



Shivaji University, Kolhapur

Department of Chemistry

M.Sc. Part-II (sem-III and IV) Chemistry
(Inorganic, Organic, Physical and Analytical)

Revised Syllabus

Choice Based Credit System Pattern

To be implemented from June- 2013

Applicable for University Department and Affiliated Colleges PG Center

M.Sc. Part-II, (Sem-III and IV) Inorganic Chemistry

SEMESTER- III

Paper No-ICH-IX : INORGANIC CHEMICAL SPECTROSCOPY

Paper No. ICH-X : COORDINATION CHEMISTRY – I

Paper No. ICH-XI : NUCLEAR CHEMISTRY

ELECTIVE PAPERS

Paper No. ICH-XIIA : ENVIRONMENTAL CHEMISTRY

Paper No. ICH-XIIB : ORGANOMETALLIC CHEMISTRY

Paper No. ICH-XIIC : SELECTED TOPICS IN INORGANIC CHEMISTRY

Practical Course : ICH-V and ICH- VI

SEMESTER-IV

Paper No. ICH –XIII : INSTRUMENTAL TECHNIQUES.

Paper No. ICH- XIV : COORDINATION CHEMISTRY-II

Paper No. ICH-XV : CHEMISTRY OF INORGANIC MATERIALS

ELECTIVE PAPERS

Paper No. ICH-XVI A : SEPARATION SCIENCE

Paper No. ICH-XVIB : RADIATION CHEMISTRY

ELECTIVE CBCS PAPER

Paper No ICH- XVI : APPLIED BIOINORGANIC CHEMISTRY

Practical Course : ICH - VII and ICH-VIII

M.Sc. Part-II (Semester-III)

Paper No.-ICH-IX: INORGANIC CHEMICAL SPECTROSCOPY

UNIT-I: Group Theory (15)

Molecular symmetry, elements of symmetry and symmetry operations, Products of operation, point group, classification of Molecules into point group, reducible and irreducible representation, the great Orthogonality theorem, character table, symmetry aspects of Molecular orbitals.

UNIT-II: Electronic absorption Spectroscopy (15)

Term symbols, energies of atomic and Molecular transitions, Selection rule, and Morse potential energy diagram, electronic transitions, polarized absorption spectra. Nature of

absorption spectra, nature of absorption spectra of transition metal complexes, Orgel diagram, Tanabe Sugano diagram, and charge transfer spectra.

UNIT-III: A] Infrared and Raman Spectroscopy (9)

Molecular vibrations, force constants, Molecular vibrations and absorption of Infrared Radiations Raman Spectroscopy, polarized Raman lines, Use of symmetry considerations to determine the no. of lines in IR and Raman Spectra, Spectra of gases, applications of Raman and Infrared spectroscopy. Selection rule in Inorganic structure determinations, Hydrogen bonding and infrared spectra, metal ligand and related vibrations.

B] X-ray Fluorescence spectroscopy (XRF) (6)

Introduction and basic theory, instrumentation, spectral analysis and applications.

UNIT-IV: A] Nuclear Magnetic Resonance Spectroscopy (NMR) (8)

Principle Instrumentation of NMR, the chemical shift, mechanism of electron shielding and factors contributing to the magnitude of chemical shift. Local & remote effect, spin-spin splitting, applications of spin coupling to structural determination, double Resonance techniques. The contact and Pseudo contact shifts Factors affecting nuclear relaxation, an overview of NMR of metal nucleus with emphasis on ^{195}Ag & ^{119}Sn NMR, applications of solid-state NMR technique.

B] X-ray Photo electron Spectroscopy (XPS) (7)

Introduction and basic theory, Instrumentation, sample selection and preparation, spectral analysis, Ar ion sputtering technique and applications of XPS.

Recommended books:

1. K. Burger, Coordination Chemistry-experimental methods, Butterworth's
2. R. Drago: Physical method in Inorganic Chemistry, DUSAP.
3. Hill & Day advanced methods in Inorganic Chemistry, J. Wiley
4. F.A. Cotton, chemical application of group theory, Wiley eastern
5. Figgis, Introduction to ligand field theory field
6. Schaefer & Gilman: Basic principles of ligand field Theory, J. Wiley
7. P.R. Backer: Molecular symmetry and Spectroscopy A.P.
8. Ferraro Ziomek, Introduction to Group theory, plenum
9. Scotland Molecular symmetry DVN
10. Dorian: symmetry in Chemistry EWAP
11. Hall: Group theory and symmetry in Chemistry MGLt
12. Nakamoto Infrared R Raman Spectra of Inorganic & Coordination compounds
J. Wiley
13. Nakanisha: Spectroscopy and structure J. Wiley
14. Ferrero: Metal ligand and related vibrations
15. CNR Rao Spectroscopy in Inorganic Chemistry Vol I, II, III
16. Durie: vibrations spectra and structure Vol. I to IV, Elsevier
17. Dudd, chemical Spectroscopy Elsevier
18. Popel: H.N.M.R. Spectroscopy J. Wiley
19. R.J. Abraham, J. Fisher and P Loftus Wiley Introduction to NMR spectroscopy.
20. P.K. Bhattacharya: Group Theory & Its Chemical Applications
21. K.V. Reddy: Symmetry & spectroscopy of Molecules.

UNIT-I: Theories of Metal-Ligand bonding (15)

VBT, CFT and their limitations; d-orbital splitting in octahedral and tetrahedral complexes, Crystal field stabilization energy (CFSE), Factor affecting the crystal field parameters, low-spin and high-spin complexes, LFT and Molecular Orbital (MO) theory of selected octahedral and tetrahedral complexes.

UNIT-II: Structural studies of coordination compounds (15)

Compounds of first transition series elements with respect to their electronic spectra, magnetic & thermal properties (DTA, TGA)

UNIT-III: Magnetism (15)

Magnetism: Types of magnetic behaviour, magnetic susceptibilities, Pascal's constants the origin of paramagnetism, antiferromagnetism and ferromagnetism of metal complexes, temperature independent paramagnetism; van Vleck's equation, its derivation and its applications; Spin-orbit coupling and susceptibility of transition metal ions;; spin cross over phenomenon,

UNIT-IV: A] Transition metal complexes and catalysis (8)

Introduction, General Principle, Transition metal ion catalysts for organic transformations and their applications in hydrogenation, isomerization, olefin oxidation, carbonylation and polymerization reactions, Current and feature trend in catalysis.

B] Mixed Ligand complexes (7)

Stabilities of ternary complexes, Dynamics of formation of ternary complexes reaction of Coordination ligand in ternary complexes, Mimicking reactions in biological systems, enzyme models, Amino acids ester hydrolysis, peptide synthesis & hydrolysis, Decarboxylation of β -keto acids

Recommended Books:

1. Jones: Elementary Coordination Chemistry. J. Wiley
2. Graddon: Introduction to Coordination Chemistry. J. Wiley
3. Drago: Physical methods of Inorganic Chemistry. J. Wiley.
4. Graddon: Introduction to coordination Chemistry, Parasmom
5. Lewis and Wilkins: Coordination Chemistry. J. Wiley
6. Msrtel: Coordination Chemistry Vol I, II VNR
7. Earnshaw: Introduction to Magneto Chemistry
8. Mabbs & Machin Magnetism & transition metal complexes Chamman hall
9. Calvin, Magnetic properties of transition metal complexes.
10. L.N. Maley: Magneto Chemistry
11. Datta & Shymlal Elements of Magneto Chemistry
12. Martel & Taqui Khan: homogeneous catalysis with metal complexes Vol.I & II AP.
13. James E. Huheey: Inorganic Chemistry Principles of Structure and reactivity, Harber & Row, Publishers Inc. New York 1972.
14. K.P. Purcell & J.C. Kote: An Introduction to Inorganic Chemistry Holt Sounders, Japan 1980.
15. William L. Jolly: Modern Inorganic Chemistry, Mecgrow Hill USA, 1984
16. F.A. Cotton & R.G. Wilkinson: Advanced Inorganic Chemistry.

UNIT-I: Systematics of alpha, beta and gamma decays (15)

Alpha decay, energy curve, spectra of alpha particles, Geiger-Nuttall law, theory of alpha decay, penetration of potential barrier, beta decay, range of energy relationship, beta spectrum, Geiger-Nuttall curve, Fermi theory of beta decay, matrix elements, allowed and forbidden transitions, Curie plots, gamma decay, Nuclear energy levels, selection rule, isomeric transitions, Internal conversion, Auger effect.

UNIT-II: Nuclear Structure and Stability (15)

Binding energy, empirical mass equation, The nuclear models, the liquid drop model, Single particle shell model, Fermi gas model & collective/unified nuclear model, nuclear spin, parity & magnetic moments of odd mass number nuclei and numerical.

UNIT-III: Nuclear reactions and Nuclear fission (15)

Introduction, Production of projectiles, nuclear cross section, nuclear dynamics, threshold energy of nuclear reaction, Coulomb scattering, potential barrier, potential well, formation of a compound nucleus, Nuclear reactions, direct Nuclear reactions, heavy ion induced nuclear reactions, photonuclear reactions.

Liquid drop model of fission, fission barrier and threshold, fission cross section, mass energy and charge distribution of fission products, symmetric and asymmetric fission, decay chains and delayed neutrons.

UNIT-IV: Reactor Theory and Applications of Radioactivity (15)

Nuclear fission as a source of energy, Nuclear chain reacting systems, critical size of a reaction, research reactors, graphite moderated, heterogeneous, enriched uranium reactors, light water moderated, heterogeneous, enriched uranium reactors, water boilers enriched aq. Homogeneous reactors, Thermonuclear reactors, gamma interactions, shielding and health protection. Reactors in India.

Tracer technique in the field of analytical chemistry structure determination elucidation of reaction mechanism, isotopic dilution analysis, neutron activation analysis applications in biological, medical, industrial fields, Age determination.

Reference Books:

1. Friedlander, Kennedy and Miller, Nuclear and Radio Chemistry: John Wiley
2. B. G. Harvey, Nuclear Chemistry
3. Hassinsky: Translated by D. G. Tuck, Nuclear Chemistry and its application: Addison Wiley
4. B.G. Harvey, Introduction to Nuclear Physics and Chemistry
5. Maclefort: Nuclear Chemistry: D. Van Nostrand
6. An N. Nesmeyannoy: Radiochemistry: Mir
7. Jacobs et al: Basic Principles of nuclear Science and Reactors, V. Nost & EWAP
8. N. Jay: Nuclear Power Today Tomorrow: ELBS
9. Kenneth: Nuclear Power Today, Tomorrow: ELBS
10. Essentials of Nuclear Chemistry, W. J. Arnikar, John Wiley
11. Nuclear and Radiation Chemistry: B. K. Sharma, Krishna Publication
12. A Introduction to Nuclear Physics: R. Babber. And Puri.

Elective Papers

UNIT-I: Air pollution and water pollution (15)

Air pollution – types and sources; Atmospheric chemistry, depletion of stratospheric ozone, industrial and transport-related air pollution; Global warming and its effects. Acid rain

Water pollution – types and sources, physical and chemical water pollutants, waste water treatment, criteria of water quality, mercury pollution and estimation of organomercurials.

Effect of Air pollutant and Water pollutant on living and nonliving things.

UNIT-II: Control of Air and water pollutants (15)

Method of control of air pollution, electrostatic precipitation wet & dries scrubber, filters, gravity and cyclonic separation, Adsorption, absorption and condensation of gaseous effluent.

Water and waste water treatment, aerobic and anaerobic, aeration of water, principle of coagulation, flocculation, softening, disinfection, demineralization and fluoridation.

UNIT-III: Electrochemical and spectral methods for pollutant analysis (15)

Polarography: Principle, instrumentation and applications, Cyclic Voltammetry, Anodic stripping voltammetry, Amperometry, Coulometry, and conductance methods; Potentiometry: Ion selective electrodes; Atomic absorption spectroscopy; Atomic fluorescence spectrometry; Turbidimetry and Nephelometry. GC & HPLC.

UNIT-IV: Monitoring, sampling and Analysis of Air and water pollutants (15)

Methods of monitoring and sampling of gaseous, liquid and solid pollutants, analysis of CO, CO₂, NO₂, SO₂, H₂S, analysis of toxic heavy metals, Cd, Cr, Hg, As, Pb, Speciation Separation and analysis of Co, Cu, Mg, Mn, Fe, Al, analysis of anions SO₄²⁻, PO₄³⁻, NO₃⁻, NO₂⁻.

Pesticide, residue analysis soil pollution, Sources of pesticide residue in the Environment, pesticide degradation by natural forces, effect of pesticide residue on life, Analytical techniques for pesticide residue analysis.

Reference Books:

1. Environmental Pollution, A. K. De
2. Air Pollution, Wark & Werner
3. Environmental Pollution Control in Process Industries, S. P. Mahajan
4. Environmental Pollution, B. K. Sharma & H. Kaur
5. Introduction to Air Pollution, P. K. Trivedi
6. Environmental Pollution Analysis, S. M. Khopkar
7. A Text Book of Environmental Pollution: A. D. Tyagi, M. Mehre
8. Environmental Pollution Engineering and Control, C. S. Rao
9. Chemical in the Environment, Satake & M. Midu
10. Environmental Sciences, E. G. Engel
11. Fundamentals of Electroanalytical chemistry: John Willey & Sons (2001) P. M. S. Monk
12. Environmental Chemistry at a Glance: Blackwell publishing (2006), I. Pulford 4 H. Flowers
13. Instrumental Methods of Chemical Analysis, H. Kaur.

Paper No. ICH-XIIB: ORGANOMETALLIC CHEMISTRY.

UNIT-I: Techniques of Organometallic Chemistry (15)

Methods of synthetic chemistry, vacuum techniques, inert atmosphere, non aqueous media, handling and hazards of organometallic compounds.

UNIT-II: Transition metal- Carbon bond (15)

Brief review of Stability of transition metal alkyls, classification of σ -bonded hydrocarbyls, preparation, structure and bonding, General characteristics of metal alkyl and aryls, organocopper compounds, Transition metal carbene complexes, Transition metal alkylidene complexes

UNIT-III: Transition metal π -complex (15)

Transition metal-alkene complexes, Transition metal-alkyne complexes, Transition metal-allyl complexes, Butadiene complexes, Cyclobutadiene complexes, Cyclopentadienyl complexes, η^6 -Arene complexes, Trienyl complexes.

UNIT-IV: A] Reactions of Organometallic compounds (08)

Oxidation-addition reaction, Reductive-elimination reaction, Insertion reaction, Deinsertion reaction, Nucleophilic and electrophilic attack on coordinated ligands.

B] Catalytic processes: (07)

General feature of catalysts, Catalytic steps, Hydrogenation of alkynes, Ziegler-Natta polymerization of alkenes, Hydrocarbonylation of alkenes, Wacker process, Monsanto acetic acid synthesis, The Fischer-Tropsch synthesis, Hydrosilation, Activation of C-H bond.

Recommended books:

1. Yamamoto, Organo Transition Metal Chemistry, Wiley (1986).
2. R. H. Crabtree, The Organometallic Chemistry of the Transition Metals (4th edn.), John Wiley (2005).
3. A. J. Pearson. Metallo-Organic Chemistry, John Wiley & Sons (1985).
4. M. Bochmann. Organometallics-I Complexes with Transition Metal-Carbon σ -Bonds, Oxford Chemistry Primers (1994).

Paper No. ICH-XIIC: SELECTED TOPICS IN INORGANIC CHEMISTRY**UNIT-I: Catalysis (15)**

a) Basic principles, thermodynamics and kinetic aspects, industrial requirements, classification, theories of catalysis, homogeneous & heterogeneous catalysis, reaction catalyzed by transition metal complexes and Organometallic compounds, Mechanism of reaction viz. Hydrolysis, polymerization, esterification, hydrogenation, ammonia synthesis, sulphur dioxide Oxidation.

b) Zeolites, synthesis of different zeolites, Isomorphous metal substitution in zeolites, Post-Synthetic Modifications of zeolite framework, characterization, determination of surface acidity, shape-selectivity and applications.

UNIT-II: Inorganic Polymers (15)

Classification, types of Inorganic polymers, Chemistry of following polymers a) Silicones b) phosphonitric halides c) condensed phosphates d) coordinated polymer e) silicates f) Isopoly & heteropoly acids g) Geopolymers as alternative cement materials.

UNIT-III: Non-conventional sources of energy (15)

a) Alternate source of energy

Solar sources: Photochemical methods, thermodynamic efficiency of energy conversion, energy from solar radiations, transition metal complexes for energy production, solar hydrogen system, photochemical processes at semiconductor electrodes, photo galvanic & Photovoltaic cells based on Inorganic photochemical systems.

- b) Geothermal energy
- c) Energy from biogas sources, biodiesel,
- d) Tidal wind sources
- e) Energy from fission and fusion reaction.

UNIT-IV: Fertilizers

(15)

Classification of fertilizers, nitrogen fertilizers, phosphate fertilizers, Potash Fertilizer, NPK fertilizers, H_3PO_3 production without using H_2SO_4 , position of fertilizer Industries in India.

Recommended Books:

1. Heterogeneous catalysis 2nd edn. Bond C. Chapman all (1987).
2. The application & Chemistry of catalysis by suitable transition metal complexes Parashall. W. Wiley N. 1980.
3. Homogeneous transition metal catalysis, A general art, Masters C. Chapman and Hall, London 1981.
4. Introduction to the principles of heterogeneous catalysis, Thomas J.M., Thomas W.J. Academic press N.Y. 1967
5. Inorganic polymers: Mark J.F., Allock H.R. West, Prentice hall
6. Inorganic polymers: Ring N.H., Academic Press N.Y. 1978
7. The Inorganic heterocyclic chemistry of sulphur, nitrogen, phosphorous, Heal A.G. Acta, Press N.Y. 1980.
8. Solar energy Principles of thermal collections and storage, Sukhatme S.P., Tata Macgrow Hill New Delhi 1984.
9. Fuel Cells, Bockeris JOM, Srinivasan S. and Mac grow Hills 1969
10. Solar Energy Rai C.D.
11. Energy Resources, Simon A.L. 1975
12. Direct Energy Conversion, Addison Wesley, 1970, All M and Kottani S.
13. Outlines in Chemical Technology Vol I, S.D. Sukla & Pandey G.N.M.

