant and bond strengths; anharmonicity, Morse potential energy diagram, vibration-rotation spectroscopy. PQR branches. Breakdown of Oppenheimer approximation; vibrations of polyatomic molecules. Selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factors affecting the band positions and intensities, far IR region, metal-ligand vibrations, normal co-ordinate analysis.


Applications of Vibrational Spectroscopy: Symmetry and shapes of AB2, AB3, AB4, AB5, AB6, mode of bonding of ambidentate ligands, ethylene diamine and diketone complexes, application of resonance Raman spectroscopy particularly for the study of active sites of metalloproteins.
Unit-III

Electronic Spectroscopy

Atomic Spectroscopy: Energies of atomic orbitals, vector representation of momenta and vector coupling, spectra of hydrogen atom and alkali metal atoms.


Photoelectron Spectroscopy: Basic principles; photo-electric effect, ionization process, Koopman’s theorem. Photoelectron spectra of simple molecules, ESCA, chemical information from ESCA. Auger electron spectroscopy - basic idea.

Unit-IV

Magnetic Resonance Spectroscopy

Nuclear Magnetic Resonance Spectroscopy: General introduction, Nuclear spin, nuclear resonance, shielding mechanism, chemical shift and its measurements, factors influencing chemical shift, deshielding. 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 & mercaptan). Spin-spin interactions, coupling constant $J$, factors influencing coupling constant. Complex spin-spin interaction between two, three, four and five nuclei (ABX, AMX, ABC, A2B2, etc.). Spin decoupling, chemical exchange, effect of deuterium. Simplification of complex spectra - nuclear magnetic double resonance, NMR shift reagents, solvent effects. NMR of Paramagnetic substances in solution, the contact and pseudocontact shifts, factors affecting nuclear relaxation. Fourier transform technique (FT NMR), nuclear Overhauser effect (NOE). NMR active nuclei other than proton - $^{13}$C, $^{31}$F and $^{31}$P.

Electron Spin Resonance Spectroscopy: Basic principles, zero field splitting and Kramer’s degeneracy, Isotropic and anisotropic Hyperfine coupling, spin-orbit coupling and significance of g-tensors, factors affecting the ‘g’ value, application to transition metal complexes; spin Hamiltonian, spin densities and McConnell relationship, applications - spin polarization for atoms and transition metal ions.

Unit-V


Electron Diffraction: Scattering intensity vs. scattering angle, Wierl equation, measurement technique, elucidation of structure of simple gas phase molecules. Low energy electron diffraction and structure of surfaces.

Neutron Diffraction: Scattering of neutrons by solids, measurements techniques. Elucidation of structure of magnetically ordered unit cell.
Books suggested
5. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.

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Paper-V : CH-405 (a) Mathematics for Chemists
(For students without Mathematics in B.Sc)

Duration : 3 hrs.

Max. Mark: 25

Unit-I

Vectors and Matrix Algebra
Vectors: Vectors, dot, cross and triple products etc. gradient, divergence and curl. Vector calculus.

Unit-II

Differential Calculus
Functions, continuity and differentiability, rules for differentiation, applications of differential calculus including maxima and minima (examples related to maximally populated rotational energy levels. Bohr's radius and most probable velocity from Maxwell's distribution etc).

Unit-III

Integral Calculus
Basic rules for integration, integration by parts, partial fraction and substitution. Reduction formulae, applications of integral calculus. Functions of several variables, partial differentiation, co-ordinate transformations (e.g. Cartesian to spherical polar).
Unit-IV

Elementary Differential equations
First order and first degree differential equations, homogenous exact and linear equations. Applications to chemical kinetics, secular equilibria, quantum chemistry, etc. Second order differential equations and their solutions.

Unit-V

Permutation and Probability
Permutations and combinations, probability and probability theorems, average, variance, root mean square deviation, examples from the kinetic theory of gases etc., fitting (including least squares fit etc.) with a general polynomial fit.

Books Suggested
1. The chemistry Mathematics Book, E. Steiner, Oxford University Press.

Paper-V : CH-405 (b) Biology for Chemists
(For students without Biology in B.Sc.)

Duration : 3 hrs. Max. Marks : 25

Unit-I

Cell Structure and Functions

Unit-II

Carbohydrates
Unit-III

Lipids
Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Lipoproteins - composition and function, role in atherosclerosis.
Lipid metabolism - β-oxidation of fatty acids.

Unit-IV

Amino-acids, Peptides and Proteins
Amino acid metabolism - degradation and biosynthesis of amino acids, sequence determination : chemical / enzymatic / mass spectral, racemization/ detection. Chemistry of oxytocin and tryptophan releasing hormone (TRH).

Unit-V

Nucleic Acids
Purine and pyrimidine bases of nucleic acids, base pairing via H bonding. Structure of ribonucleic acids (RNA) and deoxyribonucleic acids (DNA), double helix model of DNA and forces responsible for holding it. Chemical and enzymatic hydrolysis of nucleic acids. The chemical basis for heredity, an overview of replication of DNA. Transcription, translation and genetic code. Chemical synthesis of mono and trinucleoside.

