Syllabus prescribed for M.Sc. Chemistry Semester III

CH-301: Paper IX (Spectroscopy)

60 h (4 h per week): 15 h per unit 80 Marks

Unit - I: Symmetry properties of molecules and group theory: **15h**

Symmetry elements and symmetry operations. Properties of group. Point groups and Schoenflies symbols. Symmetry operations as a group. Matrix representations of groups. Multiplication table for C_{2v}, C_{3v} and C_{2h}. Reducible and irreducible representations. Similarity transformation. Classes of symmetry operations. Great Orthogonality Theorem. Derivation of character tables for H_2O and NH_3 using Great Orthogonality Theorem. Application of character tables in selection rules of IR, Raman and Electronic spectroscopy.

Unit - II: **15h**

A] Mass spectrometry: Theory, ion production(EI, CI, FD, FAB), ion analysis, ion abundance, isotopic contribution, N-rule, types of fission processes, high resolution mass spectrometry, metastable peak, molecular ion peak, Mclaffferty rearrangement, mass spectral fragmentation of organic compounds alkanes, alkenes, alkynes, alcohols, amines, amides, acids, aldehydes, ketones, halides, Structure determination of organic molecules by mass spectrometry

B] Mossbauer spectroscopy: Basic principle, experimental techniques, recoil emission and absorption, source, absorber, isomer shift, quadrupole interaction, magnetic hyperfine interaction, applications in determining electronic structure, molecular structure, crystal symmetry, magnetic structure, surface studies, biological applications.

Unit - III: **15h**

A] Microwave spectroscopy: Classification of molecules on the basis of M.I., rigid and non rigid rotor, effect of isotopic substitution on transition frequencies, stark effect, microwave spectrometer, application in deriving: molecular structure, dipole moment, atomic mass and nuclear quadrupole moment.

B] ESR spectroscopy: Introduction, principle of ESR, ESR spectrometer, hyperfine coupling, zero field splitting, factors affecting g values, Kramer's degeneracy, application of ESR spectra to study free radicals like hydrogen, methyl radical, 1,4 semibenzoquinone, naphthalene, transition metal complexes, biological systems.

Unit IV: **15h**

A] Infrared spectroscopy: 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 interactions of rotations and vibrations. P,Q,R branches, vibration of polyatomic molecules, selection rules, normal modes of vibration, group frequencies, overtone and combination frequencies. Structure determination of organic molecules by IR spectroscopy.

B] 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. Selection rules, coherent antiStokes Raman spectroscopy, Structure determination from Raman and Infra-red spectroscopy.

List of books

1] Spectroscopic identification of organic compound-RM Silverstein,GC Bassler and TC Morril, John Wally

2] Introduction to NMR spectroscopy-R. J. Abraham, J. Fisher and P Loftus Wiely

3] Application of Spectroscopy to Organic Compound-J. R. Dyer, Printice Hall

4] Organic Spectroscopy-William Kemp, ELBS with McMillan

5] Spectroscopy of Organic Molecule-PS Kalsi, Wiley, Esterna, New Delhi

6] Organic Spectroscopy-RT Morrison and RN Boyd

7] Practical NMR Spectroscopy-ML Martin, JJ Delpench, and DJ Martyin

8] Spectroscopic Methods in Organic Chemistry-DH Willson, I Fleming

9] Fundamentals of Molecular Spectroscopy-CN Banwell

10] Spectroscopy in Organic Chemistry-CNR Rao and JR Ferraro

11] Photoelectron Spectroscopy-Baber and Betteridge

12] Electron Spin Resonance Spectroscopy-J Wertz and JR Bolten

13] NMR –Basic Principle and Application-H Guntur

14] Interpretation of NMR spectra-Roy H Bible

15] Interpretation of IR spectra-NB Coulthop

16] Electron Spin Resonance Theory and Applications-W gordy

17] Mass Spectrometry Organic Chemical Applications, JH Banyon

INORGANIC CHEMISTRY SPECILIZATION

CH-302: Paper X (Special I-Inorganic Chemistry)

60 h (4 h per week): 15 h per unit 80 Marks

Unit -I **15h**

A) Essential and trace metals in biological systems: Biological functions of inorganic elements, biological ligands for metal ions. Coordination by proteins, Tetrapyrrole ligands and other macrocycle. Influence of excess and difficiency of V, Cr, Mn, Fe, Co, Cu,& Zn. Genetic defects in the absorption of trace elements. Regulation and storage of trace elements. Role of minerals. Toxic effects of metals.

B) Metal storage, transport and biomineralization with respect to Ferritin, Transferrin and Siderophores, Na^+ /K^+ pump. Role of Ca in transport and regulation in living cells.

C) Medicinal use of metal complexes as antibacterial, anticancer, use of cis-platin as antitumor drug, antibiotics & related compounds. Metal used for dignosis and chemotherapy with particular reference to anti cancer drugs.

Unit-II **15h**

A) Bio-energetics and ATP cycle: DNA polymerization, metal complexes in transmission of energy, chlorophylls, photosystem I and photosystem II in cleavage of water, Model systems.

B) Electron transfer in Biology: Structure and functions of metalloproteins in electron transfer proteins, cytochromes & Fe-S proteins, Non-heme iron proteins; Rubredoxins, Synthetic models. Biological Nitrogen fixation (in vitro and in vivo)

Unit-III **15h**

Transport & Storage of Dioxygen: Heme proteins & oxygen uptake, structure and functions of haemoglobin, myoglobin, hemocyanins & hemerythrin. Perutz mechanism showing structural changes in porphyrin ring system. Oxygenation and deoxygenation. Model compounds. Cyanide poisoning and treatment. Vanadium storage and transport.