M.Sc. Part-II (Semester-III)

Inorganic Chemistry Practical Course ICH-V and ICH-VI

- 1. Ore Analysis -3**
- 2. Alloy Analysis – 3**
3. Preparation of coordination complexes
4. Ion exchange study of separation of mixtures and estimations
5. Spectrophotometry
6. Separation and estimation of ions using ion exchange chromatography
7. Nephelometry
8. Potentiometry
9. Conductometry

10. Thermal analysis
11. Magnetic properties of transition metal complexes
12. Spectro Fluorimetry
13. Solvent extraction
14. Nuclear chemistry
15. Soil Analysis
16. Data analysis

(Any other experiments may be added when required)

M.Sc. Part-II (Sem-IV) Inorganic Chemistry

Paper No. ICH –XIII: INSTRUMENTAL TECHNIQUES

UNIT-I: X-ray diffraction and neutron diffraction

a) X-ray powder diffraction: (07)

X-ray source, Diffraction of X-rays-ray powder diffraction, Instrumentation and use of standards, identification of compounds using powder diffraction. The importance of intensities, Absences due to lattice centering, Determination of unknown cubic structure by $\sin^2\theta$, parameter to be determined from XRD: Qualitative analysis, Quantitative analysis-percent crystallinity, Crystal size, surface area, unit cell dimension.

b) Single crystal X- ray diffraction: (05)

Solving single crystal structures; refining a structure-ray crystal structures in literature.

c) Introduction to neutron diffraction, theory, Instrumentation and application. (03)

UNIT-II: Thermal analysis (15)

a) Thermogravimetry [TGA]: Definition, Types of TGA, Instrumentation, Information of TGA curve, factor affecting TGA curves (Instrumental as well as characteristic of sample factors); Applications of thermogravimetry, calculation of percent decomposition and composition of compounds; Limitations and Advantages of TGA

b) Differential thermal analysis (DTA): Definitions, Theoretical Basis of DTA, Instrumentation of DTA apparatus, Factors affecting the DTA curve; Application of DTA; Advantages and disadvantages of DTA.

c) Differential Scanning Calorimetry [DSC]; Definition; Comparison of DTA and DSC techniques; Instrumentation of DSC, Factors affecting to DSC curves.

d) Thermometric titrations: Theory, Instrumentation and applications.

e) Thermomechanical analysis: Theory, Instrumentation and applications

UNIT-III: Mossbaur Spectroscopy (15)

Introduction, Principles, Condition of Mossbaur spectroscopy, Mossbaur effect, recoilless

emission & absorption. Instrumentation, Parameter from Mossbauer spectra, isomer shift, Quadrapole splitting and hyperfine interactions, application of Mossbauer effect to the investigations of compounds of iron and tin.

UNIT-IV: A] Electron spin Resonance [ESR] (08)

Principles of ESR, Selection rule, intensity width, position of spectral line, multiplet structure of EPR spectra, hyperfine interaction, spin orbital coupling, zero field splitting and Krammers degeneracy, rules for interpreting the spectra, Instrumentation, factors affecting G values, applications to inorganic complexes.

B] Nuclear Quadra pole Resonance Spectroscopy [NQR] (07)

Introduction, effects of magnetic field on the spectra, relation between electric field gradient and structure, instrumentation and application of NQR.

Recommended Books:

1. Elements of x-ray diffraction, B.D.Cullity, Addison Wisley, 1967.
2. Diffraction Method, Wormald, Oxford University, Press, 1973
3. Standard Method of Chemical Analysis IIIA6th end.
4. Neutron Scattering in Chemistry, Baun, G.E. Butleworth, London, 1971.
5. Mossbauer Spectroscopy, Greenwood N.N., Gibbs T.C., Chapman Hall, 1971.
6. Chemical Application of Mossbauer Spectroscopy, Goldanski V.I & Harber R.H., Academic Press 1968.
7. Spectroscopy in Inorganic Compounds CNR Rao & Ferraro G.R., Academic Press, 1970.
8. Basic Principles of Spectroscopy Cheney R. Mac Grows Hill, 1971.
9. Thermal Method, Wendlandt, W.W. John, Wiley, 1986.
10. Principles of Instrumental analysis, Skoog, III rd edn., Sounders, 1985.

Paper No. ICH- XIV: COORDINATION CHEMISTRY-II

UNIT-I:

A] Classification of Inorganic reactions, reaction intermediates, order of a reaction and reaction mechanism techniques to follow rate of reactions, liability of complexes and crystal field interpretation. (08)

B] Mechanism of atom and electron transfer reactions. (07)

Key ideas concerning electron transfer, outer sphere electron transfer and inner sphere electron transfer, two electron transfers, $[\text{Co}(\text{CN})_5]^{3-}$. A redox and catalytic reagent.

UNIT-II (05)

A] Substitution reaction, reactions of Transition Metal complexes, kinetics and mechanism of substitution reactions of octahedral complexes, acid hydrolysis, base hydrolysis, kinetics and mechanism of substitution reaction.

B] Substitution Reactions of Square-Planar Complexes: (05)

Evidence for Associative Type SN^2 Mechanism, Trans effect, Applications of Trans effect, Theories of Trans Effect, Cis Effect.

C] Stereochemical aspects of substitution reaction of Octahedral Complexes. (05)

Stereochemical changes in dissociation (SN^2) and displacement (SN^2) mechanism through various geometries of coordination compounds. Isomerization and racemization reactions in octahedral complexes.

UNIT-III: Photochemistry (15)

Photochemistry of Coordination compounds, Electronically excited states of Metal complexes, type of photochemical reactions, substitutions reactions, rearrangement reactions, redox reaction and photochemistry of metallocene.

UNIT-IV: Applications of Coordination Compounds. (15)

Metal Complexes in Analytical Chemistry Inorganic Qualitative Analysis, The 'brown ring' test, Complexometric Titrations, Complexes in Colourimetry, Coordination Compounds in Gravimetry, Stabilization of Oxidation States, Complexes in Separation of Metals. **Metal Complexes in Medicinal Chemistry:**-Complexation in Food Poisoning, Metal Complexes in Therapy. **Metal Complexes in Industrial Processes:** - Heavy Metals-protein Complexes in the Rasching Process, The Ziegler-Natta Catalyst, Metal complexes in alkene conversions, Complexes and Electroplating, Complexes in Metallurgy. Copper Metal dissolves in Aqueous Potassium Cyanide, Complexes in water softening. **Metal complexes in Agriculture.**

Recommended Books:

1. R. Gopalan and V. Ramlingam: Concise Coordination Chemistry.
2. J. E. Huheey, Ellen A. Keiter and Okhil K. Medhi: Inorganic Chemistry: Principle of Structure and Reactivity.
3. K. F. Purcell, J. C. Kotz: An Introduction to Inorganic Chemistry.
4. F. Basolo and R. Pearsons: Mechanism of Inorganic Reactions: A Study of Metal Complexes in Solution.
5. Obe, M. L. Inorganic reaction mechanism, Nelson, London, 1972.
6. Taube, electron transfer reactions of metal complex ions in solution. Academic Press, 1970.
7. E. S. Gould, Inorganic Chemistry.
8. V. Balzani and V. Cavassiti, Photochemistry of coordination compounds, AP, London, 1970.
9. K. Burger, Coordination Chemistry Experimental methods, Butterworths.
10. K. K. Rastogi and Mukharjee, Fundamentals of photochemistry, Wiley eastern.
11. J. G. Calverts and J. N. Pitts, Photochemicals of Photochemistry, John Wiley.
12. Wells, Introduction to Photochemistry.
13. K. M. Macky, R. A. Macky, Modern Inorganic Chemistry, 4th edn., Blackie, London-1989.
14. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Vallabh Publications, Delhi, 2005.

UNIT–I: Solid state Reactions (15)

Preparative methods: Vapor phase transport, preparation of thin films – electrochemical methods, Chemical Vapor Deposition (CVD); Single Crystal growth – Bridgman & Stockbarger methods, zone melting, Coprecipitation, Sol-gel Method, Hydrothermal. Characterization of Solids: Crystal diffraction of X-rays, X-ray diffraction method; Powder method – principles and uses; Scattering of X-rays by crystals – systematic absences; Electron diffraction; Neutron diffraction. Defects and Non-Stoichiometry.

UNIT–II: Solid electrolytes (15)

Typical ionic Crystals: Alkali metal halides (vacancy conduction), Silver chloride (interstitial conduction); Solid Electrolytes – α -alumina, silver iodide, halide and oxide ion conductors; Applications of Solid Electrolytes. Fuel cells: electrochemical power generator (hydrogen-oxygen cell), Solid state Galvanic cell; Thermoelectric Effects: Seebeck effects; Hall effect.

UNIT–III: Magnetic and optoelectronic properties of Solids (15)

Behavior of substances in magnetic field; Effects of temperature (Curie & Curie-Weiss laws); Magnetic moments; Mechanism of ferro- and antiferromagnetic ordering – super exchange.

Luminescence and phosphors; Configurational coordinate model, Antistoke phosphors, Lasers – ruby and neodymium.

Conduction Organics: Organic conductors, preparation, mechanism of conduction in organic semiconductors, photoconductivity of polymers. Superconductivity, Superconductivity in metals, alloys and ceramics materials (mixed oxides) BCS theory, Meissner effect, type I & II superconductors, application Fullerenes as superconductors. Dielectric polarization: piezoelectricity and Ferro electricity. Lasers and Maseres actions, laser production and application.

UNIT–IV: Nanomaterials an Emerging Technology (15)

General introduction to nanomaterials and emergence of nanotechnology; Moore's law; synthesis of nanoparticles of gold, rhodium, palladium, platinum and silver; Synthesis of nanoparticle semiconductors, nanowires and nanorods; Techniques of synthesis: electroplating and electrophoretic deposition, conversion through chemical reactions and lithography; Thin films: Chemical vapor deposition and Atomic layer deposition techniques; Carbon fullerenes and nanotubes. Applications of nanoparticles.

Recommended Books

1. Synthesis of Inorganic Materials: Ulrich Schubert, Nicola Hüsing.
2. Solid State Chemistry: Lasley E. Smart, Elaine A. Moore.
3. Introduction to Solid State Physics: Charles Kittel.
4. Solid State Chemistry: A. H. Hannay
5. C.N.R. Rao, Solid State Chemistry : Dekker
6. Wilcox : Preparation and Properties of Solid State Materials: Vol I & II, Dekker
7. Hagenmuller, Preparative Methods in Solis State Chemistry
8. Lohn Wulff, The Structure and Properties of Materials Vol. IV, Electronic Properties (Wily Eastern)
9. N. N. Greenwood: Ionic Crystals, Lattice Defects and Nonstiochiometry (Butterworth's)
10. L. V. Azorooof and J.J. Brophy: Electronic Processes in Materials, MacGraw Hills.
11. T. J. Rey et al : The Defect Solid State (Interscience)
12. E.A. Kroger, Chemistry of Imprefect Crystals (Holland)
13. A. R. West, Solid State Chemistry
14. H. V. Keer: Principles of the Solid State Chemistry, Wiley Eastern.

15. S. O. Pillai: Solid state physics, Academic press
16. F. Gutmann & L. E. Lyons: Organic Semiconductors.
17. G. Zhong Cao. Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press (2004).
18. R. J. D. Tiley. Defect Crystal Chemistry and its Applications, Chapman and Hall, New York (1987).
19. T. Pradeep: Nano the Essentials, McGraw Hill Education.

Elective Papers

Paper No. ICH-XVI A: SEPARATION SCIENCE

UNIT-I: Solvent Extraction Separation (15)

Principles of solvent extraction, Distribution Equilibria, Types of Solvent Extraction, formation of metal complexes, distribution of extractable species, quantitative treatment of extractable equilibria, Methods of extraction, techniques in extraction, application of diketone, hydroxyquinoline, oximes, Dithiocarbamates, xanthates, thiols, macrocyclic polyethenes and organo phosphorous compounds, Macrocyclic Polyethers in solvent extraction. Separation of nonmetals and metals. Applications of Solvent Extraction.

UNIT-II: Chromatographic separation techniques (15)

Extraction chromatography, theoretical aspects of extraction chromatography, correlation between solvent extraction and extraction chromatography, techniques in extraction chromatography, chromatographic inert support, Types of inert Support, Fractionation of inert support, Separation of elements from the same group, Alkali Metals, Precious Metals, Types of Extractant used, stationary phases, use of extraction chromatography for separation of fission products.

UNIT-III: Ion exchange separation (15)

Fundamental properties of ion exchangers, Synthesis of ion Exchange Resin, Classification of Ion Exchange Resin, theories of ion exchange, exchange capacity, screening effect, penetration of electrolytes into the ion exchange resins, sorption of complex ions, ion exchanges equilibrium, column operation, theory of break through curves, elution steps, use of non aqueous solvents in one exchange separation, application of ion exchange separation in determination of total salt concentration, removal of interfering ions, separation of anions and metals. Separation of Lanthanides and Actinides.

UNIT-IV: A] Separation by electrolysis (8)

Basic principles, over potentials, electrogravimetry, constant current electrolysis, Separation with controlled electrode potentials, constant voltage electrolysis, potential buffers, and physical characteristics of metal deposits, internal electrolysis, electrography, electrophoresis, and electro chromatography. Applications of Electrolysis.

B] Gas Chromatography (7)

Principles of gas chromatography, plate theory of gas chromatography, Instrumentation for gas chromatography, working gas chromatography, application of gas chromatography, programmed temperature chromatography, flow programming chromatography, gas-solid chromatography, and hyphenated techniques in chromatography Problems, Applications of gas Chromatography.

Recommended Books:

1. Solvent extraction in analytical A chemistry by G.H. Morrison, F. Frieiser, John Wiley & Sons, NY.
2. Ion exchange and solvent extraction of metal compounds by Y. Macros, A.S.Kertes, Wiley, Interscience.
3. Solvent extraction Chemistry, Selkine and alegagawa.
4. O.Samuelson, Ion exchange separation in Analytical Chemistry, J.Wiley & Sons.
5. A.I.Vogel, A Text Book of quantitative Inorganic Analysis, Longmann Green.
6. D.A. Skoog & D.M. West, Fundamentals of Analytical Chemistry - Holy Rinchart.
7. G.W. Ewing, Instrumentation Methods of Chemical Analysis, McGraw Hills.
8. S.M. Khopkar, Basic Concepts of Analytical Chemistry.
9. D. Ambrose and B.A. Amborse, As chromatography.

Paper No. ICH-XVIB: RADIATION CHEMISTRY

UNIT-I: A] Isotopes (08)

Difference between Isotopes and Isobars, isotope separation, thermodynamic and kinetic isotope effects, isotope exchange reaction kinetics, determination of exchange rate constant, production and applications of radio isotopes.

B] Biological effects of Radiation (07)

Introduction, genetic and somatic effect on human being, effect of radiation on plants and aquatic Environment.

UNIT-II: Radiochemical Separation (15)

The need of radiochemical separation techniques, carrier techniques, isotope and nonisotopic carriers, coprecipitation and adsorption, ion exchange, solvent extraction, electrolytes behavior of carrier free tracer radionuclide.

UNIT-III: Principle of tracer chemistry (15)

Introduction to tracers, application of tracers in physiochemical studies, diffusion studies, isotopic and exchange reactions, tracer in the study of the mechanism of the inorganic chemical reaction, atom transfer and electron transfer mechanisms. Heterogeneous catalysis and surface area measurements, radio carbon dating, tracer studies with tritium, application in metallurgy and preservation of food, geochemical application and hot atom chemistry.

UNIT-IV: Radiation detection and measurements. (15)

Ionization current measurements, multiplicative ion collector, methods not based on ion collection, auxiliary Instrumentation and health physical instruments and counting statistics. Working of Scintillation and Geiger Muller Counter.

Recommended Books:

1. Friedlander, Kennedy and Miller, Nuclear and radio Chemistry, ohm Wiley.
2. B.G. Harvey, Nuclear Chemistry.
3. Haissinsky, Translated by D.G, Tuck, Nuclear physics and Chemistry.
4. Mark lefort, Nuclear Chemistry, D.V. Nostrand.
5. An N.Nesmeyanov, Radiochemistry, Mir.
6. Jacobs, et al, Basic Principles of nuclear science and reactors, V.Nost, EW AP.
7. N. Jay, Nuclear power, today tomorrow, ELBS.
8. Kenneth, Nuclear power, today and tomorrow, ELBS.
9. Essentials of Nuclear Chemistry, J. Arnikar, John Wiley.
10. D.C. Dayal, nuclear physics.

Elective CBCS Paper

Paper No ICH- XVI: APPLIED BIOINORGANIC CHEMISTRY

UNIT-I: An Overview of Characterization Methods in Bioinorganic Chemistry (15)

Review the basic principles of these analytical techniques and their application to inorganic biomolecules: Methods used for structural elucidation, as well as mechanistic studies - X-Ray crystallography; nuclear magnetic resonance (NMR) spectroscopy; vibrational spectroscopies, such as infrared (IR) and Raman spectroscopies; and electronic spectroscopies, such as ultraviolet-visible (UV-Vis) spectroscopy and electron paramagnetic resonance (EPR) spectroscopy.

UNIT-II: Metalloproteins and Metalloenzyme (15)

Transition elements in biology - their occurrence and function, active-site structure and function of metalloproteins and metalloenzymes with various transition metal ions and ligand systems; O₂ binding properties of heme (haemoglobin and myoglobin) and non-heme proteins hemocyanin & hemerythrin), their coordination geometry and electronic structure, co-operativity effect, Hill coefficient and Bohr Effect; characterization of O₂ bound species by Raman and infrared spectroscopic methods; representative synthetic models of heme and non-heme systems.

Electron transfer proteins - active site structure and functions of ferredoxin, rubredoxin and cytochromes, and their comparisons. Vitamin B₁₂ and cytochrome P450 and their mechanisms of action.

UNIT-III: A] Applications of bioinorganic chemistry (8)

Metals in medicine - therapeutic applications of anti-cancer agents e.g. cis-platin, radiopharmaceuticals – e.g. radio-isotopes Tc and I₂, and MRI agents e.g. Gd in MRI.

Toxicity of Hg, Cd, Pb and As and chelation therapy.

B] Nitrogen Fixation, Nitrification, Denitrification (7)

Transport of O₂ - the hemoglobin family, the hemocyanin family.

UNIT-IV: A] Trace Metals in Plant Life (8)

Micronutrients in soil, role of micronutrients in plant life

B] Biogeochemistry (7)

Biodegradation of minerals bacteria leaching and its applications.

Recommended Books:

1. D. F. Shriver, P. W. Atkins and C. H. Langford, Inorganic Chemistry, Oxford Univ. Press, 1990.
2. J. E. Huheey, E. A. Keiter and R.L. Keiter Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education, 2004.
3. F. A. Carey G. Wilkinson, C. A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, Wiley Interscience, 2003.
4. C. E. Housecroft and A. G. Sharpe, Inorganic Chemistry, Prentice Hall, 2005.
5. S. J. Lippard and J. M. Berg, Principles of Bioinorganic Chemistry, Univ. Science Books, 1994.
6. W. Kaim and B. Schwederski, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life (An introduction and Guide), John Wiley & Sons, 1994.
7. Eichhorn: Inorganic Biochemistry : Vol I , 2 Elsevier
8. Ochiai: Bioinorganic Chemistry: Allyn & Bacon Burton
9. Williams: an Introduction to Bioinorganic Chemistry, C.C. Thomos Spring III
10. Wallace: Decade on synthetic chelating agent in Inorganic plant nutrition, Wallace
11. Williams: Metals in Life
12. Zagic: Microbial Biogeochemistry, Academic press
13. Ahuja: Chemical Analysis of the Environment, Plenum press.