Books Suggested

Paper-VI : CH-406 Computers for Chemists

Duration 3 hrs. Max. Marks : 50

Unit-I

Introduction to Computers and Computing

University of Bahrain


Unit-II

Computer Programming in FORTRAN/C/BASIC

(The language features are listed here with reference to FORTRAN. The instructor may choose another language such as BASIC or C and the features may be replaced appropriately). Elements of the computer language. Constants and variables. Operations and symbols. Expressions. Arithmetic assignment statement. Input and output. Format statement. Termination statements. Branching statements such as IF or GO TO statement. LOGICAL variables. Double precision variables. Subscripted variables and DIMENSION, DO statement. FUNCTION and SUBROUTINE, COMMON and DATA statements (students learn the programming logic and these language features by 'hands on' experience on a personal computer from the very beginning of this topic).

Unit-III

Programming in Chemistry

Developing of small computer codes (FORTRAN / C / BASIC) involving simple formulae in Chemistry, such as Van der Waals equation. Chemical kinetics (determination of Rate constants), Radioactive decay (Half Life and Average Life). Determination of Normality, Molarity and Molality of solutions. Evaluation of Electronegativity of atom and Lattice Energy from experimental data. Determination of molecular weight and percentage of elements in organic compounds using data from experimental methods. Representation of molecules in terms of elementary structural features such as bond lengths, bond angles, dihedral angles, etc.

Unit-IV

Use of computer Programmes

Operation of PC. Data Processing. Running of standard Programs and Packages such as MS WORD, MS EXCEL - special emphasis on calculations and chart formations. X-Y plot. Simpson's Numerical Integration method.

Unit-V

Programmes with data preferably from physical chemistry Laboratory. Introduction of working of any one of the packages such as LOTUS / EXCEL / FOXPRO / MOPAC and Word Processing software such as WORDSTAR/ MS WORD.

Books Suggested:
1. Fundamentals of Computers - V. Rajaraman (Prentice Hall)
3. Computer Programming in FORTRAN IV - V Rajaraman (Prentice Hall)

M.Sc. (Prev.) PRACTICAL

Duration 14 hrs. (2 days)  Max. Marks : 200

INORGANIC CHEMISTRY

Qualitative and Quantitative Analysis

a) Less common metal ions - Ti, Mo, W, Ti, Zr, Th, V, U (two metal ions in cationic/anionic forms)
b) Insolubles - oxides, sulphates and halides.
- c) Separation and determination of two metal ions - Cu-Ni, Ni-Zn, Cu-Fe involving volumetric and gravimetric methods.

Chromatography
Separation of cations and anions by
a) Paper Chromatography
b) Column Chromatography - Ion exchange.

Preparations
Preparation of selected inorganic compounds and their studies by IR, electronic spectra, Mössbauer, ESR and magnetic susceptibility measurements. Handling of air and moisture sensitive compounds.
1. \([\text{VO(acac)}_2]\)
2. \(\text{TiO} (\text{C}_4\text{H}_6\text{NO})_2 \cdot 2\text{H}_2\text{O}\)
3. \(\text{cis-K}[\text{Cr(C}_2\text{O}_4)_3(\text{H}_2\text{O})_2]\)
4. \(\text{Na}[\text{Cr(NH}_3)_3(\text{SCN})_4]\)
5. \([\text{Mn(acac)}_2]\)
6. \(\text{K}_4[\text{Fe(C}_2\text{O}_4)_3]\)
7. Prussian Blue, Turnbull's Blue.
8. \([\text{Co(NH}_3)_6][\text{Co(NO}_3)_6]\)
9. \(\text{cis-Co(trien)}(\text{NO}_2)_3\text{Cl.H}_2\text{O}\)
10. \(\text{Hg}[\text{Co(SCN)}_4]\)
11. \([\text{Co(Py}_3]\text{Cl}_3]\)
12. \([\text{Ni(NH}_3)_6]\text{Cl}_2\)
13. \([\text{Ni(dmg)}_2]\]
14. \([\text{Cu(NH}_3)_4]\text{SO}_4\cdot\text{H}_2\text{O}\)

ORGANIC CHEMISTRY

Qualitative Analysis
Separation, purification and identification of compounds of binary mixture, one liquid and one solid using TLC and column chromatography, chemical tests, IR spectra to be used for functional group identification.

Organic Synthesis (at least six to be carried out)

a) One step Preparations:
1. Acetylation: Acetylation of cholesterol and separation of cholesterol acetate by column chromatography.
2. Oxidation: Adipic acid by chromic acid oxidation of cyclohexanol / cyclohexene.
3. Aldol condensation: Dibenyl acetone from benzaldehyde.

b) Two step Preparations
1. Aniline → Sym. Tribromoaniline → Sym. Tribromobenzene
2. Benzoin → Benzil → Dibenzyl
3. Aniline → Dibenzoaminobenzene → p-Aminoazobenzene
4. Nitrobenzene → m-Dinitrobenzene → m-Nitroaniline
5. Phthalic anhydride → Fluorescein → Eosin
The products may be characterised by Spectral Techniques.

Quantitative Analysis (At least 3 to be performed)
1. Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation method.
2. Estimation of amines / phenols using bromate bromide solution or acetylation method.
3. Estimation of Sulphur by Messenger or Fusion method.
5. Determination of Iodine number and Saponification value of an oil sample.
6. Determination of DO, COD and BOD of water sample.