Unit-IV **15h**

Metallo enzymes: Apoenzymes, Haloenzyme & Coenzyme. The principle involved and role of various metals ini) Zn-enzyme:- Carboxyl peptidase & Carbonic anhydrase. ii) Fe-enzyme:-Catalase Peroxidase & Cytochrome P-450 iii) Cu-enzyme:-Super Oxide dismutase iv) Molybdenum:-Oxatransferase enzymes, Xanthine oxidase,Co-enzyme Vit.B12, Structure of vitamin B12 Co-C bond cleavage, Mutase activity of co- Enzyme B-12, Alkylation reactions of Methyl Cobalamin. Synthetc model of enzyme action, stability and ageing of enzyme.

List of Books:

1. Akhmetov, N.: General and Inorganic Chemistry.

2. Aylett, B. and Smith, B.: Problems in Inorganic Chemistry, (English University Press)

3. Bertini, et al: Bioinorganic Chemistry (Viva)

4. Charlot, G and Bezier, D.: Quantitative Inorganic Analysis (johnWiley).

5. Douglas, B. E. McDanirl, D. H. et al: Concept and Models of Inorganic Chemistry (4th edt.) J. Wiley

6. Dutt P. K.: General and Inorganic Chemistry.(Sarat Books House)

7. Fenton, David E.: Biocoordination chemistry, Oxford

8. Jolly, W. L. : Inorganic Chemistry (4th edn.) Addison-Wesley.

9. Katakis, D. and Gordon, G.: Mechanism of Inorganic Reactions.(J.Wiley).

CH-303: Paper XI (Special II-Inorganic Chemistry)

60 h (4 h per week): 15 h per unit 80 Marks

Unit-I **15 h**

Crystal Structure of Some Simple Compounds:

i) Ionic Crystals &Their structures, radius ratio rule, effect of polarization on crystals.

ii) Covalent structure type- Sphalerite & Wurtzite.

iii) Geometry of simple crystal AB type: NaCl, CsCl & NiAs, reasons for preference for a particular structure in above AB type of compounds.

iv) AB_2 type: Fluorite, antifluorites, Rutile structures. Li_2O, Na_2O,,$CdCl_2$, CdI_2 structures.

v) Ternary Compounds ABO_3 type: Perovskite, Barium titanate, lead titanate, $CaTiO_3$, Tolerance factor, charge neutrality & deviation structures. $FeTiO_3$.

Unit-II **15h**

A) AB_2O_4 type- compounds: Normal & inverse,2-3 and 4-2 spinel ,packing of oxygen in tetrahedral & octahedral sites, sites occupancy number of site surrounding each oxygen, application of charge neutrality principles, site preferences in spinel, distorted spinel.Hausmannite(Jahn-Teller distortions),Factors causing distortion in spinel.

B) Lattice Defects: Per fect &Imperfect crystals, point defects**,** Interstitial, Schottky defect, Frenkel defect, line defect & other entities, thermodynamics of Schottky & Frankel defects. Dissociation, theory of dislocation, plane defects- Lineage boundary, grain boundary, stacking fault, 3D defects, Defects & their concentrations, ionic conductivity in solids, Non stoichiometric compounds. Electronic properties of Non-stoichiometric oxides.

Unit-III **15h**

Glasses, Ceramics and composite:

Glasses, Ceramics Composites and Nano-materials: Glassy state, glass formers and Glass Modifiers. Glasses, Ceramics, Clay products, Refractories with reference to: preparation, Properties and applications. Microscopic composites, dispersion, strengtheried and particle reinforced, fibre reinforced Composites, microscopic composites, nanocrystaline phase, preparation procedure, special properties and applications.

Unit-IV **15 h**

A) Liquid Crystals: Mesomorphic behaviour, thermotropic liquid crystals, positional order, bond orientational order, nematics & smectic mesophases; smectic-Nematic transition clearing temperature-homeotrpic, planer & schlieren textures twisted nematics, chiral nematics, molecular arrngement in smectic A & smectic C phases, optical properties of liquid crystals. Dielectric susceptibility & dielectric constants. Lyotropic phases & their description of ordering in liquid crystals.

CH-305: Practical-V (Inorganic Chemistry Special)

9 h /week Marks: 80

Instrumental methods and Analytical Techniques:

A) Exercise based on experimental technique-

i) Colorimetry and Spectrophotometry: a)Simultaneous determination of manganese ($KMnO_4$) , and Chromium ($K_2Cr_2O_7$) and b) Cobalt and Nickel.

ii) Determination of composition and stability constant of complexes by Job's/continuous variation and mole ratio methods

1. Iron-phenanthroline complex: By Job's method of continuous variation
2. Zirconium-Alizarin Red-S complex: By mole ratio method
3. Copper-Ethylene diamine complex: By slope-ratio method.

iii) $_P$H-metry: stepwise proton-ligand and Metal-ligand stability constant of complexes by Irving Rossotti method.

iv) Polarography: Composition and stability constant of complexes.

v) Flame photometric determination: Na, K and Ca.(Individual or together)