M.Sc. Part-II (Sem-IV)

Inorganic Chemistry Practical Course ICH-VII and ICH-VIII

(A) Practicals

1. Ore Analysis -3
2. Preparation of coordination compounds (Three) and preparations of mixed metal oxides(two)
3. Ion Exchange chromatography; separation of multicomponent mixtures
4. Solvent extraction

5. Spectrophotometry
6. Ph Metry
7. Conductometry
8. Polarography
9. Electrogravimetry
10. Nuclear and radiochemistry

B) Interpretation exercises

1. X-ray powder diffraction analysis of cubic compound

- a. Determination of lattice constants and geometry
- b. Partical Size
- c. Density

2. Interpretation of Mossbaur spectrum with reference to determination of a) isomer shift b) quadruple splitting c) Internal magnetic field d) general comment

3. Interpretation of IR spectrum with reference to stretching vibration 0-2 C=N, C=O, N-, M-O.

4. Interpretation of NMR spectrum with reference to calculation of chemical shifts and general comments.

5. Interpretation of absorption spectra for

- a. Verification of position of ligands in spectrochemical series
- b. Determination of geometry (Octahedral, Square planar, tetrahedral) of a given compound.
- c. Calculation of spectral splitting parameters.

6. Interpretation of polar gram for determination of half wave potentials and unknown concentration.

7. Calculation of band gap of semiconductors with the help of plots of $\log V_s$ Vs. 10^{-3} .

In all 20 experiments with at least five experiments in each course should be completed.

Addition of other experiments in place of existing one may be allowed. A variety of small projects designed by teacher based on the interest of students and capabilities should be worked out. (**Project** work or the review report (50 Marks) will be examined by internal and external examiners.

Study tour is compulsory for M.Sc. Part- II Students to visit Chemical Industries in India.

M.Sc. Part-II, (Sem-III and IV) Organic Chemistry

M.Sc. Part-II (Sem-III)

- Paper No. OCH- IX : Organic Reaction Mechanism
Paper No. OCH -X : Advanced Spectroscopic methods
Paper No. OCH –XI : Advanced Synthetic methods
Paper No. OCH –XII : Drugs and Heterocycles
Practical Course : OCH-V and OCH-VI

M.Sc. Part-II (Sem-IV)

- Paper No. OCH- XIII : Theoretical Organic Chemistry
Paper No. OCH –XIV : Stereochemistry
Paper No. OCH- XV : Chemistry of Natural Products

ELECTIVE PAPER

- Paper No. OCH-XVI-A: Applied Organic Chemistry

ELECTIVE CBCS PAPER

- Paper No. OCH-XVI : Bioorganic Chemistry
Practical Course : OCH-VII and OCH-VIII

M.Sc. Part-II (Sem- III) Organic Chemistry

Paper No. OCH- IX: ORGANIC REACTION MECHANISM

UNIT-I: Methods of determining reaction mechanism, (15)

Kinetic Methods: Order and Molecularity, Methods of following reaction rates, Types of reactions : 1st, 2nd and 3rd order reactions; Reversible, Consecutive and Parallel reactions. Energy of Activation, Entropy of Activation , Effect of Ionic strength, Solvent effect and Kinetic isotopic effect **Non-Kinetic Methods:** Identification of reaction products, Testing of the possible intermediates, Trapping of the intermediates, Isotopic labeling, Reaction catalysis, Cross-over experiments , Stereochemical studies and Use of physical properties. **Hammett and Taft equations.**

UNIT–II: Pericyclic reactions (15)

Molecular orbital symmetry, Frontier orbital of ethylene, 1,3- butadiene, 1,3,5-hexatriene and allyl system, classification of pericyclic reaction, Wood-ward Hoffman correlation diagrams, FMO and PMO approach, electrocyclic reactions, conrotatory and disrotatory motions, $4n$, $4n+2$ and allyl systems, cycloaddition, and supra and antara facial additions, $4n$ and $4n+2$ systems, $2+2$ additions of ketenes, 1,3-dipolar cycloaddition and chelotropic reactions, sigmatropic rearrangement , supra and antarafacial shifts of H, Sigmatropic shifts involving carbon moieties, (3,3) and (5,5) sigmatropic rearrangement and Claisen and Cope and Aza Cope rearrangement, Ene reaction.

UNIT – III: A) Study of reactive intermediates (7)

Synthesis and Applications of nitrogen, sulphur and phosphorous ylides.

B) Study of following reactions (8)

Mechanism, Stereochemistry, migratory aptitude, (application using complicated example): Dienone –phenol, Favorskii, Baeyer-Villiger, Pinacol- pinacolone, Wolff, Smile's , Reactions of carboxylic acids and esters.

UNIT–IV: Photochemistry (15)

Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions, photodissociation gas phase photolysis, photochemistry of alkynes, intramolecular reactions of the olefinic bonds, geometrical isomerism, cyclisation reactions, rearrangements of 1,4 and 1,5-dienes, photochemistry of carbonyl compounds, intramolecular reactions of carbonyl compounds saturated cyclic and acyclic α , β -unsaturated compounds, cyclohexadienones, intermolecular cycloaddition reactions, dimerisation and oxitane formation, photochemistry of aromatic compounds, photo fries reactions of anilides, photo fries rearrangements. Singlet molecular oxygen reactions, photochemistry of vision.

RECOMMENDED BOOKS:

1. A guide book to mechanism in organic chemistry (orient- Longmans)- Peter Sykes
2. Organic Reaction Mechanism (Benjumin)- R. Breslow
3. Mechanism and structure in Organic Chemistry (Holt Reinhartwinston)- B. S. Gould
4. Organic chemistry (McGraaw Hill)- Hendrikson, cram and Hammond
5. Basic principles of organic chemistry (Benjamin) J. D. Roberts and M. C. Caeserio.
6. Reactive intermediates in organic chemistry, (J. Wiley) N. S. Issacs.
7. Organic reaction mechanism (McGraw Hill) R. K. Bansal
8. Fundamentals of photochemistry K. K. Rohtagi- Mukherji Wiley- Eastern
9. Essentials of molecular photochemistry, A. Gilbert and J. Baggott. Blackwell Scientific Publication.
10. Molecular photochemistry, N.J. Urro, W. A. Benjamin
11. Introductory photochemistry. Cox and T. Camp McGraw –Hill
12. Photochemistry R.P. Kundall and A. Gilbert. Thomson Nelson.
13. Organic photochemistry J. Coxon and B. Hallon Cambridge University press.

Paper No. OCH -X: ADVANCED SPECTROSCOPIC METHODS

UNIT-I: a) Ultraviolet Spectroscopy (05)

Woodward- Fisher rules for conjugated dienes and carbonyl compounds; Calculation of λ max. Ultraviolet spectra of aromatic and heterocyclic compounds, Steric effect in biphenyls.

b) IR Spectroscopy (10)

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. FT-IR of gaseous; solids and polymeric materials.

UNIT-II: NMR Spectroscopy (15)

General introduction and definition; chemical shift; spin –spin interaction; shielding mechanism of measurement; chemical shift values and correlation for protons bonded to carbons [aliphatic; olefinic; aldehydic and aromatic] and other nuclei [alcohols; phenols; enols; acids; amines; amides and mercaptans]; 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 spectra; nuclear magnetic double resonance; shift reagent; solvent effect. Fourier transform technique, nuclear overhauser effect [NOE] Resonance of other nuclei – F; P.

UNIT-III: Mass Spectrometry (15)

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. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

UNIT – IV: A) Carbon-13 NMR Spectroscopy (7)

General considerations; chemical shift [aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl compounds]; problems associated with ^{13}C , FT-NMR, proton decoupled off resonance.

B) Structural problems based on combined spectroscopic techniques (including reaction sequences) (8)

RECOMMENDED BOOKS:

1. V.M. Parikh, Application spectroscopy of organic molecules. (Mehata)
2. D.W. Williams and Flemming, Spectroscopic methods of organic compound.
3. Silverstein and Basslar, Spectroscopic identification of organic compounds V.M. Parikh ORPTION SPECTROSCOPY OF ORGANIC MOLECULES (J. Wiley)
4. P.S. Kalsi Spectroscopy of organic compounds (New age publisher)
5. J.R. Dyer. Application of absorption spectroscopy of organic compounds.
6. Jackman and Sterneil , Application of NMR spectroscopy
7. Nuclear magnetic resonance. J.D. Roberts (J. Wiley)
8. Theory and application of U.V. Jafee and Orchin.
9. Mass spectroscopy K. Benjamin.
10. The mass spectra of organic molecules. Beynon J H.
11. Interpretation of carbon 13 NMR Wehli F.W, Marchand A. P. (J. Wiley)
12. Organic Spectroscopy W. Kemp, ELBS

13. Instrumental methods of analysis CBS. Willard Merritt and Dean.
14. Mass Spectroscopy. Das and Jame
15. Organic structural spectroscopy : J. B. Lambert, S. Gronert, H. F. Shurvell, D. Lightneli, R. G. Cooks (Prentice Hall 2nd edition)

Paper No. OCH -XI: ADVANCED SYNTHETIC METHODS

UNIT–I: Disconnection approach (15)

An introduction to Synthons and synthetic equivalents, disconnection approach, functional group interconversions. One group C-X and two group disconnections in 1, 2; 1,3 -1, 4 & 1, 5-difunctional compounds, Retro - synthesis of alkene, acetylenes and aliphatic nitro alcohols and carbonyl compounds, amines. Importance of the Order of events in organic synthesis, Chemoselectivity, Regioselectivity. Protecting groups, Diels-Alder reaction, Michael addition and Robinson annulation. Retro- synthesis of aromatic heterocycles and 3, 4, 5 and 6 membered carbocyclic and heterocyclic rings. Reversal of polarity (Umpolung).

UNIT–II: Application of the following reagents and reaction in synthesis. (15)

Complex metal hydrides, sodium cyanoborohydride, lithium diisopropylamide(LDA) Dicyclohexylcarbodiimide(DCC), Trimethylsilyl iodide, peracids, lead tetra acetate, PPA, Diazomethane, ozone, phase transfer catalyst, Woodward-Prevost hydroxylation, Barton and Shapiro reaction, Hoffmann – Loffler-Fretag, Peterson synthesis, Selenium dioxide, Dess-Martin periodinane, periodic acid and iodoisobenzyl diacetate, organocatalysis and Grub's catalysts.

UNIT–III: Applications of following metal in organic synthesis (15)

Pd, Hg, Cu, Rh, Tl and Si

UNIT–IV: Application of the following in synthesis (15)

Merrifield resin, polymeric reagents. Solid phase synthesis of polypeptide and Oligonucleotides, Electro-organic synthesis, Enzyme catalyzed reaction in synthesis, Ionic liquids, Multicomponent reactions, Microwave and Ultrasound techniques and their applications.

RECOMMENDED BOOKS:

1. Designing of organic synthesis. S. Warren
2. Organic synthesis J. Fuhrhop & G. Penzlin. (2nd ed.)
3. Some modern methods of organic synthesis. Carruthers:
4. Modern synthetic reaction. H.O. House
5. Reagent in organic synthesis. Fieser & Fieser
6. Principle of organic synthesis. R.O.C. Norman
7. Advanced organic Chemistry. Carey & Sundharg
8. Organic synthesis. P.E. Realand:
9. Comprehensive organic Chemistry. Barton and Ollis :
10. Organic reactions. R. Adams:
11. Advances in organometallic Chemistry. Stone & West:
12. Transition metal intermediate in organic synthesis. C.W. Bird:
13. Organometallic in organic synthesis. Swan & Black :
14. Synthesis of prostaglandins. A. Mitra :
15. Total synthesis of natural products. John Apsimon:

16. Polymers as aid in organic synthesis. M. K. Mathur, C. K. Narang & R. E. Williams:
17. Polymer supported reaction in organic synthesis. P. Hodge & D. C. Sherrington:
18. Enzyme catalysed reactions. C. J. Gray:
19. Electroorganic Chemistry. T. Shono:
20. Phase transfer catalyst in organic synthesis. Weber & Gokel :

Paper No. OCH -XII: DRUG AND HETEROCYCLE

Part- A: Drugs

UNIT-I: a Drug design (10)

Development of new drugs, procedures followed in drug design, concepts of prodrugs and soft drugs. Theories of drug activity, Quantitative structure activity relationship. Theories of drug activity, Quantitative structure activity relationship. History and development of QSAR. Concepts of drug receptors.

b) Study of Antibiotics (05)

Preparation of semi synthetic penicillin, conversion of penicillin into cephalosporin, general account of tetracycline & macrocyclic antibiotics (no synthesis).

UNIT-II: Study of the Following types of drugs (15)

- a) **Antimalerials:** Trimethoprim.
- b) **Analgesic & Antipyretics:** Paracetamol, Meperidine, methadone, Aminopyrine.
- c) **Anti-inflammatory:** Oxyphenylbutazone, Diclophenac, Indomethacin.
- d) **Antitubercular & antileprotic:** Dapsone
- e) **Anaesthetics :** Lidocaine, Thiopental.
- f) **Antihistamines:** Diphenylhydramine.
- g) **Tranquilizers:** Diazepam, Trimeprazine.
- h) **Anti AIDS:** General study
- i) **Cardiovascular:** Synthesis of dilliazem, quinidine, methyl dopa, atenolol, oxyprenol.
- j) **Anti-neoplastic drugs:** Cancer chemotherapy, Synthesis of mechloreaethamine, cyclophosphamide, Mephalan, uracils, mustards. Recent development in cancer chemotherapy. Hormones and natural products.

Part-B: HETEROCYCLES

UNIT-III: a) Small ring Heterocycles (05)

Three membered and four membered Heterocycles- synthesis and reactions of aziridines, oxiranes, thiranes, azetidines.

b) Benzofused five membered Heterocycles (05)

Synthesis and reactions of benzopyrroles, benzofurans and benzothiophenes.

c) Six membered Heterocycles with one heteroatom (05)

Synthesis and reactions of pyrilium salts and pyrones and their comparison pyridinium And thiopyrylium salts and pyridones. Synthesis and reactions of coumarins, chromones.

UNIT – IV: a) Six membered Heterocycles with two and more Heteroatoms (8)

Synthesis and reactions of diazines & triazines.

b) Seven membered Heterocycles

(7)

Synthesis and reactions of azepines, oxepines & hiepines.

RECOMMENDED BOOKS:

1. Medicinal Chemistry. Burger :
2. Medicinal Chemistry A. Kar. (Wiley East)
3. Principals of medicinal chemistry. W. O. Foye :
4. Text book of organic medical and pharmaceutical chemistry. Wilson, Gisvold & Dorque:
5. Pharmaceutical manufacturing encyclopedia.
6. An introduction to chemistry of heterocyclic compounds. R. M. Acheson : (Interscience).
7. Heterocyclic chemistry. Joule & Smith : (Van Nostrand).
8. Heterocyclic chemistry. R. K. Bansal: (Wiley E).
9. Principals of modern heterocyclic chemistry. L. A. Paquette :
10. The structure and reactions of heterocyclic compounds. M. H. Palmer :
11. Advances in Heterocyclic chemistry. A. R. Katritzky: (A.P.).
12. Organic chemistry (Vol. 1 & 2) Finar.
13. Outline of Biochemistry. Cohn & Stumpf
14. Introduction to the chemistry of enzyme action. Williams :
15. The Organic Chemistry of Drug design and Drug action. R. B. Silverman Academic press.
16. Strategies for Organic Drug synthesis and Design. D. Lednicer, J. Willey.
17. Heterocyclic Chemistry. Vol-1-3, R. R. Gupta, M. Kumar and V. Gupta, Springer Verlag.
18. The Chemistry of Heterocycles. T. Eicher and S. Hauptmann, Thieme
19. Heterocyclic Chemistry. J. A. Joule, K. Mills and G. F. Smith, Chapman and Hall
20. Heterocyclic Chemistry. T. L. Gilchrist, Longman Scientific Technical
21. Contemporary Heterocyclic Chemistry. G. R. Nikome and W. W. Poudler, Willey
22. An Introduction to Heterocyclic Compounds., R. M. Acheson, J. Willey
23. Comprehensive Heterocyclic Chemistry. A. R. Katritzky and C. W. Rees

M.Sc. Part-II (Sem-III)

Organic Chemistry Practical Course OCH-V and OCH -VI

A. Qualitative Analysis

Separation, purification and identification of compounds of ternary mixtures using **semi-microanalysis**, TLC, column chromatography and chemical tests. IR spectra to be used for functional group identification.

B. Quantitative analysis

1. Two step Preparations

- a) Preparation of m-Nitroaniline
- b) Preparation of Benzanilide from benzophenone
- c) Preparation of Phthalimide

- d) Preparation of N-Bromosuccinimide
2. Colorimetry and pH metry experiments.
 3. Expt. on Hammett equation
 4. Structure elucidation by using given spectral data.

5. Any other suitable expt. may be added

RECOMMENDED BOOKS:

1. Textbook of Practical Organic Chemistry – A. I. Vogel.
2. Practical Organic Chemistry – Mann & Saunders.
3. A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke.
4. Organic Synthesis Collective Volumes by Blat

M.Sc. Part-II (Sem-IV) Organic Chemistry

Paper No. OCH -XIII: THEORETICAL ORGANIC CHEMISTRY

UNIT–I: Molecular Orbital Theory (15)

Aromaticity in benzenoids, alternant and non alternant hydrocarbon, Huckels rule, energy level of pi- molecular orbital and concept of aromaticity, calculation of energies of orbitals cyclic and acyclic systems. Determination energies and stabilities of different systems calculation of charge densities PMO theory and reactivity index.

UNIT – II: Non benzenoid aromatic Compounds (15)

Aromaticity in Non- benzenoids compounds Annulenes and heteroannulenes, fullerenes C₆₀, tropone, tropoloneazulene, fulvene, tropylium salts, ferrocene, Three and five membered systems. Crown ether complexes, cyclodextrins, cryptands, catenanes and rotaxanes, bonding in fullerenes.

UNIT – III: Free radical reactions (15)

Types of free radical reactions, detection by ESR, free radical substitution mechanism, mechanism at an aromatic substrate, neighboring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in attacking radicals. The effect of solvent on reactivity. Allylic hydrogenation (NBS), oxidation of aldehydes to carboxylic acids, auto oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salt, Sandmeyer's reaction. Free radical rearrangement, Hunsdiecker reaction.

UNIT – IV A) Kinetic and thermodynamic control of reactions (9)

Nitration and Sulphonation of naphthalene, Wittig, Enolization, Friedel-Crafts and Diels Alder reactions.

B) Non-classical carbocations: Formation, stability and reactivity. (6)

RECOMMENDED BOOKS :

1. 1. Lehar and Merchand: Orbital Symmetry.
2. R. B. Woodward and Hoffman: Conservation of orbital symmetry.
3. Kan: Organic Photochemistry

4. Cixon and Halton : Organic photochemistry
5. Arnold: Photochemistry
6. N. Turro : Modern molecular photochemistry.
7. Rohatgi- Mukherji : Fundamentals of photochemistry.
8. Ginsburg: Nonbenzenoid aromatic compound.
9. A. Streitwieser : Molecular orbital theory for organic chemistry.
10. E. Cler : The aromatic sextet.
11. Lloyd: Carbocyclic non- benzenoid aromatic compounds.
12. W. B. Smith: Molecular orbital methods in organic chemistry.
13. Grratt; Aromaticity.