PHYSICAL CHEMISTRY
Number of hours of each experiment 3-4 hours. A list of experiment under different headings is given below.
Typical experiments are to be selected from each type. Students are required to perform at least 30 experiments.

PART A

Error Analysis and Statistical Data Analysis
Errors, types of errors, minimization of errors distribution curves, precision, accuracy and combination; statistical treatment for error analysis, student ‘t’ test, null hypothesis rejection criteria, F & Q test; linear regression analysis, curve fitting.
Calibration of volumetric apparatus, burette, pipette and standard flask.

PART B

Adsorption
To study surface tension-concentration relationship for solutions (Gibbs equation).

Phase Equilibria
(i) Determination of congruent composition and temperature of a binary system (e.g., diphenylamine-benzophenone system)
(ii) Determination of glass transition temperature of a given salt (e.g. CaCl₂) conductometrically.
(iii) To construct the phase diagram for three component system (e.g. chloroform - acetic acid - water).

Chemical Kinetics
(i) Determination of the effect of (a) Change of temperature (b) Change of concentration of reactant and catalyst and (c) Ionic strength of the media on the velocity constant of hydrolysis of an ester/ionic reactions.
(ii) Determination of the velocity constant of hydrolysis of an ester/ionic reaction in micellar media.
(iii) Determination of the rate constant for the oxidation of iodide ions by hydrogen peroxide studying the kinetics as an iodine clock reaction.
(iv) Flowing clock reaction (Ref: Experiments in Physical Chemistry by Snowmaker)
(v) Determination of the primary salt effect on the kinetics of ionic reactions and testing of the Bronsted relationship (iodide ion is oxidized by persulphate ion).
(vi) Oscillatory reaction.

**Solutions**

(i) Determination of molecular weight of non-volatile and non-electrolyte / electrolyte by cryoscopic method and to determine the activity coefficient of an electrolyte.

(ii) Determination of the degree of dissociation of weak electrolyte and to study the deviation from ideal behaviour that occurs with a strong electrolyte.

**Electrochemistry**

A. **Conductometry**

(i) Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically.

(ii) Determination of solubility and solubility product of sparingly soluble salts (e.g., PbSO₄, BaSO₄) conductometrically.

(iii) Determination of the strength of strong and weak acids in a given mixture conductometrically.

(iv) To study the effect of solvent on the conductance of AgNO₃ / acetic acid and to determine the degree of dissociation and equilibrium constant in different solvents and in their mixtures (DMSO, DMF, dioxane, acetone, water) and to test the validity of Debye-Hückel-Onsager theory.

(v) Determination of the activity coefficient of zinc ions in the solution of 0.002 M zinc sulphate using Debye-Hückel's limiting law.

B. **Potentiometry/pHmetry**

(i) Determination of strengths of halides in a mixture potentiometrically.

(ii) Determination of the valency of mercurous ions potentiometrically.

(iii) Determination of the strength of strong and weak acids in a given mixture using a potentiometer/pH meter.

(iv) Determination of temperature dependence of EMF of a cell.

(v) Determination of the formation constant of silver-ammonia complex and stoichiometry of the complex potentiometrically.

(vi) Acid-base titration in a non-aqueous media using a pH meter.

(vii) Determination of activity and activity coefficient of electrolytes.

(viii) Determination of the dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH.

(ix) Determination of the dissociation constant of monobasic/dibasic acid by Albert-Serjeant method.

(x) Determination of thermodynamic constants, $\Delta G$, $\Delta S$, and $\Delta H$ for the reaction by e.m.f. method.

\[ \text{Zn} + 2\text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + 2\text{H} \]

**Polarimetry**

(i) Determination of rate constant for hydrolysis/inversion of sugar using a polarimeter.

(ii) Enzyme kinetics - inversion of sucrose.

**Reference Books:**


INSTRUCTIONS TO THE EXAMINERS
M.Sc. (Previous) Chemistry Practical
Max. Marks : 200 Duration of Exam: 14 hrs (spread in 2 days) Min. Marks : 72

Inorganic Chemistry
Qualitative and Quantitative Analysis
(i) Analysis of mixture containing 8 radicals including one radical of rare elements.
Or
Separation and determination of two metal ions Cu-Ni, Ni-Zn, Cu-Fe involving volumetric and gravimetric method.
(Both these exercises should be given in equal ratio by lots.)
(ii) Separation of cations and anions by paper chromatography or column chromatography.
Or
Preparation of one selected inorganic compound and its study by IR.

Organic Chemistry
(i) Qualitative and Quantitative Analysis
Separation, purification and identification of compounds of binary mixture (one liquid and one solid) using TLC and column chromatography, chemical tests. IR spectra to be used for functional group determination.
Or
Perform one of the quantitative analysis given in syllabus.
(Both these exercises should be given in equal ratio by lots.)
(ii) Organic synthesis
Perform one of the 8 organic synthesis as mentioned in the syllabus and may be characterized by spectral techniques.

Physical Chemistry
(i) One physical experiment (minor) from Part A of syllabus.
(ii) One physical experiment (major) from Part B of syllabus.