B) Separation and quaqntitative estimation of binary ant ternary mixture by the use of following separation techniques:

i) Paper and thin layer chromatography

ii) Ion exchange

iii) Solvent extraction

iv) Electrophoretic separation

List of Books

1. Day and Underwood: Quantitative Analysis
2. Vogel A.I: A textbook of quantitative Inorganic analysis, Longman.
3. Flaschka: EDTA Titration
4. Meites and Thomas: Advanced Analytical Chemistry.
5. Ewing,G.W.: Instrumental Methods of Chemical Analysis,McGraw-Hill
6. Drago,R.S: Physical Methods in Inorganic Chemistry
7. Christian G.D.: Analytical Chemistry
8. Khopkar S.M.: Basic Concept of Analytical Chemistry.
9. Kolltath and Ligane: Polarography
10. Braun: Instrumental methods of chemical Analysis
11. Willard, Merritt and Dean: Instrumental methods of Chemical Analysis,Van Nostrand
12. Strouts, Crifillan and Wison: Analytical Chemistry.
13. Skoog S.A.and West D.W.: Fundamental of Analytical Chemistry
14. Dilts R.V.: Analytical Chemistry
15. Jahagirdar D.V.- Experiments in Chemistry
16. Chondhekar T.K.- Systematic Experiments in Physical Chemistry,Rajbog S.W.,Anjali Pubn.
17. Wlehov G.J.- Standard methods of Chemical analysis, 6th Ed.
18. Ramesh RandAnbu M,Chemical Methods for Environmenta Analyss:Water and Sedient, Macmillion India.
19. Akhmetov, N.: General and Inorganic Chemistry.
20. Aylett, B. and Smith, B.: Problems in Inorganic Chemistry, (English University Press)
21. Bertini, et al: Bioinorganic Chemistry (Viva)
22. Charlot, G and Bezier, D.: Quantitative Inorganic Analysis (johnWiley).
23. Douglas, B. E. McDanirl, D. H. et al: Concept and Models of Inorganic Chemistry (4th edt.) J. Wiley
24. Dutt P. K.: General and Inorganic Chemistry.(Sarat Books House)
25. Fenton, David E.: Biocoordination chemistry, Oxford
26. Jolly, W. L. : Inorganic Chemistry (4th edn.) Addison-Wesley.
27. Katakis, D. and Gordon, G.: Mechanism of Inorganic Reactions.(J.Wiley).

ORGANIC CHEMISTRY SPECIALIZATION

CH-302: Paper X (Special I-Organic Chemistry)

60h (4h/week) 15h/ unit 80 Marks

UnitI: Photochemistry **15 h**

Interaction of radiation with matter, types of excitation, rate of excited molecules, quenching, Quantum efficiency, quantum yield, transfer of excitation energy, actinometry, singlet and triplet states, experimental methods in photochemistry of carbonyl compounds, and transition, Norrish type I and Norrish type II reactions Paterno–Buchi reaction, Photoreduction, Photochemistry of enones, Hydrogen abstraction rearrangement of unsaturated ketones and cyclohexadienones, Photochemistry of parabenzoquinones, photochemistry of Aromatic compounds with reference to isomerisation additon and substitution Photochemical isomerization of cis and trans alkenes, Photochemical cyclization of reaction, Photo-Fries rearrangement, Photo theory reaction of anilides Barton reaction, Hoffmann-Loefler-Freytag reaction, photochemistry of vision, Applications of photochemical methods in synthesis: Isocumene, Cedrene, Hirsutene

Unit II: Pericyclic Reactions **15 h**

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1, 3, 5-hexatriene, allyl system, classification of pericyclic reaction. FMO approach, Woodward-Hoffman correlation diagram method and Peturbation of molecular orbital (PMO) approach of pericyclic reaction under thermal and photochemical conditions Electrocyclic reactions, conrotatary and disrotatary motion 4n and (4n+2) systems, with more emphasis on [2+2] and [4+2] Cycloaddition of ketones Secondary effects in [4+2] cycloaddition. Stereochemical effects and effect of substituents on rate of cycloaddition reaction, Diels-Alder reaction, 1,3-dipolarcycloaddition and chelotropic reaction. Sigmotropic rearrangement, suprafacial,and antarafacial shift involving carbon moieties, retension and inversion of configuration, [3,3] and [3,5] sigmotropic rearrangements, Claisen, Cope, Sommelet-Hauser rearrangements, Ene reaction.

Unit III **15 h**

A] Oxidation

a) Oxidation of alkanes, aromatic hydrocarbons and alkenes, Dehydrogenation with S, Se, Fremy's salt, DDQ, chloranil and $PhI(OAc)_2$, Oxidation with SeO_2, Epoxidation of olefins, Synthetic application of epoxides, Sharpless asymmetric epoxidation, Dihydroxylation of olefins using $KMnO_4$, OsO_4, Woodward and Prevost dihydroxylation, Oxidative cleavage of olefins, Ozonolysis

b) Oxidation of alcohols: Chromium reagents, pyridinium chlorochromate (PCC), pyridinium dichromate (PDC), Collin and Jones reagent, Combination of DMSO with DCC, $(COCl)_2$, NCS and $(CH_3CO)_2O$ for oxidation of alcohols, Oxidation with MnO_2, Oppenauer oxidation

c) Oxidation of aldehydes and ketones, Conversion of ketones to α, β-unsaturated ketones and α-hydroxy ketones, Baeyer-Villiger oxidation , Chemistry and synthetic applications of $Pb(OAc)_4$, Dess-Martin periiodinane, IBX

B] Reduction

a) Catalytic heterogeneous and homogeneous hydrogenation, Hydrogenation of alkenes, alkynes and arenes, Selectivity of reduction, Mechanism and stereochemistry of reduction, Raney Ni-catalyst, Adam catalyst, Lindlar catalyst, Wilkinson catalyst.