Paper No. OCH -XIV: STEREOCHEMISTRY

UNIT- I: Newer methods of stereoselective synthesis. (15)

Introduction and Stereoselective and Stereospecific reactions; Enantioselective synthesis (chiral approach) reactions with hydride donors, hydroboration, catalytic hydrogenation via chiral hydrazones and oxazolines, Sharpless epoxidation, Diels Alder selective synthesis, use of calculations of optical purity and enantiomeric excess.

UNIT- II: Stereochemistry of acyclic and alicyclic compounds

A) Conformation and reactivity in acyclic compounds and of cyclohexanes. (5)

Stability and Reactivity of diastereoisomers. **Curtin- Hammett principle.**

B) Some aspects of the stereochemistry of ring systems: (5)

Stereoisomerism and determination of the configuration of alicyclic rings; Stability of rings and ease of rings formation

C) The shapes of the rings other than six membered: (5)

Shapes of five, six, and seven membered rings. Conformational effects In medium sized rings, Concept of τ strain.

UNIT-III: Stereochemistry of the ring system, conformation and configuration

a) Fused and bridged rings: Fused bicyclic ring systems: (8)

Types of fused ring systems, Cis and trans-Decalins, Perhydroanthracene, Perhydrophenanthrene; **Bridged rings:** Types of bridged ring systems, Nomenclature, stereochemical restrictions, and Bredt^{'s} rule.

b) O.R.D. and C.D.: Types of curves, circular dichroism, Determination of the conformation and configuration, The Octant rule and axial haloketone rule. (7)

UNIT-IV: Stereochemistry of compounds containing no chiral carbon atoms and diastereoisomerism (Geometrical isomerism).

a) Stereochemistry of Allenes, Spiranes and Biphenyls (8)

Assignment of configuration

b) Configuration of diastereomers (Geometrical isomerism) based on physical and chemical methods. (7)

RECOMMENDED BOOKS:

1. E.L. Eliel : Stereochemistry of carbon compounds.
2. D. Nasipuri : Stereochemistry of organic compounds
3. P.S. Kalsi: Stereochemistry, Conformation and Mechanism.
4. Eliel, Allinger, Angyal and Morrison : Conformational analysis.
5. Hallas: Organic stereochemistry
6. Mislow and Benjamin: Introduction to Stereochemistry.
7. H. Kagan : Organic stereochemistry.
8. Carl Djerassi ; Optical Rotatory Dispersion.
9. P. Crabbe : Optical Rotatory Dispersion and C.D.

Paper No. OCH -XV: CHEMISTRY OF NATURAL PRODUCTS

UNIT-I: a) Introduction of natural products (3)

Classification and isolation methods.

b) Terpenoids (12)

Introduction of natural products : Classification and isolation methods. Structure and synthesis of camphor, carvone, abietic acid, zingiberene, α -santonin, β -cuparenone and β -caryophyllene.

UNIT-II: Alkaloids (15)

Structure, stereochemistry, synthesis and biosynthesis of the following: Morphine, Reserpine, Ephedrine and (+) Conin.

UNIT-III: a) Steroids (10)

Occurrence, nomenclature, basic skeleton, Diels hydrocarbon. **Study of the following:** hormones, Cholesterol, Androsterone, Testosterone, Estrone, Progesterone, Aldosterone and cortisone (only synthesis).

b) Prostaglandins (5)

Occurrence, nomenclature, classification, biogenesis and physiological effects, Synthesis of PGE₂ and PGF₂

UNIT-IV: a) Biogenesis (8)

a) **Terpenoids** : mono, sesqui., di- and triterpenoids, cholesterol.

b) **Alkaloids** : Derived from ornithine, lysine, tyrosine, tryptophan, pyridine, morphine and indole type alkaloids.

c) **Shikimate pathway** – cinnamic acids, lignans, coumarins, flavonoids, isoflavonoids and terpenoids quinines and the compds. belonging to the classes bisabolene, eudesman and steroids, cholesterol, steroids.

b) Vitamins **(7)**

Synthesis and structure of **biotin** and vitamin **B₁, B₂, B₆**: **biological** functions of Vitamin **B₆, D** and **E**.

RECOMMENDED BOOKS:

1. Apsimon: The total synthesis of natural products.
2. Manskey and Holmes: Alkaloids
3. A.A. Newmen: Chemistry of Terpenes.
4. P. D B.Mayo: The chemistry of natural products.
5. Simonson: Terpenes.
6. T.W. Goddwin: Aspects of terpenoid chemistry and biochemistry.
7. Woguer: Vitamins and Co- enzymes.
8. P. W. Bently: Chemistry of Natural products,
9. Fieser and Fieser: Steroids
10. I. Finar: Organic chemistry Vol. II and I
11. J.B. Hendrickson, The molecules of nature.
12. Peter Bernfield: The biogenesis of natural products
13. R.T. Slickenstaff A.C. Ghosh and G.C. Wole : Total synthesis of steroids.
14. The chemistry of natural products, vol. Nakanishi.

Elective Paper

Paper No. OCH -XVIA: APPLIED ORGANIC CHEMISTRY

UNIT-I: Agrochemical **(15)**

a. Carbamate pesticides: Introduction and synthesis of carbaryl, carbofuran, Baygon, Aldicarb, Ziram, Zineb.

b. Organophosphorus pesticides: Malathion, monocrotophos, dimethoate, phorate, mevinphos, chloropyriphos.

c. Natural and synthetic pyrethroids: Isolation and structures of natural allethrin, fenvalerate, cypermethrin.

d. Plant growth regulators: General survey and synthesis of simple compounds and applications.

e. Insect repellents: General survey , synthesis and applications.

f. Juvenile hormone: introduction & structures JHA importance synthesis

g. Pheromones: introduction, examples, and importance in IPM. Synthesis of juvabione bombykol, grandisol and disparlure.

UNIT-II: A) Synthesis and applications of perfumery **(5)**

2-Phenylethanol, vanillin and other food flavours, synthetic musk and ionones.

B) Synthesis and applications of pharmaceuticals: (5)

Beridryl, Oxyphenbutazone & Ethambutol

c) Sugarbased chemicals : Manufacture of furfural from bagasse, citric acid from molasses, acetic acid, butanaldehyde & butylacetate from ethanol. (5)

UNIT-III: Dyes and Intermediates (15)

Classification and synthesis of important dye intermediates by using nitration, sulphonation, diazotization reactions. Commercial processes for azo-dyes, reactive dyes, optical brighteners, thermal sensitive dyes, dispersed dyes and reactive dyes.

UNIT-IV: Polymers (10)

a) Mechanism of polymerization. Study of polyesters, polyamides, PVC, polystyrene, polyvinyl acetate and polyvinyl alcohol, polyethenes, viscose rayon, synthesis of polyethylene, polypropylene. Synthetic rubbers: Styrene-butadiene, butyl polyisoprene, phenol formaldehyde resin. Plasticizers and anti-oxidants for polymers, natural polymers: starch and cellulose.

b) Applications of Oxo and Wacker process ; Soaps and Synthetic detergents. (5)

RECOMMENDED BOOKS:

1. Allan: Colour Chemistry
2. K. Venkataraman: Chemistry of Synthetic Dyes Vol- 1 to 7
3. Abrahart: Dyes & their intermediates
4. N. N. Melikov: The Chemistry of Pesticides and formulations
5. K. H. Buchel: Chemistry of Pesticides.
6. R. Clemlyn: Pesticides
7. K. H. Buchel: Chemistry of Pesticides
8. H. R. Alcock and F. W. Lambe: Contemporary Polymer Chemistry
9. J. M. G. Cowie, Blackie: Physics & Chemistry of Polymers
10. P. H. Groggins: Unit Processes in Organic Synthesis
11. B. Biollot & P. V. Wells: Perfumary Technology
12. M. Ash & I. Ash: A formulary of Cosmetic Preparations

ELECTIVE CBCS PAPER

Paper No. OCH -XVI: BIOORGANIC CHEMISTRY

UNIT-I: a) Cell Structure and Functions (10)

Structure of prokaryotic and eukaryotic cells, Intracellular organelles and their functions, comparison of plant and animal cells. Overview of metabolic process- catabolism and anabolism. ATP – the biological energy currency. Origin of life- unique properties of carbon, chemical evolution and rise of living system. Introduction to biomolecules, building blocks of bio-macromolecules.

b) Enzymes (5)

Structure activity and reactions, catalyzed determination of active site, inhibition mechanism chemical transformations using enzymes.

UNIT-II: Carbohydrates

(15)

Conformation of monosaccharides, structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars. Naceylmuramic acid, sialic acid disaccharides and polysaccharides. Structural polysaccharides- cellulose and chitin. Storage polysaccharides- starch and glycogen.

Structure and biological functions of glucosaminoglycans or mucopolysaccharides. Carbohydrates of glycoproteins and glycolipids. Role of sugars in biological recognition. Blood group substances. Ascorbic acid.

Carbohydrate metabolism- Krebs's cycle, glycolysis, glycogenesis and glycogenolysis, pentose phosphate pathway.

UNIT-III: Lipids

(15)

Fatty acids, essential fatty acids, structures and function of triglycerides, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Lipoproteins- composition and function, role in atherosclerosis. Properties of lipid aggregates – micelles, bilayers, liposomes and their possible biological functions. Biological membranes. Fluid mosaic model of membrane structure. Lipid metabolism - β -oxidation of fatty acids

UNIT-IV: a) Amino acids, Peptides and Proteins

(10)

Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of protein, forces responsible for holding of secondary structures. α - helix, β -sheets, super secondary structure, triple helix structure of collagen. Tertiary structure of protein- folding and domain structure. Quaternary structure. 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).

b) Nucleic Acids

(5)

Purine and pyrimidine of nucleic acids, base pairing via H – bonding. Structure of ribonucleic acids (RNA) and deoxyribonucleic acid (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 poly nucleosides.

RECOMMENDED BOOKS:

1. Principles of Biochemistry, A. L. Lehinger, Worth Publications.
2. Biochemistry, L. Stryer, W. H. Freeman
3. Biochemistry, J. David Rawn, Neil Patterson.
4. Biochemistry, Voet and Voet, John Wiley.
5. Outlines of Biochemistry, E. E. Conn and P. K. Stumpf, John Wiley.

M.Sc. Part-II (Sem-IV)

Organic Chemistry Practical Course OCH-VII and OCH-VIII

Three stage preparations starting with 5g or less and TLC.

1. Estimation of Sulphur and Nitrogen.

3. Organic preparations

- | | |
|--|----|
| 1. Preparation of Anthranilic acid. | 2. |
| Preparation of p- Amino benzoic acid. | 3. |
| Preparation of p- Chloro nitrobenzene by Sandmeyer reaction. | 4. |
| Preparation of p- Iodonitrobenzene by Sandmeyer reaction. | 5. |
| Multicomponent synthesis. | |

4. Project: Literature survey. Studies of reactions, synthesis, mechanism, isolation of natural products, standardization of reaction conditions, use of new methods etc. Identification of organic compounds by spectroscopic methods. External and internal examiners will examine the project (50 Marks) jointly at the time of practical examination.

5. Any other suitable experiments may be added.

6. Study tour is compulsory for M.Sc. Part- II Students to visit Chemical Industries in India.

REFERENCE BOOKS:

1. A Textbook of Practical Organic Chemistry – A. I. Vogel.
2. Practical Organic Chemistry – Mann & Saunders
3. A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke
4. Organic Synthesis Collective Volumes.
5. Organic Reactions (Wiley)

M. Sc. Part-II (Sem-III and IV) Physical Chemistry

SEMESTER- III

Paper No. PCH-IX : ADVANCED QUANTUM CHEMISTRY

Paper No. PCH-X : ELECTROCHEMISTRY

Paper No. PCH-XI : MOLECULAR STRUCTURE-I

ELECTIVE PAPERS

Paper No. PCH-XII (A) : ADVANCED CHEMICAL KINETICS

Paper No. PCH-XII (B) : RADIATION AND PHOTOCHEMISTRY

ELECTIVE CBCS PAPER

Paper No. PCH-XII : SOLID STATE CHEMISTRY

PRACTICAL COURSE : PCH- V and PCH- VI

SEMESTER- IV

Paper No. PCH-XIII : THERMODYNAMICS AND MOLECULAR MODELING

Paper No. PCH-XIV : CHEMICAL KINETICS

Paper No. PCH-VX : MOLECULAR STRUCTURE-II

ELECTIVE PAPERS

Paper No. PCH-XVI (A): SURFACE CHEMISTRY

Paper No. PCH-XVI (B): CHEMISTRY OF MATERIALS

Paper No. PCH-XVI (C): BIOPHYSICAL CHEMISTRY

PRACTICAL COURSE : PCH- VII and PCH- VIII

M.Sc. Part-II (Sem-III) Physical Chemistry

Paper No. PCH -IX: ADVANCED QUANTUM CHEMISTRY

UNIT-I: Basics of Quantum Chemistry (15)

Brief review of basic principles of quantum mechanics. Exact solution of Schrödinger wave equation for rigid rotator, linear harmonic oscillator and hydrogen and hydrogen like atoms. Transition dipole moment integral and selection rules for rotational, vibrational and electronic transitions.

UNIT- II: Variation Principle and Hückel Molecular Orbital Theory (15)

Variation principle and its application to some simple systems. Hückel molecular orbital theory – Assumptions of HMO theory, the Born-Oppenheimer approximation, π -electron approximation, Secular determinant and secular equations, Hückel rule and aromaticity, HMO calculations for organic molecules, free valence index and prediction of chemical reactivity, use of molecular symmetry for simplification of HMO calculations, HMO treatment for molecules containing heteroatoms, extended Hückel methods

UNIT –III: Ab initio methods (15)

Self-consistent field (SCF) theory, Hartree-Fock (HF) method, quantum particles and their spins, properties of Slater determinant, HF equation, restricted Hartree-Fock (RHF) and unrestricted Hartree-Fock (UHF) models, Fock matrix, HF calculations, Roothaan-Hall equations, Koopman's theorem, electron correlation method. Basis sets: Slater type orbitals (STO), Gaussian type orbitals (GTO), difference between STO and GTO, energy calculations using such orbitals for multielectron systems, classification of basis sets, minimal basis sets, energy calculations for H-atom using STO basis sets at different levels, double- and triple-zeta basis sets, valence-split basis sets, polarized basis sets, truncation and superposition errors in basis sets, methods to overcome above errors. Correlation energy, configuration interactions, many body perturbation theory, Möller-Plesset perturbation, coupled cluster method. Introduction to various software packages for performing ab initio and density functional theory calculations

UNIT- IV: Semi-empirical methods and Molecular Mechanics, Semi-empirical methods (15)

Introduction, need of semi-empirical methods, zero differential overlap (ZDO) approximation, neglect of differential overlap (NDO) method, complete neglect of differential overlap (CNDO), intermediate neglect of differential overlap (INDO), modified intermediate neglect of differential overlap (MINDO), modified neglect of differential overlap (MNDO), neglect of diatomic differential overlap (NDDO). AM1, PM3, PM5, PM6 etc. methods, Hamiltonian in semi-empirical methods, comparisons in various above mentioned methods, limitations of semi-empirical methods. Introduction to various software packages for performing semi-empirical calculations.

REFERENCE BOOKS:

1. A.K. Chandra, Introductory Quantum Chemistry, 4th Edition, Tata McGraw- Hill, New 1994.
2. D. A. McQuarrie and J. D. Simon, Physical Chemistry: A molecular Approach, Viva Books, New Delhi, 1998.
3. D. A. McQuarrie, Quantum Chemistry, Viva Books, New Delhi, 2003.
4. P. W. Atkins, Physical Chemistry, 6th Edition, Oxford University press, New York, 1998.
5. P. Atkins and R. Friedman, Molecular Quantum Mechanics, 4th Edition, Oxford University Press, New York, 2005.
6. Leach, A.R. Molecular Modelling. Principles and Applications, 2nd Edition, Prentice-Hall, Harlow, England, 2001.
7. K.I. Ramachandran, G. Deepa and K. Nimboori, Computational Chemistry and Molecular Modelling: Principles and Applications, Springer-Verlag, Berlin, Germany, 2008.
8. Becker, O.; MacKerell, A.D.; Roux, B.; Watanabe, M. eds. Computational Biochemistry and Biophysics, Marcel Dekker, New York, 2001.
9. F. Jensen, Introduction to Computational Chemistry, 2nd Edition, John Wiley & Sons Ltd, West Sussex, England, 2007.
10. D.B. Cook, Handbook of Computational Chemistry, Oxford University Press, New York, 1998.

Paper No. PCH-X: ELECTROCHEMISTRY

UNIT –I: Electrokinetic phenomena (15)

Electrical double layer, theories of double layer, electro-capillary phenomena, electro-capillary curve. Electro-osmosis, electrophoresis. Streaming and Sedimentation potentials. Zeta potentials and its determination by electrophoresis, influence of ions on Zeta potential.

UNIT- II: Ion-solvent Interactions (15)

Structure of water, hydration, heats of hydration of electrolytes, individual ions and their comparison, calculation of heats of hydration(Born, Van Arkel & de Boer, Bernal-Fowler methods), entropy of hydration and hydration numbers. Ion transport in solutions, diffusion, chemical potential and work of transport, Ficks laws, expressions for flux and diffusion coefficient. Ionic liquids: Introduction, difference between electrolytes and ionic liquids, diffusion in fused salts, viscosity and diffusion coefficient in molten salts.

UNIT-III: Electrode reactions (15)

Electrified interface, electron transfer under interfacial electric field, symmetry factor, electrode at equilibrium, exchange current density, over potential, Butler-Volmer equation, high field and low field approximations, Tafel equations, kinetics of discharge of hydrogen ions. Diffusion over potentials. Electrode kinetics of semiconductor/solution interface; n and p type semiconductor, current-potential relation of n and p type semiconductors.

UNIT-IV: Fuel cells and corrosion (15)

Significance of fuel cells: hydrogen - oxygen, hydrocarbon - air, natural gas and carbon monoxide, air fuel cells.

Corrosion: concept and importance, mechanism of corrosion and Pourbaix

REFERENCE BOOKS:

1. An Introduction to Electrochemistry by S. Glasstone
2. Modern Electrochemistry Vol. I & II by J. O. M. Bockris and A.K.N. Reddy .
3. Physical Chemistry by S. Glasstone
4. Electrolytic Solutions by R. A. Robinson and R. H. Stokes
5. Physical Chemistry by P. W. Atkins. ELBS.