Viva
Record

Asstt. Registrar (Acad.)
University of Rajasthan
JALWAR
M.Sc. (Final) 2016-17

Paper-1 : CH-501 Applications of Spectroscopy, Photochemistry and Solid State Chemistry
(4 hrs. or 6 periods / week)

Duration : 3 Hrs.                              Max. Marks : 100

Unit-I

Ultraviolet and Visible Spectroscopy
Various electronic transitions (185-800 nm), Beer-Lambert law, effect of solvent on electronic transitions, ultraviolet spectra of 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.

Unit-II

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$^{2+}$ and Sn$^{4+}$ compounds, nature of M-L bond, coordination number, structure and (3) detection of oxidation state and inequivalent M-B atoms.

Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD) and Magnetic Properties of Transition Metal Complexes
Definition, deduction of absolute configuration, octant rule for ketones. Spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical conformation, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

Unit-III

Carbon-13 NMR Spectroscopy
General considerations, chemical shift (aliphatic, olefinic, alkynic, 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
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 states - 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.

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, \( \beta \), \( \gamma \)-unsaturated and \( \alpha,\beta \)-unsaturated compounds, cyclohexadienones.

Intermolecular cycloaddition reactions - dimerisations and oxetane formation.

Photochemistry of Aromatic Compounds: Isomerisations, additions and substitutions.

Unit-V

Solid State Reactions: General principles, experimental procedure, co-precipitation as a precursor 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 solids, band theory, band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, super conductors.


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

Books Suggested (UNIT I, II and III)


Books Suggested (UNIT IV)

Books Suggested (UNIT V)

Paper-II : CH-502
Bioinorganic Chemistry, Bioorganic Chemistry and Biophysical Chemistry
(4 hrs or 6 period/ week)

Duration : 3 hrs. Max. Marks : 75

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.

Transport and Storage of Dioxygen : Haem proteins and oxygen uptake, structure and function of haemoglobin, myoglobin, haemocyanin and hemerythin, model synthetic complexes of iron, cobalt and copper.

Electron Transfer in Biology : Structure and function of metalloproteins in electron transport processes cytochromes and iron-sulphur proteins, synthetic models.

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

Unit-II

Bioorganic Chemistry : 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 labeling 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.

Types 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 isomerization reactions. β-Cleavage and condensation, some isomerization and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.

Unit-III


Enzyme Models: Host-guest chemistry, chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality. Biomimetic chemistry, crown ether, cryptates. Cyclodextrins, cyclodextrin-based enzyme models, calixarenes, ionophores, micelles, synthetic enzymes or synthetic.

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.

Unit-IV

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.

Statistical Mechanics in Biopolymers: Chain configuration of macromolecules, statistical distribution end to end dimensions, calculation of average dimensions for various chain structure. Polypeptide and protein structures, introduction to protein folding problem.

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

Unit-V

Thermodynamics of Biopolymer Solutions: Thermodynamics of biopolymer solutions, osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanism chemical system.

Biopolymers and their molecular weights: Evaluation of size, shape, molecular weight and extent of hydration of biopolymers by various experimental techniques. Sedimentation equilibrium, hydrodynamic methods, diffusion, sedimentation velocity, viscosity, electrophoresis and rotational motions.

Diffraction Methods: Light scattering, low angle X-ray scattering, X-ray diffraction and photo correlation spectroscopy, ORD.

Books Suggested

7. Understanding Enzymes, Trevor Palmer, Prentice Hall.
Paper-III : CH-503 : Environmental Chemistry

(2 Hrs. or 3 period / week)

Duration : 3 hrs.  Max. Marks : 50

Unit-I


Atmospheric Chemistry : Sources of trace atmospheric constituents : nitrogen oxides, sulphur dioxide and other sulphur compounds, carbon oxides, chlorofluorocarbons and other halogen compounds, methane and other hydrocarbons.


Unit-II

Air Pollution : Air pollutants and their classification. 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 SO$_2$ and NOx - Acid rain control strategies.


Green House Effect : Terrestrial and solar radiation spectra. Major greenhouse gases and their sources and Global warming potentials. Climate change and consequences.


Unit-III


Unit-IV

Environmental Toxicology

Toxic Heavy Metals - Mercury, lead, arsenic and cadmium. Causes of toxicity. Bioaccumulation, sources of heavy metals. Chemical speciation of Hg, Pb, As and Cd. Biochemical and damaging effects.

Toxic Organic Compounds - Pesticides, classification, properties and uses of organochlorine and organophosphorus pesticides, detection and damaging effects.
Syllabus: M.Sc. Chemistry

- Polychlorinated Biphenyls - Properties, uses and environmental contamination and effects.
- Polynuclear Aromatic Hydrocarbons - Sources, structures and as pollutants.

Unit-V

Soil and Environmental Disasters
Soil composition, micro and macronutrients. Soil pollution by fertilizers, plastic and metals. Methods of remediation of soil.

Bhopal gas tragedy, Chernobyl, Three mile island, Minamata Disease, Sevoso (Italy), London smog.

Books Suggested:
5. Introduction to Atmospheric Chemistry, P.V. Hobbs, Cambridge.