b) Reduction by dissolving metals, Reduction of carbonyl compounds, conjugated systems, aromatic compounds and alkynes. Birch reduction, Hydrogenolysis

c) Reduction by hydride transfer reagents, Meerwein-Pondorff-Verley reduction, Reduction with $LiAlH_4$ and $NaBH_4$, stereochemical aspects of hydride addition, Derivatives of $LiAlH_4$ and $NaBH_4$, Selectivity issues, Diisobutylaluminium hydride (DIBAL-H), Sodium cyanoborohydride, Reduction with boranes and derivatives Reduction with Bu_3SnH., Enzyme catalyzed reduction, Reduction of carbonyl group to methylene, Reduction with diimide and trialkylsilanes

Unit IV: Chemistry of P, S, Si, B, and Ti compounds **15 h**

a) Phosphours and sulphur ylide: Preperation and their synthetic application along with stereochemistry

b) Umpolung concept: Dipole inversion, generation of acyl anion, use of 1,3-dithiane, ethylmethylthiomethylsulphoxide, bis-phenylthiomethane, metallated enol ethers, alkylidene dithiane, ketone thioacetals, 2-propenethiobismethyl thioallyl anion, thiamine hydrochloride based generation of acyl anion

c) Organoboranes- preparation and properties of organoborane reagents e.g. RBH_2, R_2BH, R_3B, 9-BBN, catechol borane. Thexyl borane, cyclohexyl borane, $ICPBH_2$, IPC_2BH, Hydrboration-mechanism, stereo and regeoselectivity, uses in synthesis of primary, secondary tertiary alcohols, aldehydes, ketones, alkenes, Synthesis of EE, EZ, ZZ dienes and alkyenes. Mechanism of addition of IPC_2BH. Allyl boranes- synthesis, mechanism and uses

d) Organo silicon compounds in organic synthesis, Me_3SiCl, Me_3SiH and Paterson synthesis

e) Synthetic methodologies based on titanium compounds

List of books

1] Books as suggested in Semester I for organic chemistry

2] Organic Synthesis, The disconnection approach-S. Warren

3] Designing Organic Synthesis-S. Warren

4] Some Modern Methods of Organic Synthesis-W. Carruthers

5] Advance Organic Chemistry Part-B-F. A. Caray and R. J. Sundberg Plenum Press

6] Protective Group in Organic Synthesis-T. W. Greene and PGM

7] The Chemistry of Organo Phosphorous-A. J. Kirbi and S.G. Warren

8] Organo Silicon Compound-C. Eabon

9] Organic Synthesis via Boranes-H. C. Brown

10] Organo Borane Chemistry-T. P. Onak

11] Organic Chemistry of Boron-W. Gerrard

12] Fundamentals of Photochemistry-K. K. Rohatgi-Mukharji, Wiley Eastern Limited

13] Photochemistry-Cundau and Gilbert

14] Aspects of Organic Photochemistry-W. M. Horspoot

15] Photochemistry-J. D. Calvert

16] Photochemistry-R. P. Wayne

CH-303: Paper XI (Special II-Organic Chemistry)

60h (4h/week) 15h/ unit 80 Marks

A]Terpenoids **15 h**

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules: Citral, Geraniol, α-terpeneol, Menthol, Farnesol, Zingiberene, Santonin, Phytol, Abietic acid and β-carotene, Vitamin A and H

B] Porphyrins: Structure and synthesis of Haemoglobin and Chlorophyll

Unit II **15 h**

A] Alkaloids

Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants

Structure, stereochemistry, synthesis and biosynthesis of the following: Ephedrine, (+)-coniine, Nicotine, Atropine, Quinine, Reserpine and Morphine

B] Prostaglandins: Occurrence, nomenclature, classification, biogenesis and physiological effects. Synthesis of PGE_2 and $PGF_{2\alpha}$

Unit-III **15 h**

A]Steroids

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Cholesterol, Bile acids, Androsterone, Testosterone, Estrone, Progesterone and Aldosterone. Biosynthesis of steroids

B] Plant Pigments

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

Unit IV: **15 h**

A] Carbohydrate: Types of naturally occurring sugars, deoxy sugars, amino sugars, branched chain sugars, methyl ethers and acid derivatives of sugars, general methods of structure and ring size determination with reference to maltose, lactose, sucrose, starch and cellulose.

B] Amino acids, protein and peptides: Amino acids, structural characteristics, acid base property, stereochemistry of amino acids, optical resolution, Stecker synthesis, peptide and proteins structure of peptide and protein, primary, secondary, tertiary and quaternary structure. Reaction of polypeptide, structure determination of polypeptide, Solid phase peptide synthesis, end group analysis.

List of books

1] Chemistry of Alkloids-S. W. Pelletier
2] Chemistry of Steroids-L. F. Fisher and M. Fisher
3] The Molecules of Nature-J. B. Hendricsion
4] Biogenesis of Natural Compound - Benfield
5] Natural Product Chemistry and Biological Significance- J. Mann, R. S Devison, J. B. Hobbs, D. V. Banthripde and J. B. Horborne
6] Introduction to Flavonoids-B. A. Bohm, Harwood
7] Chemistry of Naturally Occurring Quinines-R. H. Thomson
8] The Systematic Identification of Flavonoids- Marby, Markham, and Thomos
9] Text Book of Organic Medicinal Chemistry-Wilson, Geswold
10] Medicinal Chemistry Vol I and II-Burger
11] Synthetic Organic Chemistry -Gurudeep Chatwal.