Paper No. PCH- XI: MOLECULAR STRUCTURE - I**UNIT- I: Symmetry properties of molecules and group theory (15)**

Symmetry elements, symmetry operations and point groups, properties of group, symmetry operations as a group, multiplication table. Classes of symmetry operations, basis, representative and matrix representations of operations. Reducible and irreducible representations, orthogonality theorem. Properties of irreducible representations. Constructions of character table for point groups. Explanations for the complete character table for a point group. Representations of vibrational modes in nonlinear molecules. Infrared and Raman activities of normal modes of vibrations.

UNIT– II: Introduction of spectroscopy and Rotational Spectra (15)

Characterization of electromagnetic radiation. The qualification of energy. Regions of Spectrum, transition probability, the width and intensity of spectral transitions.

Classification of molecules according to their moment of inertia. Rotational spectra of rigid and non rigid diatomic molecules. The intensities of spectral lines. The effect of isotopic substitution. Polyatomic and symmetric top molecules. The stark effect.

UNIT- III: Infrared spectroscopy and Raman Spectroscopy (15)

Diatomic molecules: 1) Molecules as harmonic oscillator, Morse potential energy function, vibrational spectrum, fundamental vibrational frequencies. Force constant, zero point energy, isotope effect. The anharmonic oscillator, the diatomic vibrating rotator, the interactions of rotations and vibrations.

Polyatomic molecules: Fundamental vibrations and their symmetry, overtone and combination frequencies. The influence of rotations and molecular spin on the spectra of polyatomic molecules. Analysis by Infrared techniques.

Raman Spectroscopy: Rayleigh scattering. Raman Scattering, classical and quantum theories of Raman effect. Rotational Raman Spectra for linear and symmetric top molecules. Vibrational Raman Spectra, rotational fine structure. Polarization of light and the Raman effect . Structure determination from Raman and Infra-red spectroscopy.

UNIT – IV: Electronic Spectroscopy (15)

General nature of band spectra. Beer- Lambert Law integrated absorption coefficient and oscillator strength. Term symbols for atoms and molecules. The hydrogen atom and hydrogen like species spectrum.

Sequences and progressions, the vibrational course structure and rotational fine structure of electronic band. The Franck-Condon principle, dissociation energy and dissociation products. Birge-Sponer extrapolation. The Fortrat diagram. Predissociation, classification of electronic states. The spectrum of molecular hydrogen. Electronic spectra of polyatomic molecules. Chemical analysis by electronic spectroscopy. (d-d), ($\pi \rightarrow \pi^*$) and ($\sigma \rightarrow n^*$) transitions. Photochemical mechanism of vision.

REFERENCE BOOKS:

1. Fundamental of molecular spectroscopy by C. N. Banwell Tata McGraw Hill.
2. Physical Chemistry by P. W. Atkins , ELBS, 1986
3. Symmetry, Orbitals and spectra by M. Orchin & H. Jaffe, Willey , interscience.
4. Chemical applications of group theory by F. A. Cotton Willey , interscience
5. Symmetry in chemistry by H. Jaffe and M . Orchin , Jhon willey.
6. Group theory and its applications to chemistry by K. V. Ramen , Tata McGraw Hill.
7. Molecular Structure and Molecular Spectra by G. Herzberg, Van Nostrand .
8. Molecular Spectroscopy by I. N. Levine , Willey interscience.
9. Molecular Spectroscopy by G. M. Barrow.

ELECTIVE PAPERS

Paper No. PCH-XIIA: ADVANCED CHEMICAL KINETICS

UNIT-I: Hydrogen ion dependence of reaction rates (15)

Protonation and hydrolysis equilibria , determination of active reactant species from kinetic data, interpretation of hydrogen ion effect with example.

UNIT-II: Electron transfer reaction (15)

Complimentary and non-complimentary reactions, outer and inner-sphere electron transfer reactions, proton transfer, hydride transfer and hydrogen, oxygen and chlorine atom transfer reactions.

UNIT-III: Catalysis (15)

Trace metal ion catalysis and their mechanisms. Micellar catalysis, Berezini, Menger-Portonoy, cooperative and pseudo-phase ion exchange models and examples.

UNIT-IV: Mechanism of chromium(VI) oxidations (15)

One and two equivalent reductants oxidation, assumptions, limiting forms of rate laws, Westheimer mechanism and its validity. Catalysis, Induced and cooxidations. Mechanisms other than Westheimer mechanism.

REFERENCE BOOKS AND ARTICLES:

- 1) Chemical Kinetics by K. J. Laidler.
- 2) Kinetics and Mechanism by A. A. Frost and R. G. Pearson
- 3) Micellar effect on the kinetics and mechanism of chromium(VI) oxidation of organic substrates By Asim K. Das, Coordination Chemistry Reviews, Vol 248, p 81-89 (2004).
- 4) Some aspects of electron transfer reactions involving organic molecules by B. Sethuram, Allied Publishers, 2003.
- 5) Surfactants and polymers in aqueous solution by Bo Jonsson, Bjorn Lindman, Krister Holmberg and Bengt Kronberg, John-Wiley & Sons, 1998.
- 6) Inorganic reaction mechanisms, Part II Edited by John O. Edwards, Interscience, 1972.

Paper No. PCH-XIIB: RADIATION AND PHOTOCHEMISTRY

UNIT – I: Radiation Chemistry

(15) Introduction, Radiation Types, their characteristics, Radiation in chemical processes.

UNIT – II: Lasers and Lasers in Chemistry

(15)

Introduction, characteristics of laser, uses of lasers in chemical process, laser induced chemical reactions, organic photochemistry, lasers as a photochemical tool, laser induced selective bond chemistry, overview, bond selective chemistry of light atom molecules.

UNIT – III: Basics of photochemistry **(15)**

Electrochemistry of excited states, life time measurements, flash photolysis, energy dissipation by radiative and non-radiative processes, properties of excited states, structure, dipole moment, acid-base strength, reactivity, photochemical kinetics, calculations of rates of radiative process, bimolecular quenching, Luminescence for sensors and switches, charge transfer excited state, photoinduced electron transfer reactions.

UNIT – IV: Miscellaneous Photochemical reaction

(15) Photo-fries reaction of anilides, photo-fries rearrangement, Barton reaction, singlet molecular oxygen reactions, photochemical formation of smog, photodegradation of polymers, photochemistry of vision.

REFERENCE BOOKS:

- 1) Molecular Photochemistry, N. J. Turro, W.A. Benjamin
- 2) Fundamentals of Photochemistry, K. K. Rohatagi - Mukherji, Wiley - Eastern
- 3) Elements of Inorganic Photochemistry : G. S. Ferraudi, Wiley
- 4) Concepts of Inorganic Photochemistry, A.W. Adamson & P. J. Fleischauer, Wiley
- 5) A Guide To lasers in chemistry, Gerald R. Van Hecke & Kerry K. Karukstis.
- 6) Photochemistry, R.P. Kundall, A Gilbert, Thomson Nelson

ELECTIVE CBCS PAPER

Paper No. PCH-XII: SOLID STATE CHEMISTRY

UNIT-I: The solid state **(15)**

Introduction, laws of crystallography, lattice types, X-ray diffraction, Bragg's equation, Miller indices, Bragg Method, Debye-Sherrer method of X-ray structure analysis of crystals, indexing of reflections, identification of unit cells from systematic absence in diffraction pattern, structure of simple lattice and X-Ray intensities, structure factor and its relation to intensity and electron density, phase problem, procedure for an X-ray structure determination.

UNIT –II: Solid State Reactions **(15)**

General principle, types of reactions: Additive, structure sensitive, decomposition and phase transition reactions, tarnish reactions, kinetics of solid state reactions, factors affecting the reactivity of solid state reactions.

UNIT –III: Electronic Properties and Band Theory **(15)**

Metals, insulators and semi conductors, free electron theory and its

applications, electronic structure of solids, band theory, band structure of metals, insulator, and semiconductors, doping in semiconductors, p- n junction, super conductors, Molecular materials, Organic materials, some examples of organic semiconductors, charge carrier injection and transport, Optical properties of organic semiconductors, applications and devices involving optical properties, luminescence photoluminescence, effect of impurity levels on photoluminescence, light emitting diodes, luminous efficiency, photo-conduction and photoelectric effects, laser, principle of laser action, solid state laser and their applications.

UNIT-IV: Preparation of materials (5)

Purification and crystal growth, kinetics of nucleation, radius of nucleus, critical radius, principle of nucleation, crystal growth during casting, zone refining, growth from solution, growth from melt and preparation of organic semiconductors for device applications.

Polymeric Materials (10)

Molecular shape , structure and configuration, crystallinity, stress- strain behavior, thermal behavior, glass transition temperature, polymer types and their applications, conducting and optoelectronic polymers.

REFERENCE BOOKS:

1. A guide to laser in chemistry by Gerald R., Van Hecke, Keny K. Karokitis
2. Principals of solid state, H. V. Keer, Wiley Eastern,
3. Solid state chemistry, N. B. Hannay
4. Solid state chemistry , D. K. Chakrabarty , New Age International
5. An Introduction to Crystallography : F. G. Philips
6. Crystal Structure Analysis: M. J. Buerger
7. The Structure and properties of materials:
Vol. III Electronic properties by John Walss
8. Electronic processes in materials : L. U. Azroff and J. J. Brophy
9. Chemistry of imperfect crystal : F. A. Krogen
10. Elements of X-ray Diffraction by B. D. Cullity, Addison- Weily.
11. Solid state Chemistry by A.R.West (Plenum)
12. Electronics made simple by Jacobwitz.
13. Principles of Physical Metallurgy, by Abhijeet Mallick,
14. Solid State Chemistry, An Introduction, by Lesley E. Smart, & Elaine A. Moore,
Third Edition, Taylor & Francis, Indian Edition 2012.

M.Sc. Part-II, (Sem-III)

Physical Chemistry Practical Course PCH- V and PCH-VI

Potentiometry

1. To determine instability constant & stiochiometry of silver ammonia complex potentiometrically.
2. Determination of Thermodynamic Parameters for electrochemical reactions.
(To determine ΔG° , ΔH° , and ΔS° for the formation of 1 mole cadmium in 1 wt. % amalgam at 25° C and activity coefficient of solution).

Spectrophotometry

- 1) To determine pK value of methyl red indicator at room temperature spectrophotometrically
- 2) To determine stoichiometry & stability constant of ferric Sulphosalicylic acid/ salicylic acid complex by Job's Method and mole ratio method spectrophotometrically.
- 3) To dsetermine equilibrium constant of reaction $KI + I_2 \rightleftharpoons KI_3$ spectrophotometrically

Amperometry

To determine unknown concentration of Iodine using amperometry

Chemical Kinetics

To determine the order of reaction between acetone and iodine catalyzed by acid.

Conductometry

To determine equivalent conductance at infinite dilution of strong electrolytes and weak acid by using Kohlrausch Law and dissociation constant for weak acid conductometrically.

Cryoscopy

To determine molecular weight and state of benzoic acid in benzene.

Moving boundary Method

To determine transport of H⁺ ions by using Moving boundary method.

pH - Metry

To determine dissociation constant of carbonic acid pH metrically.

Polarography

To determine half wave potential of a given ion using half height method, differential method and wave equation method

Latent heat of Fusion

Determination of latent heat of fusion of a given solid.

Thermochemistry

Determination of heats of dilution and integral heat of solutions.

Any other suitable experiments may be added.

M.Sc. Part-II (Sem-IV) Physical Chemistry**Paper No. PCH -XIII: THERMODYNAMICS AND MOLECULAR MODELING****UNIT-I: Modern Theoretical Principles****(15)**

Exact and inexact differential expressions in two variables. Total differentials. Techniques of partial differentiations. Transformation of variables. Maxima and minima. Integrating factors, Paff differential equations, Caratheodary's theory. Legendre transformations. Derivation of thermodynamic identities. The second law of thermodynamics, classical formulations, mathematical consequences of second law. Entropy changes, Clausius inequality. Free energy concept. General condition of equilibrium. Thermodynamic potentials.

UNIT- II: Statistical and Molecular Mechanics**(08)**

Ensembles, ensemble average and time average of the property, ergodic hypothesis, partition functions and thermodynamic properties, classical and quantum statistics, properties of photon gas, thermodynamic properties bosons, use of quantum statistics for evaluation of absolute entropies, condensation of helium, Fermi energy, electron gas in metals.

Heat capacity of solids, Einstein and Debye specific heat equations. Characteristic temperatures. Debye T^3 law

Molecular Mechanics: (07)

Introduction, the Morse potential model, harmonic oscillator model, force fields development, various energy terms and non-covalent interactions included in force fields, Lennard-Jones type and truncated Lennard-Jones potentials, Kihara potential, commonly used force fields, parameterization, introduction to software packages used for performing molecular mechanics.

UNIT –III: Molecular Dynamic Simulation Methods (15)

Introduction, microscopic and macroscopic properties, time scale of chemical/biological process, force field methods, bonded and non-bonded interactions, advantages and limitations of Force Field Methods, molecular dynamics methods, neighbour searching, Trotter decomposition, cut-offs, temperature and pressure coupling methods, integration algorithms: Verlet algorithm, Leap-frog algorithm, Velocity Verlet, Beeman's algorithm, Constraint algorithms: shake, lincs, etc., Stochastic and Brownian dynamics, topology files, energy minimization: steepest descent method, conjugate gradient method, L-BFGS. Solvent models, Solvation, implicit and explicit solvation, heating dynamics, equilibration dynamics, production dynamics, trajectory analysis, particle mesh Edward dynamics, boundary conditions, Exclusions and 1-4 interactions, gradient based methods, steepest descent method, conjugate gradient method, replica exchange method, conformational analysis, normal mode analysis, free energy calculation: free energy perturbation method, thermodynamic integration method, thermodynamic cycles for free energy calculations, determination of hydration/solvation free energy, protein folding free energy, protein-ligand binding free energy etc. Software packages for performing Monte-Carlo and Molecular dynamic simulation as well as for visualization and analysis trajectories

UNIT- IV: Non-equilibrium thermodynamics (15)

Conversion of mass in closed and open systems, conservation of energy in closed and open systems. Law of increasing entropy. Non-adiabatic process and clausius inequality, steady state. Thermodynamic equations of motion. Chemical and electrochemical affinities. Coupling reactions. Rates and affinities. Generalized fluxes, forces and their transformation. Phenomenological equations and coefficients. Concepts of reciprocity relations and Onsager theorem of microscopic reversibility. Entropy production in closed and open systems. Entropy production due to heat flow. Chemical potentials. Diffusion, electromotive force, electro-osmosis, thermoelectric effect and other reactions involving cross relations. Saxens relations

REFERENCE BOOKS:

1. S. N. Blinder, Advanced physical Chemistry, The Macmilan Company, 1967.
2. L. K. Nash, Elements of statistical thermodynamics, 2nd Edition, Addison Wesley, 1974.
3. T.L. Hill, An Introduction to Statistical Thermodynamics, Addison-Wesley, 1960.
4. S. Glasstone, Theoretical Chemistry: An introduction to quantum mechanics, statistical mechanics, and molecular spectra for chemists, D. Van Nostrand

- Company, Inc., 1944.
5. D. A. McQuarrie and J. D. Simon, Physical Chemistry: A molecular Approach, Viva Books, New Delhi, 1998.
 6. Allen, M. P., Tildesley, D. J. Computer Simulations of Liquids, Oxford: Oxford Science Publications. 1987.
 7. Frenkel, D.; Smit, B. Understanding Molecular Simulation: From Algorithms to Applications, 2nd Edition, Academic Press, San Diego, 2002.
 8. K.I. Ramachandran, G. Deepa and K. Nimboori, Computational Chemistry and Molecular Modelling: Principles and Applications, Springer-Verlag, Berlin, Germany, 2008.
 9. F. Jensen, Introduction to Computational Chemistry, 2nd Edition, John Wiley & Sons Ltd, West Sussex, England, 2007.
 10. Schlick, T. Molecular modeling and simulation: an interdisciplinary guide, Springer-Verlag New York, Inc., Secaucus, NJ, USA, 2002.
 11. D.B. Cook, Handbook of Computational Chemistry, Oxford University Press, New York, 1998.
 12. Online Manuals for simulation and visualization packages such as GROMACS, VMD, NAMD, AMBER, TINKER, etc.
 13. I. Prigogine, Introduction to Thermodynamics of Irreversible Processes, Wiley, New York, 1968.
- R.P. Rastogi, Introduction to Non-equilibrium Physical Chemistry: Towards Complexity and Non-linear Science, Elsevier, Oxford, 2008.

Paper No. PCH- XIV: CHEMICAL KINETICS

UNIT-I: Fast Reactions

(15)

Kinetics of Fast reactions: Relaxation techniques, pressure jump and temperature jump methods, NMR relaxation, flash photolysis and molecular beam methods.

UNIT – II: Theories of Reaction Rate

(15)

Equilibrium and rate of reaction, Partition function and activated complex, Collision theory of gas reaction, collision frequency. The rate constant, molecular diameters, collision theory vs. experiment Transition state theory (Thermodynamic and partition function approach) Activated complex theory of reaction rates, reaction coordinate and transition state, formation and decay of activated complex, Eyring equation, thermodynamic aspects. Theory of unimolecular reactions.

UNIT–III: Heterogeneous Catalysis

(15)

Chemical reactions on surfaces, unimolecular surface reactions, bimolecular surface reactions, Electronic theories of chemisorptions and heterogeneous catalysis. Photocatalysis, Reaction mechanism of photocatalysis Effect of photocatalysis reaction. Heterogeneously catalyzed oxidation and reduction reactions: oxidation of hydrogen with oxygen (Determination of Pt, Pd, Ir and Rh) Reduction of silver bromide (Determination of S and Se)

UNIT- IV : Organic Reaction Mechanisms

(15)

Linear free energy relationships: Hammett plots, Hammett equation, substituent and reaction constants and their physical significance, calculation of k and K values, Yukawa-Tsunoequation. Taft equation, steric parameters Solvent effects, Grunwald-Winstein equation.

REFERENCE BOOKS:

- 1) Chemical Kinetics by K. J. Laidler.
- 2) Kinetics and Mechanism by A. A. Frost and R. G. Pearson .
- 3) Fast Reactions by Haque .
- 4) Theory of chemical reaction rates by K. J. Laidler, McGraw Hill, New York , 1969.
- 5) Fast Reactions by J. N. Bradley , Clarendon Press Oxford , 1974
- 6) Physical Chemistry by W. J. Moore.
- 6) Physical Chemistry by P.W. Atkins

Paper No. PCH-XV: MOLECULAR STRUCTURE - II

UNIT – I: The Electric Properties of Molecules (15)

Electric dipole moment of molecule, polarization of a dielectric , polarizability of molecules, Clausius-Mossotti equation. Debye equation . limitation of the Debye theory , determination of dipole moment from dielectric measurements in pure liquids and in solutions. Dipole moment and ionic character, Bond moment, Group moment, vector addition of moments, bond angles, The energies due to dipole-dipole, dipole induced dipole and induced dipole-induced dipole interaction. Lennard-Jones potential .