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ELECTIVE PAPERS

Group I
1. Organotransition Metal Chemistry
2. Bioinorganic and Supramolecular Chemistry
3. Photoinorganic Chemistry
4. Polymers.

Group II
5. Organic Synthesis-I
6. Organic Synthesis-II
7. Heterocyclic Chemistry
8. Chemistry of Natural Products

Group III
9. Analytical chemistry
10. Physical Organic Chemistry
11. Chemical Dynamics
12. Electrochemistry
ELECTIVE PAPER-I
(CH-504, Group-I) Organotransition Metal Chemistry

(2 Hrs. or 3 period/week)
Max. Marks : 50

Duration : 3 hrs.

Unit-I
Alkyls and Aryls of Transition Metals
Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis.

Unit-II
Compounds of Transition Metal-Carbon Multiple Bonds
Alkylidenes, alkylidyynes, 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, preparations, properties, nature of bonding and structural features. Important reactions relating to nucleophilic and electrophilic attack on ligands and organic synthesis.

Transition metal compounds with bonds to hydrogen
Transition metal compounds with bonds to hydrogen.

Unit-IV
Homogeneous Catalysis
Stoichiometric reactions for catalysis, homogeneous catalytic hydrogenation, Ziegler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydrocarbonylation of olefins (oxo reaction). Oxopalladation reactions, activation of C-H bond.

Unit-V
Fluxional Organometallic Compounds
Fluxionality and dynamic equilibria in compounds such as σ-olefin, η'-allyl and dienyl complexes.

Books Suggested
4. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International,
ELECTIVE PAPER-2  
(CH-505, Group-I) Bioinorganic and Supramolecular Chemistry  

Duration : 3 hrs.  
Max. Marks : 50  

Unit-I  
Metal Storage and Transport  
Ferritin transferring and siderophores  

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

Unit-III  
Metalloenzymes  

Unit-IV  
Metal-Nucleic Acid Complexes  
Metal ions and metal complex interactions. Metal complex-nucleic acids.  

Unit-V  
Metals in Medicine  
Metal deficiency and disease, toxic effects of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs.  

Supramolecular Chemistry-I  
(A.) Molecular recognition: Molecular receptors for different types of molecules including arisonic substrates, design and synthesis of coreceptor molecules and multiple recognition.  
(B.) Supramolecular reactivity and catalysis.  

Supramolecular Chemistry-II  
(A.) Transport processes and carrier design.  

Books Suggested  
5. Supramolecular Chemistry, J.M. Lehn. VCH.  

Asst. Registrar (Acad-I)  
University of Rohilkhand
ELECTIVE PAPER-3
(CH-506, Group-II) Photoinorganic Chemistry

(2 Hrs. or 3 period/week)
Max. Marks: 50

Duration: 3 hrs.

Unit-I
Basics of Photochemistry

Unit-II
Properties of Excited States

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.

Unit-IV
Ligand Field Photochemistry
Photosubstitution, photooxidation and photoreduction, liability and selectivity, zero vibrational levels of ground state and excited state, energy content of excited state, 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-exciplex 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 [Ru(bpy)]²⁺ complex, comparison with [Fe(bpy)]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.

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.

Books Suggested

Asstt. Registrar (Acad.)
University of Rajasthan
ELECTIVE PAPER-4
(CH-507, Group-I) Polymers

Duration: 3 hrs.

Unit-I

Basics

Polymer Characterization

Unit-II

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
a) Polymers based on boron - borazines, boranes and carbonanes.
b) Polymers based on silicon, silicones polymetalloxanes and polymetallosiloxanes, silazenes.

Structure, Properties and Applications of
a) Polymers based on phosphorus – phosphazenes, polyphosphates.
b) Polymers based on sulphur - tetrasulphurtriantride and related compounds.

Unit-V

Structure, Properties and Applications of - (a) Metal clusters, (b) Co-ordination and metal chelate polymers.

References:
5. Inorganic Rings and Cages, D.A. Armitage.
ELECTIVE PAPER-5
(CH-504, Group-II) Organic Synthesis-I

(2Hrs. or 3 periods/week)
Max. Marks : 50

Duration : 3 hrs.

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
Alcohols, diols, aldehydes, ketones, ketals and carboxylic acids Amines, hydrazines, and sulphides.
Oxidations with ruthenium tetroxide, iodobenzenediacetate and thallium(III) nitrate.

Unit-III

Reduction
Introduction. Different reductive processes.

Unit-IV

Rearrangements
General mechanistic considerations - nature of migration, migratory aptitude, memory effects.

Unit-V

Metallocenes, Nonbenzenoid Aromatics and Polycyclic Aromatic Compounds
General considerations, synthesis and reactions of some representative compounds, (tropone, tropolone. Azulene, ferrocene, phenanthrene, fluorene and indene).

Books Suggested
ELECTIVE PAPER-6
(CH-505, Group-II) Organic Synthesis-II
(2Hrs. or 3 periods/week)

Duration: 3 hrs.          Max. Marks: 50

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. Michael 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, Cortisone,
Reserpine, Vitamin D, Juvabione, Aphidicolin and Fredericamycin-A.