12] Organic Chemistry of Natural Products Vol I and II-O. P. Agrawal
13] Organic Chemistry of Natural Products -Gurudeep Chatwal
14] A Textbook of Pharmaceutical Chemistry-Jayshree Ghosh
15] Synthetic Dyes Series -Venkatraman
16] Chemistry Process Industries-Shreve and Brink
17] Principal of Modern Heterocyclic Chemistry-L. A. Paquelte
18] Heterocyclic Chemistry-J. Joule and G. Smith
19] Heterocyclic Chemistry-Morton
20] An Introduction to Chemistry of Heterocyclic Compound-J. B. Acheson
21] Introduction to Medicinal Chemistry-A. Gringuadge
22] Wilson and Gisvold Text Book of Organic Medicinal and Pharmaceutical Chemistry-Ed. Robert F Dorge
23] An Introduction to Drug Design-S. S. Pandey and J. R. Demmock
24] Polymer Science-V. Govarikar
25] Principle of Polymer Chemistry-P. J. Flory
26] An Outline of Polymer Chemistry-James Q. Allen
27] Organic Polymer Chemistry-K. J. Saunders

CH-305: Practical-V (Organic Chemistry Special)

9 h /week Marks: 80

[A] Quantitative Analysis

Student is expected to carry out following estimations (minimum 6 estimations.)

1. Estimation of Vitamin "C" Iodometry.
2. Estimation of Phenol by $KBrO_3$-KBr.
3. Estimation of Amine by Bromate/ Bromide solution.
4. Estimation of Formaldyde by Iodometry.
5. Estimation of Glucose by Benedict's solution.
6. Estimation of given carbonyl compound by hydrazone formation.
7. Estimation of Aldehyde by Oxidation method.
8. Determination of percentage of number of hydroxyl group in an organic compound by acetylation method.

[B] Isolation of Organic Compounds from Natural Source (Any six)

a) Isolation of caffeine from tea leaves.

b) Isolation of casein from milk (the students are required to try some typical colour reactions of proteins)

c) Isolation of lactose from milk (purity of sugar should be checked by TLC and PC and Rf value reported.)

d) Isolation of nicotine dipicrate from tobacco

e) Isolation of cinchonine from cinchona bark

f) Isolation of piperine from black pepper

g) Isolation of lycopene from tomatoes

h) Isolation of β-carotene from carrots

i) Isolation of cysteine from hair

j) Isolation of oleic acid from olive oil (involving the preparation of complex with urea and separation of linoleic acid

k) Isolation of eugenol from cloves

l) Isolation of (+) limonine from citrus rinds

[C] QUALITATIVE ANALYSIS

Separation of the components of a mixture of three organic compounds (three solids, two solids and one liquid, two liquids and one solid, all three liquids and identification of any two components using chemical methods or physical techniques. Minimum 10-12 mixtures to be analyzed.

PHYSICAL CHEMISTRY SPECIALIZATION

CH-302: Paper X (Special I-Physical Chemistry)

60h (4h/week) 15h/unit 80 Marks

UNIT I **15h**

A] Statistical thermodynamics: Concepts of distribution, thermodynamic probability and most probable distribution, ensemble averaging, postulates of ensemble averaging, canonical grand canonical and micro canonical ensembles,corresponding distribution laws using lagranges method of undetermined *multipliers ,* ortho and para hydrogen, principle of equipartition of energy, calculation of average energy

B] Partition function, Translational partition function, rotational partition function, vibrational partition function, electronic partition function, applications of partition functions.

UNIT II **15h**

A] Electrode Interfaces: Quantum aspects of charge transfer at electrode-solution interfaces, quantization of charge transfer, tunneling. Semiconductor interfaces: Theory of double layer at

semiconductor, electrolyte solution interfaces, structure of double layer interfaces, effect of light at semiconductor solution interface.

B] Electro catalysis: Comparison of electro catalytic activity, importance of oxygen reduction and hydrogen evolution reactions, and their mechanism, volcanoes.

C] Bio-electrochemistry: Threshold membrane phenomena, Nernst Plank equation, Hodges Huxley equations, core conductor models, electrocardiography.

UNIT III **15h**

A] CHEMICAL KINETICS**:** Introduction, complex reactions: reversible, consecutive, concurrent, and branching reactions, free radical and chain reactions, steady state treatment, reaction between H_2-Br_2(thermal and photochemical),H_2-Cl_2, decomposition of ethane, acetaldehyde, N_2O_5, Rice Herzfeld mechanism

B] Fast Reactions: relaxation methods, stopped flow methods, flash photolysis, magnetic resonance method, jump method, relaxation time and numericals.

UNIT IV: **15h**

A]Photophysical phenomenon: Introduction, prompt fluorescence, delayed fluorescence, and phosphorescence, fluorescence quenching: concentration quenching, quenching by excimer and exciplex emission, fluorescence resonance energy transfer between photoexcited donor and acceptor systems. Stern-Volmer relation, critical energy transfer distances, energy transfer efficiency, examples and analytical significance, bimolecular collisions, quenching and Stern-Volmer equation.

B] Photochemical reactions: photoreduction, photooxidation, photodimerization, photochemical substitution, photoisomerization, photosenitisation, chemiluminescence, photochemistry of environment: Green house effect.