UNIT – II: The Magnetic properties of Molecules (15)

Diamagnetism and paramagnetism. Volume and mass susceptibilities. Langevin's classical theory of diamagnetism and paramagnetism Atomic and ionic susceptibility. Pascal constants, Curie - Weiss law. Van Vleck general equation of magnetic susceptibility. Determination of magnetic susceptibility. Ferro and ferri magnetism, application to coordination complexes and complex ions of transition metals.

UNIT – III: Nuclear Magnetic Resonance Spectroscopy (15)

The nature of spinning particles , interaction between spin and a magnetic field. Population of energy levels, The Larmor precession . relaxation times. the meaning of resonance and the resonance condition. NMR experiment, significance of shielding constants and chemical shift . the origin and effect spin - spin coupling , factors affecting chemical shift, chemical analysis by NMR. Exchange phenomena , ^{13}C NMR spectroscopy, double resonance and nuclear-overhauser effect.

UNIT – IV: A) Electron Spin Resonance Spectroscopy (8)

Electron spin and Magnetic moment , Resonance condition in ESR and significance of 'g' value . ESR spectra of organic free radicals , McConnell relation , Electron Exchange reactions , applications of ESR,

B) Mossbauer Spectroscopy (7)

Basic principle of Mossbauer spectroscopy, hyperfine structure, quadrupole splitting, instrumentation and applications of Mossbauer spectroscopy, Problems related to Mossbauer spectra.

REFERENCE BOOKS:

1. Fundamentals of molecular spectroscopy by C. N. Banwell.
2. Physical chemistry by P. W. Atkins . ELBS. 1986
3. Introduction to molecular spectroscopy by G. M. Barrow.
4. Molecular spectroscopy by I. N. Levine , Wiley interscience.
5. Nuclear magnetic Resonance by J. D. Roberts , McGraw Hill .
6. Introduction to Magnetic resonance by A. Carrington and A. D. McLachlan. Harper and Row.
7. Electron Spin Resonance , Elementary theory and practical applications by J. E. Wetz

and J. R. Boulton , McGrew Hill .

8. Introduction to Magnetochemistry by Earnst Shaw. Academic Press

9. Electrical and optical properties of molecular behavior by M. Davies, pergman press.

10. Polar molecules by P. Debye , Dover publications.

ELECTIVE PAPERS

Paper No. PCH-XVIA: SURFACE CHEMISTRY

UNIT-I: Surface Chemistry of interfaces (15)

Types of interfaces, Liquid-vapour interface, Surface tension and interfacial tension, surface tension across curved surfaces, capillary action, methods of determination of surface tension, , vapor pressure of droplet (Kelvin equation) ,Surface activity and adsorption phenomenon, Trube's Rule, Gibb's Adsorption equation, liquid-liquid interfaces, work of cohesion and adhesion, surface spreading , spreading of one liquid on the surface of other liquid, spreading coefficient and derivation for its relation with surface tension, monomolecular films, preparation of monolayer films, Langmuir-Boldget method, physical states of films, ideal equation of states, experimental aspects based on use of Langmuir-Adam surface pressure balance,

Unit-II: Solid-gas interfaces (15)

Adsorption of gases on solids, factors affecting adsorption, Experimental methods of determining gas adsorption, volumetric method, Gravimetric method, types of adsorption isotherms, The B.E.T. equation, methods of determination of surface area, Herkins's Jura method, BET method, Point B Mehhod, Heat of adsorption, Calorimetric method of determination of heat of adsorption, Chemisorption, Kinetics of chemisorptions, Heterogenous catalysis (Contact catalysis), mechanism of catalysis, factors influencing catalytic activity.

UNIT- III: Colloids and emulsion (15)

The Colloidal state: Introduction, types, preparation and stability of colloids, properties of colloids, Electrokinetic phenomena: Electrophoresis, electro-osmosis, Emulsion: Types of emulsion, theories of emulsion and emulsion stability, identification of emulsion types, inversion emulsion, microemulsion : theory and application , micellisation, structure of micelle, reverse micelle , solubisation of water insoluble organic substances ,

UNIT –IV: Solid-Liquid and Solid - Solid interfaces (15)

Solid-liquid interfaces, Introduction, wetting phenomenon, contact angle and wetting, heat of wetting, methods of determination of contact angle, contact angle hysteresis, wetting agents, selective wetting, applications in detergency, and pesticide affectivity, Solid-Solid interfaces, introduction, Surface energy of solids, adhesion and adsorption, sintering and sintering mechanism, Tammann temperature, importance of impurities, surface structure and surface composition. Friction and lubrication, mechanism of lubrication, solid state lubricants.

REFERNCE BOOKS:

1. Physical chemistry of surfaces: A. W. Adamson.
2. Theory of adsorption and catalysis by Alfred Clark ,
3. Chemisorption by B. M. W. Trapnell and H.O. Hayward.

4. Introduction to colloids and surface chemistry by D. J. Shaw.
5. Theories of chemical reaction rates by A. J. K. Laidler
6. Surface chemistry by J. J. Bikermann
7. The Surface Chemistry of Solids, by S.J. Gregg, Second Edition, Chapman & Hall Ltd. London.
8. Advanced Physical Chemistry, by Gurdeep Raj, Goel Publishing House, Krishna Prakashan Media (P) Ltd., Meerut-250001(UP)
9. Principles of Physical Chemistry, Puri B.R., Sharma L.R. & Pathania M.S., Vishal Publishing Co., Jalandhar-144008
10. Physical Chemistry by Pahari S. New Central Book Agency (P) Ltd. Kolkata-700009.

Paper No. PCH- XVIB: CHEMISTRY OF MATERIALS

UNIT –I: Glasses, Ceramics, Composite and Nanomaterials (15)

Glassy state, glass formers and glass modifiers, applications, Ceramic structures, mechanical properties, clay products. Refractories, characterizations, properties and applications.

Microscopic composites; dispersion - strengthened and particle - reinforced, fibre - reinforced composites, macroscopic composites. Nanocrystalline phase, preparation procedures, special properties, and applications.

UNIT-II: High Tc Materials (15)

Defect perovskites, high Tc superconductivity in cuprates, preparation and characterization of 1-2-3 and 2-1-4 materials, and normal state properties; anisotropy; temperature dependence of electrical resistance; optical phonon modes, superconducting state; heat capacity; coherence length, elastic constants, position lifetimes, microwave absorption - pairing and multigap structure in high Tc materials, applications of high Tc materials.

UNIT-III: Polymeric Materials (15)

Molecular shape, structure and configuration, crystallinity, stress- strain behavior, thermal behavior, polymer types and their applications, conducting and ferro - electric polymers.

UNIT-IV: A) Thin films and Langmuir- Blodgett Films

(7)

Preparation techniques; evaporation / sputtering, chemical processes, MOCVD, sol - gel etc. Langmuir- Blodgett (LB) film, growth techniques, photolithography, properties and application of thin and LB films.

B) Materials of Solid Devices

(8)

Rectifiers, transistors, capacitors IV-V compounds, low dimensional quantum structure; optical properties.

REFERENCE BOOKS:

1. Solid State Physics, N. W. Ashcroft and N. D. Mermin, Saunders College
2. Material Science and Engineering, An introduction, W. D. Callister, Wiley.
3. Principles of Solid State, H. V. Keer, Wiley Easton.
4. Materials Science, J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rawlings, ELBS
5. Thermotropic Liquid Crystals, Ed, G. W. Gray, John Wiley.

6. Text book of liquid crystals, Kelkar and Halz , Chemie Verlag

Paper No. PCH- XVIC: BIOPHYSICAL CHEMISTRY

UNIT – I: Chemistry and Biology (15)

Amino acids , proteins , enzymes , DNA & RNA in living systems , electrolytes, the chirality of biological molecules , the biochemical process , weak and strong interactions, macromolecules and rubber elasticity , polyelectrolytes , biopolymers.

UNIT- II: Physical aspects of biopolymers (15)

X-ray diffraction, electronic absorption & luminescence Spectroscopy, optical activity, magnetic activity, magnetic-optical activity. Osmosis, hydrophobic hydration and interactions. The properties of amino acids and their aqueous solutions.

UNIT – III: Photo biological Process (15)

Photosynthesis, mechanism of vision , the molecular mechanism of photoreceptor .

UNIT – IV: Mechano-chemical processes (15)

Introduction, thermodynamics, nerve conduction and membrane equilibria, muscle and muscle proteins, their chemistry and physics , kinetic properties of muscle, mechano- chemical systems , biomechanics.

REFERENCE BOOKS:

- 1) Biophysics by M.V. Volhenshfein.
- 2) Natural products : Chemistry & Biological Significance , J. Mann , R.S. Davidson, J. B. Hobb's , D. V. Banthrope and J. B. Harborne , Longmar Essex
- 3) Elements of Inorganic Photochemistry , G. J. Ferrandi , wiley
- 4) Principals of bioinorganic chemistry , S. J. Lippard and J. M. Beng , University Science Books,
- 5) Principals of biochemistry , A. L. Lehinger, worth publisher
- 6) Biochemistry , J. David Rawn , Neil Patterson
- 7) Hydrophobic interactions by Ben-Naim, Plenum.

M.Sc. Part-II (Sem-IV)

Physical Chemistry Practical Course PCH-VII and PCH-VIII

Spectroscopy:

- 1) Characterization of the complexes by electronic and IR spectral data.
- 2) Determination of indicator constant and isobestic point of an indicator.
- 3) Determination of stability constant of ferric thiocyanate complex.

Potentiometry:

Determination of E° value of Ag / AgI electrode and thisombility product of AgI and PbI_2 .

Conductometry:

- 1) Kinetic study of hydrolysis of ethyl acetate in presence of OH^- ions.

2) Determination of the critical micelle concentration of sodium lauryl sulphate in aqueous solution.

pH - Metry:

Determination of acid - base dissociation constants of an amino acids.

Polarography:

Determination of unknown concentration of Cd^{+2} / Zn^{+2} ion in the given solution by standard addition method.

Fluorimetry:

Estimation of quinine as quinine sulfate from medicinal tablets.

Cryoscopy:

Determination of mean activity coefficient of sulfate by freezing point depression method.

Kinetics:

Study of the effect of ionic strength on the reaction between persulphate and iodide by visual method.

Thermometry: Determination of normality of given HCl & $CuSO_4$ by thermometric titration.

Research project: External and internal examiners will examine the project (50 Marks) jointly at the time of practical examination

(Any other experiment may be added when required)

Study tour is compulsory for M.Sc. Part- II Students to visit Chemical Industries in India.

M.Sc. Part-II, (Sem-III and IV) Analytical Chemistry

SEMESTER- III

Paper No. ACH – IX : General Analytical Techniques
Paper No. ACH – X : Organo Analytical Chemistry
Paper No. ACH – XI : Electroanalytical Techniques in Chemical Analysis

ELECTIVE PAPERS

Paper No. ACH–XII (A) : Environmental chemical analysis and control
Paper No. ACH- XII (B) : Recent Advances in Analytical Chemistry

ELECTIVE CBCS PAPER

Paper No. ACH- XII : Chemical Analysis in Agro, Food and Pharmaceutical Industries

Practical Course : **ACH – V and ACH-VI**

SEMESTER- IV

Paper No. ACH – XIII : Modern Separation method in Analysis
Paper No. ACH – XIV : Organic Industrial Analysis
Paper No. ACH – XV : Advanced Methods in Chemical Analysis

ELECTIVE PAPERS

Paper No. ACH – XVI (A): Applied Analytical Chemistry

**Paper No. ACH – XVI (B): Techniques in Forensic sciences and
Microbiological Analysis**

Paper No. ACH – XVI (C): Computational Chemistry

Practical Course : ACH – VII and ACH-VIII

M.Sc. Part-II (Sem-III) Analytical Chemistry

Paper No. ACH -IX: GENERAL ANALYTICAL TECHNIQUES

UNIT-I: Theory of Volumetric and Gravimetric Analysis (15)

Standard solutions Indicators, theory of indicators , types of titrations, Acid , base , precipitation, Redox and complexometric titrations, Acid–base titrations in non-aqueous media , solvent characterization , living effect , applications of non –aqueous titrations , MnO₂ in pyrolusite, Na₂CO₃ + NaHCO₃ and NaOH + Na₂CO₃ Mixture analysis , Gravimetric Analysis purity of the precipitate – Co precipitation's and post Post precipitations , precipitation from homogenous solution , organic precipitation.

UNIT-II: Ion Exchange separation (15)

Theories of ion exchange , exchange capacity , screening effects, Penetrations of electrolytes in ion exchange resin , sorption of complex ions , ion exchange equilibria , column operation , theory of break through curve , elution steps , use of non aqueous solvents in ion – exchange separation. Separation of halides, Rare earths

UNIT-III: Solvent Extraction: Transition metal ions using ion exchanges. (15)

Basic principles, Classification of solvents extraction systems, Extraction equilibria, Factors affecting extraction process , application of B- diketones , δ -Hydroxyquinoline , dithiocarbamates , xanthenes , Thiols , separation of non metals and metals.

UNIT-IV: Thermal Methods of Analysis (15)

Effect of heat on Materials, Chemical decomposition and T. G. Curves, Analysis of T.G. curve to show nature decomposition reactions , the product and qualities of compounds expelled, applications, instrumentation , T.G. in controlled atmosphere DTA, instrumentation and Methodology, application, DSC, theory instrumentation and applications, Thermometric titrations method and applications.

Reference Books:

- 1) A. I. Vogel : A text book of Quantitative inorganic Analysis , Longmans. 2) O. Samuelson : Ion Exchange separation in analytical chemistry (John Wiley , 1963)
- 3) Y. Marcus and A. S. Kertes : Ion Exchange and solvent Extraction of metal complexes . (Wiley – interscience , 1969)
- 4) J. A. Marinsky and Y . Marcus : Ion exchange and solvent Extraction (Marcel Dekker, INC , New York , 1973)
- 5) G. H. Morrison and H, Freiser : Solvent Extraction in Analytical Chemistry (John Wiley New York, 1958)
- 6) A . K Da , S. M . Khopkar and R. A. Chalmers : solvents Extraction of metals (Von Nostrand Reinhold, 1970)
- 7) J. Stary , the solvent extraction of metals chelates (Pergamon)

8) Willard , Merrit and settle : Instrumental Methods of analysis.

Paper No. ACH -X: ORGANO ANALYTICAL CHEMISTRY

UNIT-I: Hyphenated Techniques (15)

Advanced techniques of analysis: UV-Visible, IR, ¹H-NMR (Recapitulation), ¹³CNMR, Mass spectrometry (advanced examples); Problems related to structure determination and applications of spectroscopic techniques as analytical tools.

UNIT-II : A) Drug Analysis (10)

Introduction to drugs, their classification, sources of impurities in pharmaceutical raw materials such as chemical, atmospheric and microbial contaminants etc. Limit tests: Limit test for impurities for Pb, As, Fe, Se, etc. Estimation of moisture (K-F method), halide (Schnoiger's oxygen flask method), sulfate, boron, etc. Analysis of commonly used drugs such as antihistamines, sulfa drugs, barbiturates, etc. using non-aqueous titrations, sodium nitrite titrations, differential UV methods, colorimetric and fluorimetric methods of analysis.

B) Analysis of vitamins (thiamine, ascorbic acid, Vit. A, Vit. B₆, Vit. K) and hormones (progesterone, oxytocin, insulin) chemical, instrumental and biological assay wherever applicable.

(05)

UNIT – III: A) Clinical Analysis (8)

Biological significance, analysis of assay of enzymes (pepsin, monoamine, oxidase, tyrosinase), Composition and detection of abnormal level of certain constituents leading to diagnosis of diseases. Sample collection and preservation of physiological fluids, analytical methods to the constituents of physiological fluids (blood, urine and serum). Blood - Estimation of glucose, cholesterol, urea, hemoglobin and bilirubin, Urine- urea, uric acid, creatinine, calcium, phosphate, sodium, potassium and chloride.

B) Body fluid analysis (7)

Composition and detection of abnormal level of certain constituents leading to diagnosis of diseases. Sample collection and preservation of physiological fluids, analytical methods to the constituents of physiological fluids (blood, urine and serum) Blood-Estimation of glucose, cholesterol, urea, hemoglobin and bilirubin Urine- urea, uric acid, creatinine, calcium, phosphate, sodium, potassium and chloride.

UNIT-IV: A) Pesticides Analysis (7)

Introduction, classification, analysis of DDT, gammexane, endosulphan, zinab, ziram, malathion, thiram, thiometon, simazine and chloridane. Applications of colorimetric and chromatographic techniques (GC-MS, HPLC-MS) in analysis of pesticide residue.

B) Forensic Analysis (8)

Special features of forensic analysis, sampling, sample storage, sample dissolution, classification of poisons, lethal dose, significance of LD-50 and LC-50. General discussion of poisons with special reference to mode of action of cyanide,

organophosphate and snake venom. Estimation of poisonous materials such as lead, mercury and arsenic in biological samples.

Reference Books:

1. F. J. Welcher: Standard methods of Chemical analysis, 6th Ed. Vol. I and II(D. Van Nostard Comp.)
2. I. M. Kolthoff: Treatise on Analytical Chemistry Vol. I & II
3. F. D. Snell: Encyclopedia of industrial Chemical Analysis Vol. 1 to 20 (John Wiley)
4. Riech: Outline of Industrial Chemistry.
5. K. H. Buchel: Chemistry of Pesticides (John Wiley)
6. Indian, Pharmacopoeia, British Pharmacopoeia and U. S. Pharmacopoeia.
7. V. M. Parikh: Absorption spectroscopy of organic molecules (Addison Wesley)
8. Willard, Merritt, Dean and Settle: Instrumental methods of analysis (CBS)
9. D. H. Williams and J. Fleming: Spectroscopic methods in organic chemistry (Mc Graw Hill)
10. Silverstein : Spectroscopic Identification of organic compounds (John Wiley)
11. Jackmann and Sternhill : Applications of NMR spectroscopy of organic Chemistry (Pergamon Press)
12. J. D. Roberts : Nuclear Magnetic Resonance (Mc Graw Hill)
13. K. Benjamin : Mass Spectrometry
14. Nichollas: Aids to the Analysis of foods and Drugs.
15. A. H. Beckett and J. B. Stanlake; Practical Pharmaceutical Chemistry Vol. I & II (CBS publishers)
16. S. Ranganna: Handbook of analysis and quality control for fruits and vegetable products (McGraw Hill)
17. Ramalu: Analysis of pesticides

Paper No. ACH -XI: ELECTROANALYTICAL TECHNIQUES IN CHEMICAL ANALYSIS

UNIT-I: Cyclic Voltammetry (10)

Introduction, Principle , instrumentation, digital simulation of cyclic Voltammograms, excitation signals in voltammetry, Determination of analytes using cyclic voltammetry, Pulse voltammetry, High frequency and High speed voltammetry , applications

Stripping voltammetry (05)

Electrodeposition step, voltammetric completion of the analysis, adsorptive stripping methods, voltammetry with microelectrodes.