Books Suggested
4. Modern Synthetic Reactions H.O. House, W.A. Benjamin
ELECTIVE PAPER-7
(CH-506, Group II) Heterocyclic Chemistry

(2 Hrs. or 3 periods/week)
Max. Marks : 50

Duration : 3 hrs.

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 $^1$H NMR spectra. Empirical resonance energy, delocalization energy and Dewar resonance energy, diamagnetic susceptibility exaltations).
Heterocyclic 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 benzopyroles, benzofurans 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 diazines, triazines, tetrazines and thiazines.
Seven-and Large-Membered Heterocycles
Synthesis and reactions of azepines, oxepines, thiepines, 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. Heterocyclic rings containing As and Sb : introduction, synthesis and characteristics of 5- and 6-membered ring system.
Heterocyclic rings containing Boron : introduction, synthesis, reactivity and spectral characteristics of 3-, 5- and 6-membered ring systems.

Books Suggested :

ELECTIVE PAPER 8
(CH-507, Group -II) Chemistry of Natural Products
(2Hrs. or 3 periods/week)

Duration : 3 hrs.
Max. Marks : 50

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, Geraniol, 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
Unit-IV

Plant Pigments
Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of Apigenin, Luteolin, Quercetin, Myricetin, Quercetin 3-glucoside, Vitexin, Diadzein, Butein, Aureusin, Cyanidin-7-arabinoside, Cyanidin, Hirsutidin. Biosynthesis of flavonoids: Acetate pathway and Shikimic acid pathway.

Porphyrrins
Structure and synthesis of Haemoglobin and Chlorophyll.

Unit-V

Prostaglandins
Occurrence, nomenclature, classification, biogenesis and physiological effects. Synthesis of PGE₂ and PGF₂α.

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
1. Natural Products : Chemistry and Biological Significance, J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J B Harborne, Longman. Essex.

ELECTIVE PAPER-9
(CH-504, Group -III) Analytical Chemistry

Duration : 3 hrs.

Max. Marks : 50

Unit-I

Introduction
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-II
Food Analysis

Unit-III
Analysis of Water Pollution

Unit-IV
Analysis of Soil and Fuel
Analysis of soil : moisture pH, total nitrogen, phosphorus, silica, lime, magnesia, manganese, sulphur and alkali salts.

Unit-V
Analysis of Body Fluids and Drugs
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 phosphatases. Immunoassay : principles of radio immunoassay (RIA) and applications. The blood gas analysis, trace elements in the body.
Drug analysis : Narcotics and dangerous drugs. Classification of drugs. Screening by gas and thin-layer chromatography and spectrophotometric measurements.

Books Suggested
7. Principles of Instrumental Analysis D.A. Skoog W.B. Saunders.

ELECTIVE PAPER-10
(CH-505, Group-III) Physical Organic Chemistry
(2Hrs. or 3 periods/week)
Max. Marks : 50

Unit-I
Concepts in Molecular Orbital (MO) and Valence Bond (VB) Theory
Introduction to Hucckel 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.


Unit-II
Principles of Reactivity

Kinetic Isotope Effect
Theory of isotope effects. Primary and secondary kinetic isotope effects. Heavy atom isotope effects. Tunneling effect, Solvent effects.

Unit-III
Structural Effects on Reactivity
Linear free energy relationships (LFER). The Hammett equation, substituent constants, theories of substituent effects. Interpretation of σ-values. Reaction constant p. Deviations from Hammett equation. Dual parameter correlations, inductive substituent constant. The Taft model, dieckerscales.

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-IV

Acids, Bases, Electrophiles, Nucleophiles and Catalysis


Steric and Conformational Properties


Unit-V

Nucleophilic and Electrophilic Reactivity

Structural and electronic effects on $S_N1$ and $S_N2$ reactivity Solvent effect. Kinetic isotope effects. Intramolecular assistance. Electron transfer nature of $S_N2$ reaction. Nucleophilicity and $S_N2$ reactivity based on curve crossing model. Relationship between polar and electron transfer reactions. $S_N1$ mechanism Electrophilic reactivity, general mechanism. Kinetics of $S_N2$ - Ar reaction Structural effects on rates and selectivity. Curve-crossing approach to electrophilic reactivity.

Radical and Pericyclic Reactivity

Radical stability, polar influence, solvent and steric effects. A curve crossing approach to radical addition, factors effecting barrier heights in addition, regioselectivity in radical reactions.

Reactivity, specificity and periselectivity in pericyclic reactions.

Books Suggested:

4. Introduction to Theoretical Organic Chemistry and Molecular Modeling.
ELECTIVE PAPER-11
(CH-506, Group-III) Chemical Dynamics

Duration: 3 hrs.

Max. Marks: 50

Unit-I

Atmospheric Reactions

Unit-II

Oscillatory Reactions
Autocatalysis and oscillatory reactions. Kinetics and mechanism of Belousov-Zhabotinski (B-Z) reaction.

Enzymes and Inhibitions
Kinetics of one enzyme - 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 (1st order and second order) Various type of micelle catalyzed reactions. Micelle inhibited reactions.