List of books:

1. G.M.Panchenkov and V.P.Labadev, " Chemical Kinetics and catalysis", MIR Publishing
2. E.A. Moelwyn- Hughes, " Chemical Kinetics and Kinetics of Solutions", Academic
3. K.J.Laidler, Chemical Kinetics, Third Edition (1987), Harper and Row, New York
4. J.Raja Ram and J.C.Kuriacose, Kinetics and Mechanism of Chemical Transformations MacMilllan Indian Ltd., New Delhi (1993)
5. 1. J.G. Calvert and J.N. Pitts, Jr., *Photochemistry,* John Wiley and Sons, New York (1966).
6. 2. K. K. Rohtagi-Mukherjee, *Fundamentals of Photochemistry,* New Age International, New Delhi(1986).
7. R. P. Wayne, *Principles and Applications of Photochemistry,* Oxford University Press, Oxford(1988).

8. N. J. Turro, *Modern Molecular Photochemistry,* Univ. Science Books, Sansalito (1991).
9. J. F. L. Lakowicz, *Principles of Fluorescence Spectroscopy,* 2nd Edition (1999), PlenumPublishers, New York.
10. F.W.Sears, " Introdction to Thermodynamics, Kinetic Theory of Gases and statistical mechanics".Addison Wesley
11. M.C.Gupta, Statistical Mechanics
12. Andrew Maczek, *Statistical Thermodynamics,* Oxford University Press Inc., New York (1998).
13. Andrew Maczek, *Statistical Thermodynamics,* Oxford University Press Inc., New York (1998).
14. B.K. Agarwal and M. Eisner, *Statistical Mechanics*, Wiley Eastern, New Delhi (1988).
15. D.A. McQuarrie, *Statistical mechanics*, Harper and Row Publishers, New York (1976).
16. J.O.M.Bokris and A.K.N.Reddy, " Modern Elcrtrochemistry". Wiley
17. S. Glasstone, " Introduction to Electrochemistry" Affilisated East West.
18. D.R.Crow, " The Principle of electrochemistry", Chapman Hall

CH-303: Paper XI (Special II-Physical Chemistry)

60h (4h/week) 15h/unit 80 Marks

UNIT-I: **15h**

A] Radioactive Decay Processes : Alpha decay- penetration of potential barriers, hindered alpha decay, alpha decay energies. Beta Decay- Fermi theory, energy, Curie plots, comparative half-lives, electron capture, selection rules, forbidden transitions, non-conservation of parity, neutrinos. Gamma decay- life-time of excited states.

B] Nuclear Energy : Basic principles of chain reacting systems, the 4-factor formula, Classification of reactors, Breeder reactor, Reactor associated problems, Reactor safety, Fuel cycle, Re-processing of spent fuel, Nuclear waste management

Unit II: **15h**

A] Solid State Reactions: 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. photographic process.

B] Nanoparticles and Nanostructural materials: Introduction,methods of preparation,physical properties,and chemical properties, sol-gel chemistry of metal alkoxide, application of nanoparticles. Nanoporous Materials: Introduction, Zeolites and molecular sieves, determination of surface acidity, porous lamellar solids, composition-structure, preparation and applications.

UNIT-III: Electrochemistry of Solution **15h**

A] Metal/Electrolyte interface : OHP and IHP, potential profile across double layer region, potential difference across electrified interface; Structure of the double layer **:** Helmholtz-Perrin, Gouy Chapman model, Stern, Graham Devanathan- Mottwatts, Tobin, Bockris, Devnathan Models

B] Over potentials, exchange current density, derivation of Butler Volmer equation under near equilibrium and non-equilibrium conditions, Tafel plot

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

UNIT IV: Irreversible Thermodynamics **15h**

Local equilibria,Thermodynamic criteria for non equilibrium states, generalized flux, forces, phenomenological laws, matter flow and current flow, entropy production and entropy flow for different irreversible reactions(e.g. heat flow, chemical reaction and electrochemical reactions), saxen relations, reciprocity relations, coupled reactions- Onsager theorem of microscopic reversibility, irreversible thermodynamics of biological systems.

List of books:

1. C.N.Rao. Nuclear Chemistry
2. B. G. Harvey, *Introduction to Nuclear Physics and Chemistry,* Prentice Hall, Inc. (1969).
3. H.J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edition (1995), Wiely-Eastern Ltd., New Delhi
4. L.V.Azaroff, " Introduction to solids", McGraw Hill
5. C.Kittel, " Introduction to solid state Physics",Wiley
6. J.O.M.Bokris and A.K.N.Reddy, " Modern Elcrtrochemistry". Wiley
7. S. Glasstone, " Introduction to Electrochemistry" Affilisated East West.
8. D.R.Crow, " The Principle of electrochemistry", Chapman Hall
9. I.Prigoggine, " An Introduction to Thermodynamics of Irreversible Processes," Interscience
10. G. Fridlander, J.W. Kennedy, E.S. Macias and J.M. Miller, Nuclear & Radiochemistry, 3rd Edition (1981) John-Wiley & Sons, New York.

CH-305: Practical-V (Physical Chemistry Special)

9 h /week Marks: 90

Solutions:

1.Study the variation of solubility of potassium hydrogen tartarate with ionic strength using a salt having a common ion and hence determine the mean ionic activity coefficients.

2.Determination of partial molar volume of solute and solvent(ethanol-water,methanol-water,KCl-water mixture)

3.Determination of temp. dependence of the solubility of a compound in two solvents having similar intermolecular interactions(benzoic acid in water and DMSO –water mixture) and calculation of the partial molar heat of solution.

Phase equilibrium:

4. To study the effect of addition of an electrolyte such as NaCl, KCl,Na_2SO_4,K_2SO_4 etc.on the solubility of an organic acid(benzoic acid or salicylic acid).