UNIT –II: Dynamic light scattering (DLS) technique (15)

Introduction, Principle, Instrumentation, sample cell and sample handling, settling velocity and particle size, Stokes equation, Particle size distribution analysis and applications.

UNIT-III: Coulometry (15)

Introduction: Theory and instrumentation, current voltage relationship, controlled potential Coulometry, types of coulometric methods, coulometric titration,

and applications.

UNIT –IV: A) Ion selective electrodes (10)

Terminology, types and construction of electrodes, glass electrode, solid state and precipitate electrodes, liquid – liquid membrane electrodes, enzyme and gas electrodes, and applications.

B) Electrophoresis (05)

Introduction: paper electrophoresis: Technique, factors affecting migration of ions, capillary and zone electrophoresis and applications.

Reference Books:

1. R.D. Braum, Introduction to Instrumental Analysis.
2. D.A.Skoog, F. J. Holler, Principles of Instrumental Analysis, 6th edition.
2. Willard, Deritt, Dean and Settle, Instrumental methods of Analysis.
3. F. J. Welcher, Standard Methods of chemical Analysis Vol.3, Part A & B.
4. G.W. Ewing, Instrumental Methods of Analysis 4th and 5th editions.
5. Chatawal and Anand, Instrumental Methods of Analysis.
6. Bassett, Denney-Jeffery and Mendham, Vogel's Textbook of Quantitative Inorganic Analysis, (5th edition).
7. Electro-analytical chemistry, edited by H.W. Nurnberg.
8. Stulic, Ion selective electrodes (John Wiley).

ELECTIVE PAPERS

Paper No. ACH–XIIA: ENVIRONMENTAL CHEMICAL ANALYSIS AND CONTROL

UNIT-I: Sampling in analysis

(15)

Definition, theory and techniques of sampling, sampling of gas, liquids and solids, Criteria of Good sampling, Minimization of Variables, transmission and storage of samples, high pressure ashing techniques (HPAT), particulate matter, its separation in gas stream, Filtering and gravity separation. Analysis of particulate matter like asbestos, mica, dust and aerosols etc

UNIT-II: Electrochemical and spectral methods Environmental analysis

(15)

Introduction to instrumental techniques, principle instrumentation and applications with respect to environmental analysis of Conductometry, Potentiometry, Ion selective electrodes, Cyclic voltammetry, Amperometry, Coulometry, Atomic absorption spectrometry, Atomic fluorescence spectrometry, Inductively coupled plasma spectrometry, Turbidimetry, Non Dispersive Infrared Analysis (NDIR).

UNIT-III: Air and Water Pollutant Analysis

(15)

Chemistry of Air pollutants, Characterization. Source, methods of analysis of air pollutants; CO, CO₂, NO_x, NH₃, H₂S, SO₂ etc. Monitoring Instruments, Potable and Industrial water, major and minor components, dissolved oxygen (DO) Chemical oxygen demand (COD) Biochemical oxygen demand (BOD) and their measurements. Analysis of Pb, Cd, Hg, Cr, As and their physiological manifestations. Quality of industrial waste water analysis for organic and inorganic constituents. Chemistry of odour and its measurements.

UNIT-IV: Organic Pollutants and Their Analysis (15)

Sources, disposal, treatment and analysis of phenolic residues, methods of recovery of phenols from liquid effluents, Organomercurials and its analysis, Analysis of organochlorine pesticides, volatile organic pollutants and their analysis

Recommended books:

1. A.K. De : Standard Methods of Waste and Waste water analysis.
2. P. M. S. Monk Fundamentals of Electroanalytical chemistry-John Wiley & sons(2001)
3. Instrumental methods of chemical analysis H. Kaur
- 4 S.M. Khopkar, Environmental Chemistry ; Environmental pollution analysis
5. M.S. Creos and Morr, Environmental Chemical Analysis, American publication(1988)
6. A.K. De, Environmental Chemistry, New Age International publishers.Moghe and
7. Ramteke, Water and waste water analysis : (NEERI)
8. A.C. Stern, Air pollution: Engineering control vol.IV(AP)
9. P.N.Cheremisinoff and R.A.Young, Air Pollution control and Design.Hand Book Vol.I&II (Dekker)
10. R.B.Pohasek, Toxic and Hazardous waste disposal, Vol.I&II (AAS)
11. M.Sitting, Resources Recovery and Recycling, Handbook of industrial Waste.
12. B.K.Sharma, Industrial Chemistry.
13. S.P.Mahajan, Pollution Control in Process Industries.
14. R.A.Horne, Chemistry of our Environment.

Paper No. ACH- XIIB: RECENT ADVANCES IN ANALYTICAL CHEMISTRY

UNIT-I: Ultra Purity and Ultra trace Analysis

(15)

Ultra purity and ultra trace analysis, laboratory dosing, purification of reagents, Preconcentration Techniques, Methods of trace analysis such as NAA, XRF, AAS and ICP, High purity materials for electronic industry, contamination control during analytical operations.

UNIT-II: Radio-analytical Chemistry (15)

Separation methods, Precipitation, solvent extraction and chromatographic methods. Activation analysis, basic principles, fast neutron activation analysis, radiochemical methods in activation analysis, Applications if Geo-chemistry, oxygen in metals. Isotope dilution analysis: Principles and applications. Sub-stoichiometric determination of traces of metals: Principles, techniques and experimental methods in the determination of As, Pb and Hg.

UNIT-III: Advanced Techniques in Analysis (15)

C^{13} , P^{15} and O^{17} NMR Spectroscopy applications.

UNIT-IV: Electron Spin Resonance Spectroscopy

(15)

Electron behavior, ESR spectrometer, Spectra, Hyperfine interaction, free radical and interpretation of the spectra, Applications in quantitative analysis. Numerical problems.

Recommended Books:

1. Garen W. Ewing, Analytical Instrumentation, Handbook, Marcel Dekker Inc. (1997).
2. Mereitt, Dean, Settel, Instrumental methods of Chemical Analysis.
3. M. Zeif and J.W.Mitchell, Contamination Control in trace elemental analysis.
4. Ajuja, Ultrapurity.
5. Minczewski, Chwastowska and Dycozynski, Separation and pre-concentration methods in Inorganic trace analysis. Ellis Haward.
6. Cali, trace Analysis of semiconductor Materials Pergamon.
7. Overman and Cleark, Radioisotopes techniques MGH.
8. Tolgyessy, Brown and Kyrs, Isotope dilution analysis.
9. Leniham and Thomson, Activation Analysis(AP)
10. Ruzica and Sary, Substopchiometry in Radiochemical Analysis. Pergamon.
11. Ladd and Lee, Radiochemistry.
12. Clerk, Handbook of Radiochemical methods
13. Price, Nuclear radiation detections.

ELECTIVE CBCS PAPER

Paper No. ACH- XII: CHEMICAL ANALYSIS IN AGRO, FOOD AND PHARMACEUTICAL INDUSTRIES.

UNIT – I: Analysis of soil, Fuel, Body Fluids and Drugs (15)

Analysis of soil: Moisture, pH, total nitrogen, phosphorous, silica, lime, Magnesia, Manganese, sulfur & alkali salts. Food analysis: Solid, liquid and Gas , ultimate and proximate analysis heating values , grading of coal , liquid fuels , flash points , aniline point , octane number and carbon residue , gaseous fuels – producer gas and water gas – calorific value.

UNIT-II: Clinical Chemistry (15)

Composition of blood collection, and preparation of samples, clinical analysis – serum electrolytes, blood glucose, blood urea nitrogen , uric acid , albumin , globulin , barbiturates , acidic and alkaline phosphates , Immunoassay , principals of radioimmunoassay, and applications . The blood gas analysis – trace elements in the body. Drug analysis: Narcotics and dangerous drugs, classification of drugs, screening by gas m thin layer chromatography and spectrophotometric analysis.

UNIT – III: Food analysis (15)

Moisture, ash, crude protein, fat, crude fiber, carbohydrate, calcium, potassium, sodium, and phosphates, food adulteration – common adulteration in food, contamination of food stuffs, microscopic examination of foods for adulterants, Pesticide analysis in food products, Extraction and purification of sample, HPLC, gas chromatography for organo – phosphates, thin layer chromatography for identification of chlorinated pesticides in food products

UNIT –IV: Fluorescence in Biological, Medical and Drug Development (15)

Fluorescence instrumentation for analysis, fluorescence and their modification, pH-indicators, membrane potential probes, lipid membrane protein labeling of protein and DNA.

Recommended Books:

1. Fundamentals of analytical chemistry by D. A. Skuog , D. M. West and F. J. Honer, W. B. Saunders.
2. Chromic phenomenon , The Technological application of color chemistry Peter Bamfield . Practical Course

M.Sc. Part-II (Sem-III)

Analytical Chemistry Practical Course ACH-V and ACH-VI

List of Experiments:

1. Determination of Al/Mg 8-Hydroxyquinoline as complexing agents by spectrophotometric method.
2. Analysis of Pyrolusite ore with respect to Acid insoluble residue, Iron and $MgCl_2$.
3. Analysis of bauxite with respect to silica, Aluminium and Iron.
4. Analysis of Cupronickel(monel metal) alloy for copper and Cickel content.
5. Fertilizer analysis for N,P,K.
6. Estimation of Na, K and Li individually by Flame Photometry.
7. Determination of sulphate by Turbidimetry.
8. Estimation of nitrogen,oxygen and Carbon dioxide in mixture by Orsat apparatus.
9. Analysis of iodized table salt.
10. Analysis of soda ash.
11. XRD and Thermal analysis Kaolinite, cobalt oxalate and zinc oxalate.
12. Analysis of glass and fluxes.
13. Estimation of hydroxy group by acetylation.
14. Analysis of vitamin A in food products.
15. Analysis of vitamin C in juices and squashes.
16. Determination of sap value and iodine value of an oil.
17. Estimation of the purity of a given azo dye by colorimetry.
18. Analysis of Lindane in BHC powder.
19. Analysis of malathion by colorimetry.
20. Determination of moisture in pharmaceuticals.
21. Estimation of nitrite in meat colorimetrically.
22. Estimation of mercury in skin ointment.
23. Chemical analysis of chill/turmeric powder.
24. Kjeldahl's method of protein estimation in foods and feeds.
25. Determination of strength of acetic acid I commercial vinegar by conductometric method.
26. Determination of pK value of an indicator.
27. Photometric titration of Ca and Mg with EDTA.
28. Simultaneous estimation of Cl and I by potentiometric method.
29. Estimation of bicarbonate and carbonate by potentiometric method.
30. Estimation of Fe by ceric sulphate and potassium dichromate titration potentiometrically.
31. Polarographic estimation of traces of Cu, Cd, Ni, Zn and Fe in sample solution.
32. Electrogravimetric estimation of copper in solution.
33. Coulometry: Coulometric determination of simple ions.
34. Identification of organic compounds by their IR spectra.
35. Determination of chloride and sulphate with an adsorption indicator.
36. Estimation of vitamin B2 in the medicinal tablets fluorimetrically.
37. Kinetic study of hydrolysis of ethyl acetate in presence of OH⁻ ions

- conductometrically.
38. Determination of normality of given HCl and CuSO₄ thermometrically.
 39. Determination of pK of given dibasic acid pH-metrically.
 40. Determination of concentration of Fe ion in ferric salicylate complex spectrophotometrically.
 41. Any other suitable experiment may be added when required.

M.Sc. Part-II (Sem-IV) Analytical Chemistry

Paper No. ACH-XIII: MODERN SEPARATION METHODS IN ANALYSIS

UNIT-I: Gas Chromatography (15)

Principles, Plate theory, Instrumentation and working of a Gas Chromatograph, Detectors, programmed, temperature G.C., Applications.

UNIT-II: High Performance Liquid Chromatography (15)

Principles, Instrumentation, Stationary support in HPLC, Applications, Super Critical Fluid Chromatography (SCFC), Characteristics, Instrumentation and Applications. Comparison of HPLC and GLC with SCFC.

UNIT-III: Ion Chromatography

(15) Principles, Structure and characteristics of resins, eluent, suppressor columns and detectors used in Ion Chromatography, analytical applications, environmental speciation by Ion Chromatography.

UNIT –IV: Extractive Chromatographic Separations (15)

Introduction, Theoretical aspects of extraction chromatography, solvent extraction and extraction chromatography with chelating ligands, extraction chromatography by ion pair formation, extraction chromatography by solvation, extraction equilibria, nature of stationary phase in extraction chromatography, inert support, techniques in extraction chromatography, extraction chromatography with tributyl phosphate and other applications.

Recommended Books:

1. A.I.Vogel, a text Book of Quantitative Inorganic Analysis.
2. W H Willard, L L Merritt and J A Dean, Instrumental Methods of Analysis.
3. S. M.Khopkar, Basic Concepts in Analytical Chemistry.
4. L.R. Shnyder and C.H.Harvath, An Introduction to separation Science. Wiley Interscience.
5. James S Fritz and George H.Schenk Jr. Quantitative Analytical Chemistry, 2nd editions Allyn and Bacon Inc. Boston.
6. J.G.Dick, Analytical Chemistry.
7. R.L.Pescok and L.D.Shield, Modern Methods of Chemical Analysis.

Paper No. ACH-XIV: ORGANIC INDUSTRIAL ANALYSIS

UNIT – I: Analysis of oils, fats and Soaps (08)

A) Introduction to natural fats and oils; Isolation of oils from natural resources and their purification. Analysis of oils and fats: Softening point, Congeal point, Titre point, Cloud point, Iodine, saponification, acid, hydroxyl, R-M and Polenske value, Elaiden test, etc.

Introduction to soaps, manufacture of soaps (in brief), analysis of soaps: total anhydrous soap and combined alkali, potassium, water, free fatty acids, saponifiable and non-saponifiable matter in soaps, estimation of phenol, copper and germicidal agents in soaps, determination of inorganic fillers and soap builders, and other additives, estimation of soap in detergents (THAM method)

B) Analysis of Detergents: (7)

Classification of detergents, analysis of raw materials, separation as alcohol soluble and alcohol insoluble matter, additives in detergent formulation (chlorides, sulfates, phosphates, silicates, borates, oxygen releasing substances, CMC, EDTA, etc.), their role and analysis; analysis of active ingredients in detergents (methylene blue and Hyamine-1622 method).

UNIT – II: Food Analysis

A) Food flavors, food colors, food preservatives, analysis of milk and milk products, adulterants in milk and their identification, analysis of honey, jam and their major component, (08)

B) Additives in animal food stuffing: Antibiotics: penicillin, chlorotetracyclin, oxytetracyclin in diet supplements; Identification and estimation of prophylactic and growth promoting drugs such as. Sulfaquinoxaline, methyl benzoate, sulfanilamide, pyrimethamine, nitrovin, nitrofurazone, acinitrazole, etc. (07)

UNIT-III: Analysis of cosmetics, hair dyes and hair care products

A) Composition of creams and lotions (08)

Determination of water, propylene glycol, non-volatile matter and ash content; Estimation of borates, carbonates, sulphates, phosphates, chlorides, ammonia, nitromethane, oxalic acid, 4- hydroxy benzoic acid, sodium iodate, free formaldehyde, H₂O₂, mercatoacetic acid, titanium and zinc oxides.

B) Analysis of face powder (07)

Composition of face powder, Estimation of boric acid, Mg, Ca, Zn, Fe, Al and Ba. Analysis of deodorants and antiperspirants-composition, analysis of fats and fatty acids, boric acid, magnesium, calcium, zinc, iron, titanium, aluminium, phenol, methanamine, hexachlorophenone, sulphonates, urea, etc.

UNIT-IV: Analysis of Paints, pigments and petroleum products

A) Preliminary inspection of sample (08)

Test on the total coating; separation and estimation of pigments, binder and thinner of latex paints; Modification of binder, Flash point of paints,

(B) Analysis of petroleum products (07)

Introduction, constituents and petroleum fractionation, quality control; - specific gravity, viscosity, Cloud point, pour point, flash point, vapor pressure, Doctor

test, sulphuric acid absorption, aniline point, and colour détermination, cloud point, pour point. Determination of water, neutralization value (acid and base numbers), ash content, sulphur and mercaptan sulphur. Determination of lead in petroleum; Analysis of coal and coke: Types, composition, preparation of sample, proximate and ultimate analysis calorific value by Bomb Colorimetry.

Reference Books:

1. S. R. Junk and H. M. Pancoast: Hand book of sugars(AVI)
2. B. Bilot and B. V. Well: Perfumary technology (JW)
3. I. M. Kolthoff: Treatise on Analytical Chemistry Vol. I and II
4. D. Pearson: Laboratory techniques in food analysis.
5. S. Ranganna: Handbook of Analysis and Quality control for fruits and vegetable products, 2nd Ed.(Mc Graw Hill.)
6. Nicholls : Aids to the analysis of foods and drugs.
7. G. J. Mountrey: Poultry product technology (AVI)
8. Karamer Twig: Quality control for food industry (AVI)
9. G. F. Longonan: the analysis of detergents and detergent products (JW)
10. A. Davidsohn & B. M. Mlwidaky : Synthetic detergents (Book center, Mumbai)
11. M. Ash and L. Ash: A formulary of cosmetic preparations. (G. Goodwin)
12. Kurl Bauer, Dorothea Garhe, Horst Surburg: Common fregrance and flavour materials, (VCH publisher, New York)
13. F. J. Welcher: Standard Methods of Chemical analysis Vol I & II (6th Ed.)
14. S. N. Mahendru: Analysis of food products (Swan Publishers)

Paper No. ACH – XV: ADVANCED METHODS IN CHEMICAL ANALYSIS

UNIT – I: Fluorescence and Phosphorescence Spectrophotometry (15)

Structural factors, photoluminescence intensity as related to the concentration, instrumentation, Fluorescence quenching mechanism, types of quenching, FRET, Applications, problems.

UNIT-II: Kinetic Methods (15)

Theoretical basis of kinetic methods of analysis, methods of determining amount of the substance, Tangent Method, Fixed Time and Concentration method. Addition Method, Oxidation Reactions of H₂O₂ with thiosulphate, iodide and amino, Enzyme catalyzed reactions. Inhibitors and Activators.

UNIT – III: Photoelectron spectroscopy (15)

Basic principles, photoelectric effects, Photoionization process, Koopman's theorem, photoelectron spectra of simple molecules, ESCA, chemical shift, Auger electron spectroscopy – basic idea.