Dynamics of Gas-surface reactions

Unit-III

Radiation Chemistry and Photochemistry

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

Unit-IV

Substitution reactions.
Substitution reactions. Classification of ligand substitution mechanism. Anion 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 mechanisms. Marcus-Cross relation in outer sphere reactions (no mathematical derivation) Its application in reactions:

\[
\begin{align*}
\text{Ce (IV)} + \text{Mo (CN)}_6^{3+} & \rightarrow \text{Ce (III)} + \text{Mo (CN)}_6^{3+} \\
\text{Fe(CN)}_6^{3+} + \text{Fe(CN)}_6^{3+} & \rightarrow \text{Fe (CN)}_6^{3+} + \text{Fe (CN)}_6^{3+}
\end{align*}
\]

Bridged outer-sphere electron transfer mechanism.

Kinetics of reactions in the presence of cyclodextrins. Considering one full case study, nucleophilic and electrophilic catalysts 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).

Kinetics of hydroformylation reaction.

**Books Recommended**

3. N.L. Bender, Mechanism of Homogeneous Catalysis from protein to protein, Wiley.

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**ELECTIVE PAPER-12**

(CH-507, Group-III) Electrochemistry

(2 Hrs. or 3 period/week)  
Max. Marks : 50

**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 output.


Electrochemical Energy Storage:

Properties of electrochemical energy storers : measure of battery performance. Charging and discharging of a battery, storage density, energy density.

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Asstt. Registrar (Acad-I)  
University of Rajasthan
Classical Batteries: (i) Lead Acid, (ii) Nickel-Cadmium, (iii) Zinc-Manganese dioxide

Unit-II

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) Diaphragms: uses and abuses, Corrosion current and corrosion potential - Evans diagrams.
Inhibiting Corrosion: Cathodic and Anodic Protection, (i) Inhibition by addition of substrates to the electrolyte environment, (ii) by charging the corroding method from external source, anodic Protection. Organic inhibitors. The Fuller Story Green inhibitors.
Passivation:

Unit-III

Bioelectrochemistry:

Unit-IV

Kinetics of Electrode Process:
Essentials of electrode reaction current density, overpotential, Tafel Equation, Butler Volmer equation. Standard rate constant (K*) and transfer coefficient (α), exchange current.
Irreversible Electrode processes: criteria of irreversibility, information from irreversible wave.

Electrocatalysis:

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 potentials methods, chronopotentiometry, theory and applications.
Bulk Electrolysis Methods: Controlled potential coulometry. Controlled coulometry. Electroorganic synthesis and its important applications.
Stripping analysis: Anodic and cathodic modes. Pre electrolysis and stripping steps, applications of stripping analysis.
Reference
1. Modern Electrochemistry Vol. I, IIA, IIB
4. Modern Polarographic Methods by A.M. Bond and Marcel Dekker
5. Polarography and allied techniques By K. Zutshi, New Age International publication, New Delhi.
M.Sc. (Final) Chemistry Practical

PRACTICAL

Duration: (14 hrs in 2 days) Max. Marks: 200

Inorganic Chemistry

Preparation

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.

Selection can be made from the following:

3. Atomic absorption analysis of Mg and Ca.
4. Trialkoxyboranes - Preparation, IR and NMR spectra.
7. Relative stability of Tin (IV) and Pb (IV). Preparation of ammonium hexachlorostannate (NH4)2SnCl6; ammonium hexachloroplatinate (NH4)2PbCl6.
8. Hexabis (4-nitrophenoxy) cyclotriphosphazene.
10. Sodium tetrathionate, Na2S4O6.
14. Magnetic moment of [Cu(acac)2]. H2O.
15. cis- and trans- [Co(en)2Cl2]2.
21. Reaction of Cr(III) with a multidentate ligand; a kinetics experiment (visible spectra Cr-EDTA complex), J. A. C. S., 1953, 75, 5670.
22. Preparation of [Co(phenanthroline-5, 6-quinone)].
25. Preparation of phosphine (Ph3P) and its transition metal complexes.
26. Any other experiment such as conversion of p-xylene to terephthalic acid catalyzed by CoBr2 (homogeneous catalysis).

Spectrophotometric Determinations
a) Manganese/Chromium/Vanadium in steel sample.
b) Nickel/Molybdenum/Tungsten/Vanadium/Uranium by extractive spectrophotometric method.
c) Fluoride/Nitrile/Phosphate.
e) Zirconium-alizarin Red-S complex: Mole-ratio method.
f) Copper ethylenediamine complex: Slope-ratio method.

Flame Photometric Determinations
a) Sodium and potassium when present together.
b) Lithium/Calcium/Barium/Strontium.
c) Cadmium and Magnesium in tap water.

Quantitative determinations of a three component mixture:
One Volumetrically and two Gravimetrically
a) Cu^{2+}, Ni^{2+}, Zn^{2+}
b) Cu^{2+}, Ni^{2+}, Mg^{2+}

Chromatographic Separations
a) Cadmium and zinc
b) Zinc and magnesium
c) Thin-layer chromatography-separation of nickel, manganese, cobalt and zinc, Determination of Rf values,
d) Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of Rf values.