5. To determine the heat of crystallization of $CuSO_4.5H_2O$

6. To determine the heat of reaction involving precipitation of a salt $BaSO_4$

7. To determine transition temperature of $CaCl_2$ by thermometric method and to determine transition temperature of $CaCl_2$, sodium bromide by solubility method

Kinetics:

8. To determine the activation energy of hydrolysis of an ester by acid.

9. Kinetics of reaction between sodium thiosulphate and KI. Determination of rate constant; study of influence of ionic strength

10. Kinetics of decomposition of H_2O_2 catalysed by iodide ion. Also determination of activation energy of reaction.

Electrochemistry:

11. Estimate the concentration of H_2SO_4, CH_3COOH, $CuSO_4.5H_2O$ in a given solution by carrying out conductometric titration against NaOH solution.

12 .Determine the eq. conductance of strong electrolyte(KCl, NaCl, HCl,KNO_3) at several concentration and hence verify Onsager's equation.

13. Carry out the following precipitation titration conductometrically-

a.50 ml.0.02N AgNO3 with 1N HCl

b.50 ml.0.02N AgNO3 with 1N KCl

c. 50 ml 0.004 N $MgSO_4$ with 0.1 N $Ba(OH)_2$

d. 50 ml 0.002 N $BaCl_2$ with 1 N Li_2SO_4

e. 50 ml.0.02 N $BaCl_2$ with 1N K_2SO_4

Potentiometry:

14.Determination of redox potential of the couples(Fe^{2+}/Fe^{3+},Co^{3+}/Co^{2+},Cr^{3+}/Cr^{2+},MnO_4^-/Mn^{2+}(any two) and equilibrium constant.

15.Study of complex formation by potentiometry e.g.Ag^+-$S_2O_3^{2,-}$,Fe^{3+}-SCN^-,Ag^+-NH_3(any two) and calculation of stability constant.

ANALYTICAL CHEMISTRY SPECIALIZATION

CH-302: Paper X (Special I-Analytical Chemistry)

60h (4h/week) 15h/unit 80 Marks

Unit-I: Radioanalytical Chemistry-I **15h**

Radioactivity-Radiation-Units-Curie, Becquerel, Gray, Rad, Sievert, RBE, REM, Half life, mixed half life, branching decay, different types of radiations and their interactions with matter, radioactive equilibrium, Elementary principles of GM and proportional counters, Gamma Ray Spectrometer, calibration using standard sources, resolution, numericals.

Unit-II: Optical methods of analysis-III **15h**

***Atomic absorption spectroscopy*:** Principle. Atomic energy levels. Grotrian diagrams. Population of energy levels. Instrumentation. Sources: Hollow cathode lamp and electrodeless discharge lamp, factors affecting spectral width. Atomizers: Flame atomizers, graphite rod and graphite furnace. Cold vapour and hydride generation techniques. Factors affecting atomization efficiency, flame profile. Monochromators and detectors. Beam modulation. Detection limit and sensitivity. Interferences and their removal. Comparison of AAS and flame emission spectrometry. Applications of AAS.

Unit-III:Electrochemical methods of analysis-II **15h**

***Stripping Voltammetry*:** Principle and technique in anodic and cathodic stripping voltammetry, applications to metal ion analysis, limitations.

Adsorptive stripping voltammetry: Principle, technique, applications to metal ions and organic analysis. Advantages over anodic stripping voltammetry. Catalytic effects in voltammetry.

Working electrodes: Mercury electrodes, carbon electrodes, film electrodes.

***Cyclic voltammetry*:** Principle and technique. Randles-Sevcik equation. Interpretation of voltammogram-reversible, irreversible and quasi-reversible systems. Applications of cyclic voltammetry in study of reaction mechanism and adsorption processes.

Electrochemical sensors *(Chemically modified electrodes):* Biosensors, catalytic sensors and gas sensors. Comparison of voltammetry with AAS and ICP-AES.

Unit-IV: Miscellaneous techniques-I **15h**

Photoacoustic spectroscopy: Theory. Instrumentation. Advantages over absorption spectroscopy. Chemical and surface applications of PAS.

***Electrochromatography*:** Principles of electrophoresis. Instrumentation. Zone electrophoresis. Curtain electrophoresis. Applications of electrochromatography. Reverse osmosis. Electrodialysis. Capillary electrophoresis. Applications of capillary electrophoresis. Micellar electrokinetic capillary chromatography.

Electrogravimery: Theory of electrolysis. Electrode reactions. Decomposition potential. Overvoltage. Characteristics of deposits and completion of deposition. Instrumentation. Application in separation of metals.

CH-303: Paper XI (Special II-Analytical Chemistry)

60h (4h/week) 15h/unit 80 Marks

Unit-I: Organoanalytical Chemistry **15h**

Elemental analysis: Outline of macro, semi-micro, micro and ultra-micro analysis, semi-micro determination of carbon, hydrogen, halogen, sulphur, nitrogen, phosphorous, arsenic, boron and metals in organic compounds.

Functional group analysis: Semi-micro determination of the following functional groups in organic compounds- hydroxyl, amino, nitro, nitroso, azo, N-acetyl, O-acetyl, methyl, aldehydes, ketones, thio, disulphide, sulphonamide, unsaturation and active hydrogen.

KF reagent: Karl Fischer reagent and its use in analysis of water in organic compounds.

Unit-II: Analysis of ores and cement **15h**

Ores: Composition and analysis of the followings ores- Bauxite, Pyrolusite, Dolomite, Chromite.

Portland cement: Composition, raw material, manufacturing processes, characteristics, analysis.