UNIT – IV: X – ray spectroscopy (15)

. Introduction, X-Ray generation, Properties of X-radiation, X-Ray Instrumentation, X-Ray Absorption, Fluorescence and Diffraction methods of analysis and their applications

Recommended Books:

1. Gary D Christian, Analytical chemistry 6th edition. John Willey and sons INC (2003) H.
2. Kaur, Instrumental Methods of Chemical Analysis. Pragati Prakashan, Meerut.
3. W H Willard, L L Merritt and J A Dean, Instrumental Methods of Analysis.
4. S. M. Khopkar, Basic Concepts in Analytical Chemistry.
5. D. Skoog and D. West, Principle of Instrumental Analysis. Holl Seamlers.
6. E. Berlin, Principles and Practice of X-Ray Spectrometric Analysis, Plenum, New York.
7. J. Winefordner, S. Schulman and T O Haver : Luminescence Spectrometry in Analytical Chemistry. Wiley Interscience New York.
8. H. Mark and G Rachnitz, Kinetics in Analytical chemistry. Interscience NY.
9. Gary D Christian, Analytical chemistry 6th edition. John Willey and sons INC (2003)
10. Engineering chemistry, R Gopalan, G. S. nagrajan.
11. Engineering chemistry B. K. Sharma

ELECTIVE PAPERS

Paper No. ACH-XVIA: APPLIED ANALYTICAL CHEMISTRY

UNIT-I: Spectrochemical Methods of Analysis (15)

Introduction to spectrochemical methods. Electronic spectra and molecular structure, NIR spectrometry for nondestructive testing. Solvents for spectrometry, FTIR spectrometer, fluorometry, optical sensors. Analysis of ores – bauxites, dolomites, monazites. Analysis of Portland cement.

UNIT-II: Analysis of metals and alloys (15)

Foundry materials, ferroalloys, and special steels, slags, fluxes. Analysis of alloys, bronze, brass, Alnico and Nichrom

UNIT-III: Analysis of soil and fertilizers (15)

Method of soil analysis, soil fertility its determination, determination of inorganic constituents of plant materials, Chemical analysis as measure of soil fertility, analysis of fertilizers.

UNIT-IV: Analysis of Commercial materials (15)

Analysis of explosive materials, TNT, RDX, lead azide, EDNA (ethylene dinitramine). Analysis of conducting polymer, resins and rubber. Analysis of luminescent paints, Analysis of lubricants and adhesive.

Recommended Books:

1. Hillebrand Lhundel, Bright and Hoffman, Applied Inorganic Analysis, John Wiley.
2. Snell and Biffen, Commercial Methods of Analysis.
3. P.G. Jeffery, Chemical Methods of Rock Analysis, Pergamon.
4. Buchel, Chemistry of Pesticides. J Wiley.
5. Rieche, Outlines of Industrial Organic Chemistry, ButterWorth.
6. F.A. Henglein, Chemical Technology, Pergamon.
7. Kent, Riegl's Industrial Chemistry, Rainhold.
8. Chopra and Kanwar, Analytical Agriculture Chemistry, Kalyani Publishers.
9. Aubert and Pintes, Trace Elements in Soils.

10. Bear, Chemistry of Soil.
11. Hauson, Plant Growth Regulators, Noyes.
12. P.G.Jeffery and D.J. Hatchinson, Chemical Methods of Rock Analysis.
13. F.J.Weleher, Standard Methods of Chemical Analysis, A Series of Volumes Robert and Krigegeer Publishing Company.
14. I. M.Kolthoff and PJ Ewing, Treatise o Analytical Chemistry, A series of Volumes.
15. R.D. Reeves and R.R. Brooks, Trace element Analysisof Geological Materials, John Wiley & Sons NewDehli.
16. W.M. Johnson and J.A.Maxwell,Rock and Mineral Analysis, John Wiley and Sons, NewYork.
17. W.F.Hildebrand, G H C Landell and HABrighot, Applied Inorganic Analysis, John Wiley 2nd Edition.
18. K.J.Das, Pesticide Analysis(MD).

**Paper No. ACH-XVIB: TECHNIQUES IN FORENSIC SCIENCE
AND**

MICROBIOLOGICAL ANALYSIS

UNIT-I: Forensic Analysis (15)

Special features of Forensic analysis, sampling, sample storage, sample dissolution classification of poisons, Lethal dose, significance of LD 50 and LC 50.

UNIT-II: Identification and Analysis in the suspects (15)

Poisonous elements viz As, Sb, Pb, Cr and Hg.

i) Insecticides Analysis of metals, Gun powder Residues, portland cement in Forensic samples.

ii) Poisoning due to cyanide dioxines & asbestos.

iii) Physiological effects of natural poisons such as Col Chicine, Morphine, Hashish ,Nicotinoids.

iv) Health hazards and Remedial measures.

UNIT-III: Analytical Microbiology (15)

Morphological structure and characteristics nutrition and physiology, classification of microorganisms, Taxonomy and nomenclature Nutritional requirements Phathoseas and Spoilage organics Microscopy, Staining techniques, Aspatic Techniques, isolation and use of differential media, sterilization and disinfection.

UNIT-IV: Applied Microbiology (15)

Air Microbiology with respect contamination control, Food Microbiology, Water microbiology, Industrial microbiology with respect to quality control.

Recommended Books:

1. Allan Cury,Irvins Sunshine,Forensic Analysis, Academic Press Publications.
2. E.G.J.Clarics, Isolation and Identification of drugs, Pharmaceutical Press.
3. C.J.Creswell, C.A.Runquist and M.M.Campbell, Spectral Analysis of Organic Compounds.
4. F.J.Welcher, Robert E,Standard Methods of Chemical Analysis, A series of volumes.
5. Hawk's Physiological Chemistry.
6. D.J.Holme and H. Pack, Analytical Biochemistry, Longman.
7. G. Keleti and W H Liederer, Hand book of micro methods for the biological science-

VNR.

8. C H Collins, Microbiological Methods, Butterworths.

Paper No. ACH -XVIC: COMPUTATIONAL CHEMISTRY

UNIT-I: A) Fortran/C:

Programming and numerical method feature of fortran C : Basic theory (08)

A) Solution of equation: Bisection, regular tabs, Newton – Raphion and related method for solving polynomial and trancended equation, convergence. errors and ill – containing.

B) Liner simultaneous equation : Gaussion alimination , Gauss – seidel method , Gauss jorden method . Fivolting strategy, errors and ill - ----- (07)

UNIT-II: Numerical Differentiation (15)

Solution of simple differential equation by Tegler seies and Rurge – Kutta methods. Newton – coted formulae, Romberg integration , errors in integration formulae .

UNIT – III: Internet (15)

Introduction to networking and search using Internet.

UNIT– IV: Running of advanced scientific packages. Project (15)

The student will develop utilities such as analysis of spectra, simulation programs which will supplement laboratory of theory exercises in Physical, Organic, Inorganic or Analytical chemistry.

Recommended Books:

1. Computational Chemistry, A.C.Norris, John Wiley.
2. Computer Programming in FORTRAN 77, Rajaraman, Prentice Hall.
3. Numerical Analysis, C.E.Frogberg, Macmillan.
4. Numerical Analysis, A Practical Approach, M.J. Maron, John Wiley.
5. Numerical Methods for Scientists and Engineers, H.M.Anita, Tata McGraw Hill.
6. Computers in Chemistry, K.V. Raman

M.Sc. Part-II (Sem-IV)

Analytical Chemistry Practical Course ACH-VII and ACH -VIII

List of Experiments

1. Standardization of perchloric acid by nonaqueous titrations.
2. Estimation of calcium from chalk.
3. Colorimetric and spectrophotometric determination of manganese insteel.
4. Statistical Revaluation of spectrophotometric data.
5. Estimation of N-methyl and c-methyl groups.
6. Determination of total salts by cation exchange.
7. Anion exchange separation of Iron, cobalt and nickel.
8. Solvent extraction separation of iron from marncrike using diethyl ether and their determination by titrimetrically.
9. Estimation of amount of copper(II) with EDTA spectrophotometrically.
10. To study the complex formation between Fe(III) and salicylic acid and determine the stability constants of the complex by Job's variation method.

11. Calculation of standard deviation from the results obtained by redox titration of Fe(III) against standard solution of $K_2Cr_2O_7$.
12. Simultaneous spectrophotometric determination of Cr and Mn and Ti and V.
13. Analysis of chrome steel alloy for chromium and nickel content.
14. Agricultural analysis of, Soil sample, animal feeds, soil micronutrients, milk powder for Ca, Fe and P content.
15. Estimation of sulphadiazine/ sulphonamide.
16. Estimation of sodium benzoate/sodium metabisulphite, boric acid and salicylic acid in food.
17. Analysis of Ferrosilicon and Ferrovandium.
18. Estimation of Ibuprofen/Paracetamol in a pharmaceutical sample.
19. Solvent separation of U(VI) from Mg(II) by oxine.
20. Experiments on chromatography such as quantitative determination of methanol Ethanol.
21. Estimation of Aluminium in steels by Rludrescence Method.
22. Determination of sovalrility product of $AgCl$ and Ag_2CrO_4
23. Analysis of Felspar ore.
24. Analysis of Rocks (Available in this region)
25. Estimation of Zinc, Managanese in moisture by direct campleometric method at controled Ph.
26. Chromatographic separation of sugars ,amino acids by paper, T. L. C. and Ion exchange methods (both qualitative and quantitative method) separation organic compounds by column chromatograpy.
27. Analysis of milk.
28. Analysis of some common pesticides, insecticides , plastics and detergents.
29. Estimation of Urea, Uric acid and creathinine in Urine.
30. Estimation of blood sugar, calcium ,and total nitrogen and non-protien nitrogen in blood.
31. Determination of dissociation constant of weak acid pH-metrically.
32. Estimation of B_2 fluorimetrically.
33. Estimation of Zn in the given solution fluorimetrically.
34. Determination o f pK 's of tribasic acid, by potentiometry.
35. Latent heat of fusion of solid naphthalene.

36. Conductometry;

- a) Determination of critical micellae concentration of given surfactants.
- b) Estimation of acetyl salicylic acid in given aspirin tablet by titration against alkali.

37. Potentiometry:

Determination of dissociation constant of Cu-ammonia complex potentiometrically. And Estimation of acetyl salicylic acid in the given aspirin tablet by titrating against 0.1N alcoholic KOH potentiometrically.

38. Polarography:

Determination of concentration of given solution by std addition method polarographically.

39. Amperometry:

To determine the stength of lead nitrate by titrating against std. $K_2Cr_2O_7$ solution amperometrically.

40. pH-metry

Determination of hydrolysis constant of aniline hydrochloride pH-metriclly To determine the acid base dissociation constant and isoelectric point of aminoacid pHmetrically

41. Spectrophotometry-

Determination of an indicator constant and isobestic point of an indicator

Spectrophotometrically and Determination of stability constant of ferric thiocyanate complex spectrophotometrically.

42.Kinetics :

To determine the thermodynamic parameters such as Free Energy, Heat Content, Change in Entropy for formation of Zinc amalgam at 298K by emf measurement.

B) Project:

Literature survey, synthesis, Reaction mechanism and Kinetics, Analysis of air, Water and soil samples, solid state materials, organometallic, Bioinorganic materials, This Project/Review work (50 Marks) will be examined jointly by internal and external examiners at the time of practical examination.

(Any other experiments may be added when required.)

Study tour is compulsory for M.Sc. Part- II Students to visit Chemical Industries in India.

SHIVAJI UNIVERSITY, KOLHAPUR

DEPARTMENT OF CHEMISTRY

A Course under Choice Based Credit System (CBCS)

(Following points (minimum) should be covered while designing the CBCS course)

1. Course Code: (To be allotted by the system):-----
2. Title of the course: **SOLID STATE CHEMISTRY (Paper No. PCH-XII)**

3. Department at which course will be conducted: **Department of Chemistry**
4. Duration: **15 weeks**
5. Contact Session: Theory-60 hours and Practical(if applicable):-----hours
6. Credits: **04 credits**

(01 credit for 15 theory hours and 01 credit for 12 Practical hours per week)

7. Course Coordinator/Instructor: **Dr. K. M. Garadkar**
8. Eligibility: M.Sc. Part-I completed
9. Intake: Min: (10) Max: (20)
10. Course offered during: **Odd semester (semester-III)**
11. Course Fee: **Rs. 3000/-**
12. Course content: Unit-I, Unit-II, Unit-III and Unit-IV of 15 hours each.
13. Examination: (Method and Details): Examination to be conducted along with semester-III Examination of 80 Marks (Question No.-1 Objective and Compulsory, two Questions from Question No.02-04 and two Questions from Question No. 05-07. Five questions are to be attempted. Each question carries 16 Marks. The examination will be of three hours duration) and 20 Marks for internal test.

14. Text Book/Reference: .

1. A guide to laser in chemistry by Gerald R., Van Hecke, Keny K. Karokitis
2. Principals of solid state, H. V. Keer, Wiley Eastern,
3. Solid state chemistry, N. B. Hannay
4. Solid state chemistry , D. K. Chakrabarty , New Age International
5. An Introduction to Crystallography : F. G. Philips
6. Crystal Structure Analysis: M. J. Buerger
7. The Structure and properties of materials:
Vol. III Electronic properties by John Walss
8. Electronic processes in materials : L. U. Azroff and J. J. Brophy
9. Chemistry of imperfect crystal : F. A. Krogen
10. Elements of X-ray Diffraction by B. D. Cullity, Addison- Weily.
11. Solid state Chemistry by A.R.West (Plenum)
12. Electronics made simple by Jacobwitz.
13. Principles of Physical Metallurgy, by Abhijeet Mallick,
14. Solid State Chemistry, An Introduction, by Lesley E. Smart, & Elaine A. Moore,
Third Edition, Taylor & Francis, Indian Edition 2012.

SHIVAJI UNIVERSITY, KOLHAPUR

DEPARTMENT OF CHEMISTRY

A Course under Choice Based Credit System (CBCS)

(Following points (minimum) should be covered while designing the CBCS course)

1. Course Code: (To be allotted by the system):-----
2. Title of the course: **CHEMICAL ANALYSIS IN AGRO, FOOD AND PHARMACEUTICAL INDUSTRIES.**(Paper No. ACH-XII)
3. Department at which course will be conducted: **Department of Chemistry**
4. Duration: **15 weeks**
5. Contact Session: Theory-60 hours and Practical(if applicable):-----hours
6. Credits: **04 credits**
(01 credit for 15 theory hours and 01 credit for 12 Practical hours per week)
7. Course Coordinator/Instructor: **Dr. (Mrs). R. S. Salunkhe**
8. Eligibility: M.Sc. Part-I completed
9. Intake: Min: **(10)** Max: **(20)**
10. Course offered during: **Odd semester (semester-III)**
11. Course Fee: **Rs. 3000/-**
12. Course content: Unit-I, Unit-II, Unit-III and Unit-IV of 15 hours each.
13. Examination: (Method and Details): Examination to be conducted along with semester-III Examination of 80 Marks (Question No.-1 Objective and Compulsory, two Questions from Question No.02-04 and two Questions from Question No. 05-07. Five questions are to be attempted. Each question carries 16 Marks. The examination will be of three hours duration) and 20 Marks for internal test.

14. Text Book/Reference:

1. Fundamentals of analytical chemistry by D. A. Skuog , D. M. West and F. J. Honer, W. B. Saunders.
2. Chromic phenomenon , The Technological application of color chemistry Peter Bamfield . Practical Course

SHIVAJI UNIVERSITY, KOLHAPUR

DEPARTMENT OF CHEMISTRY

A Course under Choice Based Credit System (CBCS)

(Following points (minimum) should be covered while designing the CBCS course)

1. Course Code: (To be allotted by the system):-----
2. Title of the course: **APPLIED BIOINORGANIC CHEMISTRY**
(Paper No. ICH-XVI)
3. Department at which course will be conducted: **Department of Chemistry**
4. Duration: **15 weeks**
5. Contact Session: Theory-60 hours and Practical(if applicable):-----hours
6. Credits: **04 credits**
(01 credit for 15 theory hours and 01 credit for 12 Practical hours per week)
7. Course Coordinator/Instructor: **Dr. S. S. Kolekar**
8. Eligibility: M.Sc. Part-I completed
9. Intake: Min: **(10)** Max: **(20)**
10. Course offered during: **Even** semester (semester-IV)
11. Course Fee: **Rs. 3000/-**
12. Course content: Unit-I, Unit-II, Unit-III and Unit-IV of 15 hours each.
13. Examination: (Method and Details): Examination to be conducted along with semester-III Examination of 80 Marks (Question No.-1 Objective and Compulsory, two Questions from Question No.02-04 and two Questions from Question No. 05-07. Five questions are to be attempted. Each question carries 16 Marks. The examination will be of three hours duration) and 20 Marks for internal test.
14. **Text Book/Reference:**
 1. D. F. Shriver, P. W. Atkins and C. H. Langford, Inorganic Chemistry, Oxford Univ. Press, 1990.
 2. J. E. Huheey, E. A. Keiter and R.L. Keiter Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education, 2004.
 3. F. A. Carey G. Wilkinson, C. A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, Wiley Interscience, 2003.
 4. C. E. Housecroft and A. G. Sharpe, Inorganic Chemistry, Prentice Hall, 2005.
 5. S. J. Lippard and J. M. Berg, Principles of Bioinorganic Chemistry, Univ. Science Books, 1994.
 6. W. Kaim and B. Schwederski, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life (An introduction and Guide), John Wiley & Sons, 1994.
 7. Eichhorn: Inorganic Biochemistry : Vol I , 2 Elsevier
 8. Ochiai: Bioinorganic Chemistry: Allyn & Bacon Burton
 9. Williams: an Introduction to Bioinorganic Chemistry, C.C. Thomos Spring III

10. Wallace: Decade on synthetic chelating agent in Inorganic plant nutrition, Wallace
11. Williams: Metals in Life
12. Zagic: Microbial Biogeochemistry, Academic press
13. Ahuja: Chemical Analysis of the Environment, Plenum press.

SHIVAJI UNIVERSITY, KOLHAPUR

DEPARTMENT OF CHEMISTRY

A Course under Choice Based Credit System (CBCS)

(Following points (minimum) should be covered while designing the CBCS course)

1. Course Code: (To be allotted by the system):-----
2. Title of the course: **Bioorganic Chemistry (Paper No. OCH-XVI)**
3. Department at which course will be conducted: **Department of Chemistry**
4. Duration: **15 weeks**
5. Contact Session: Theory-60 hours and Practical(if applicable):-----hours
6. Credits: **04 credits**
(01 credit for 15 theory hours and 01 credit for 12 Practical hours per week)
7. Course Coordinator/Instructor: Prof. **U. V. Desai**
8. Eligibility: M.Sc. Part-I completed
9. Intake: Min: **(10)** Max: **(20)**
10. Course offered during: **Even** semester (semester-IV)
11. Course Fee: **Rs. 3000/-**
12. Course content: Unit-I, Unit-II, Unit-III and Unit-IV of 15 hours each.
13. Examination: (Method and Details): Examination to be conducted along with semester-III Examination of 80 Marks (Question No.-1 Objective and Compulsory, two Questions from Question No.02-04 and two Questions from Question No. 05-07. Five questions are to be attempted. Each question carries 16 Marks. The examination will be of three hours duration) and 20 Marks for internal test.

14. Text Book/Reference:

1. Principles of Biochemistry, A. L. Lehinger, Worth Publications.
2. Biochemistry, L. Stryer, W. H. Freeman
3. Biochemistry, J. David Rawn, Neil Patterson.

4. Biochemistry, Voet and Voet, John Wiley.

5. Outlines of Biochemistry, E. E. Conn and P. K. Stumpt, John Wiley.