Organic Chemistry

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

Multi-step Synthesis of Organic Compounds
The exercises should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques.

i) Photochemical reaction:
   (Benzophenone → Benzpinacol → Benzpinacolone)

ii) Beckman Rearrangement: Benzanilide from benzene
   (Benzene → Benzophenone → Benzophenone oxime → Benzanilide)

iii) Benzilic acid rearrangement: Benzilic acid from benzoin
(Benzoin → Benzil → Benzoic acid).

iv) Synthesis of heterocyclic compounds
   a) Skraup synthesis: Preparation of quinoline from aniline
   b) Fisher Indole synthesis: Preparation of 2-phenylindole from phenylhydrazine.

v) Diazocoupling: Phthalic anhydride → Phthalimide → anthranilic acid → methyl red.

vi) Enzymatic synthesis: Reduction of ethyl acetoacetate using Bakers' yeast to yield enantiomeric excess of S(+)-ethyl-3-hydroxybutanoate and determine its optical purity. Biosynthesis of ethanol from sucrose.


viii) Synthesis using phase transfer catalyst: Alkylation of diethyl malonate or ethyl acetoacetate with an alkyl halide.

Extraction of Organic Compounds from Natural Sources
   a) Isolation of caffeine from tea leaves.
   b) Isolation of casein from milk (the students are required to try some typical colour reactions of proteins)
   c) Isolation of lactose from milk (purity of sugar should be checked by TLC and PC and $R_f$ values reported).
   d) Isolation of chlorophyll a & b from spinach / spirulina.
   e) Isolation of cinchonine from cinchona bark.
   f) Isolation of pipericine from black pepper.
   g) Isolation of lycopene from tomatoes.
   h) Isolation of β-carotene from carrots.
   i) Isolation of oleic acid from olive oil (involving the preparation of complex with urea and separation of linoleic acid).
   j) Isolation of eugenol from clove.
   k) Isolation of (+)limonene from citrus rinds.

Paper Chromatography
   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.

Spectroscopy
   Identification of organic compounds by the analysis of their spectral data (UV, IR, PMR, CMR & MS).

Spectrophotometry (UV/VIS) Estimations
   a) Amino acids
   b) Proteins
   c) Carbohydrates
   d) Cholesterol
   e) Ascorbic acid
   f) Aspirin
   g) Caffeine

Physical Chemistry
   Number of Hours to each experiment: 3 Hours
   A list of experiments under different headings are given below:

[Signature]
Typical experiments are to be selected from each type.

A. Thermodynamics
(i) Determination of partial molar volume of solute (e.g. KCl) and solvent in a binary mixture.
(ii) 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.

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

C. Polarography
(i) Identification and estimation of metal ions such as Cd²⁺, Pb²⁺, Zn²⁺ and Ni²⁺ etc. polarographically.
(ii) Study of a metal ligand complex polarographically (using Lingane’s Method).

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

E. 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. Net works of resistors, Thévenin’s theorem, superposition theorem, loop analysis, R.C. circuits, L.R. Circuits, LCR circuits. Illustration of the use of circuits in NQR spectroscopy, Mössbauer spectroscopy, cyclic voltammetry and in power supplies as filter circuits.

Active components
Introduction to ordinary diodes and Zener diodes with some emphasis on p-n junction as a solid state property. Use of diodes as rectifiers, clipping and clamping circuits, Power supplies.
Transistors: An extension of p-n Junction to 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 a transistor used as a diode and compare the results with those of (a).
2. To implement a diode dipper circuit for the given transfer characteristics and verify the waveform.
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 JFET 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
   (b) 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.

**Note:** A sheet containing 20 questions/diagrams/circuits will be provided to the students to reply. These questions based on basic electronics will cover both theory and practicals as provided in the syllabus. There will be objective type questions (MCQs) of 20 minutes duration with maximum marks 10.

**Reference Books:**

1. Inorganic Experiments, J. Derek Woonings, VCH.
INSTRUCTIONS TO THE EXAMINERS
M.Sc. (Final) Chemistry Practical

Max. Marks: 200  Duration of Exam: 14 hrs. (Spread in 2 days)  Min. Marks 72

Inorganic Chemistry
1. Preparation of one of the selected inorganic compounds as mentioned in the syllabus and its study by IR, electronic spectra, Mossbaur, ESR and magnetic susceptibility. Handling of air and moisture sensitive compounds involving vacuum lines. 25
   Or
   Quantitative determination of a three component mixture by volumetric & gravimetric methods.
2. Spectrophotometric determination of one of the 5 exercises given in the syllabus. 15
   Or
   Flame Photometric determinations (one exercise)
3. Chromatographic separation of two metal ions. 10

Organic Chemistry
1. Qualitative Analysis
   Separation, purification and identification of the components of a mixture of three organic compounds (three solids or two liquids and one solid, two solid and one liquid), using TLC for checking the purity of the separated compounds.
   Chemical analysis, IR, ^1^HMR and Mass spectral data. 30
   Perform one of the multi-step synthesis of organic compounds. 20
   Or

Spectroscopy
   Identification of Organic Compounds by the analysis of their spectral data (UV, IR, NMR, CMR and Mass)

Physical Chemistry
1. Perform one Major physical experiment given in the syllabus. 30
2. Perform one Minor physical experiment given in the syllabus. 20
   Viva 30
   Record 20

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