Unit III: Water pollution and analysis

Sources of water pollution, composition of potable water, importance of water analysis, sampling and sample preservation, physico-chemical analysis of water. Mineral analysis (temperature, pH, conductivity, turbidity, solids, alkalinity, chloride, fluoride, sulphates, hardness), Demand analysis (DO,

BOD, COD, TOC), nutrients (nitrogen-total, nitrate, nitrite, phosphate) and heavy metals (As, Cd, Cr, Hg and Pb). A brief idea of coagulation and flocculation.

Unit-IV: Air pollution and analysis **15h**

Air pollution and analysis-classification of air pollutants, sources of air pollution and methods of control, sampling of aerosols and gaseous pollutants and their effects, SO_2, NO_2, CO, CO_2, particulates-SPM, RSPM, High Volume Sampler, Fabric Filters, Cyclones (direct and Reverse), ESP, ozone layer, Green house effect, Heat Islands, Acid Rain.

List of books:

1. Essentials of Nuclear Chemistry: H. J. Arnikar (Willey Eastern Ltd)
2. Substoichiometry in Radioanalytical Chemistry: J. Ruzicka and J Stary (Pergamon Press)
3. Introduction to Radiation Chemistry: J. W. T. Spinks and R. J. Woods
4. Radiochemistry: A. N. Nesmeyanov (Mir Publications)
5. Instrumental Methods of Analysis: Willard, Meriit and Dean(Van Nostrand)
6. Instrumental Methods of Analysis: G. Chatwal and S. Anand (Himalaya Publishing House)
7. Vogel's Text Book of Quantitative Inorganic Analysis: Bassett, Denney, Jeffery and Mendham (ELBS)
8. Advanced Analytical Chemistry: Meites and Thomas (McGraw-Hill)
9. Atomic Absorption Spectroscopy: Robinson (Marcol Dekker)
10. Instrumental Methods of Chemical Analysis: Braun (Tata McGraw-Hill)
11. Analysis of Water: Rodier
12. Laboratory manual of water analysis: Moghe and Ramteke (NEERI)
13. Electroanalytical chemistry: Joseph Wang
14. Electroanalytical stripping methods: Brainina and Neyman (Wiley-Interscience)
15. Trace analysis: S. Lahiri (Narosa Publishing House)
16. Electroanalytical Chemistry: Bard (Marcel-Dekker)
17. Chemistry in Engineering and Technology- Vol I and II: J.C. Kuriacose and J. Rajaram (Tata-McGraw Hill)

CH-305: Practical-V (Analytical Chemistry Special)

9 h /week Marks: 80

pH-metry

1. Determination of percent Na_2CO_3 in soda ash by pH-metric titration.

2. Determination of isoelectric point of amino acid.

Conductometry

1. Displacement titration of CH_3COONa with HCl.

2. Precipitation titration of $MgSO_4$ and $BaCl_2$.

Potentiometry

1. Estimation of Cl^-, Br^- and I^- in a mixture.

2. Determination of percent purity of phenol by potentiometric titration with NaOH.

Coulometry

1. Estimation of nickel and cobalt by coulometric analysis at controlled potential.

2. Analysis of antimony (III) with I_3^- .

Polarography

1. Determination of $E_{1/2}$ of Cd^{2+} and Zn^{2+} at DME.

2. Estimation of Cd^{2+} and Zn^{2+} in respective solutions by calibration curve and standard addition methods.

3. Determination of composition /stability constant of complex.

Cyclic voltammetry

Study of cyclic voltammograms of $K_3[Fe(CN)_6]$.

Electrogravimetry

Estimation of nickel and copper individually as well as in mixture.

Polarimetry

1. Inversion of cane sugar in the presence of HCl.

2. Determination of percentage of two optically active substances (d-glucose and d-tartaric acid) in a mixture.

Colorimetry/spectrophotometry

1. Simultaneous determination of chromium and manganese in given mixture.

2. Simultaneous determination of two dyes in a mixture.

3. Estimation of Mn in steel.

4. Estimation of Cu/Ni in alloys.

5. Estimation of iron in water sample using 1,10-phenanthroline.

6. Estimation of Fe(III) in given solution by photometric titration with EDTA (salicylic acid method).

Flame photometry

Estimation of Li, Na, K, Ca in rock/ soil / water samples.

Turbidimetry and nephelometry

1. To determine molecular weight of polymer.

2. Estimation of sulphate in water sample by turbidimetry.

3. Estimation of phosphate by nephelometry.

Radioanalytical techniques

1. *GM-counter*: Plateau, nuclear statistics, half thickness of aluminium absorbers, dead time.

2. *Gamma ray spectrometer*: Calibration using standard sources, determination of half life (Mn-56, I-128, In-116)

3. Experiments based on radiation chemistry: G-value, radiolysis of organic solvents.

Demonstrations

UV-spectrophotometry

CH-304: Paper XII (Elective- Applied Analytical Chemistry)

60 h (4 h per week): 15 h per unit 80 Marks

Unit-I: Analysis of Pesticides and Fertilizers **15h**

***Pesticides*:** General introduction, analysis of pesticides in general with reference to DDT, Dieldrin, Malathion, Parathion, BHC by different analytical methods such as titrimetric, colorimetric, chromatography and electroanalytical methods.

***Fertilizers*:** Sampling and sample preparation, determination of water, total nitrogen, urea, total phosphates, potassium, acid or base forming quality.

Unit-II: Forensic chemistry **15h**

Introduction. Classification of poisons on the basis of physical states, mode of action and chemical properties with examples of each type. Methods of administration. Action of poisons in body. Factors affecting poisoning. Study of some common poisons used for suicide. Signs and symptoms of As, Pb, Hg and cyanide poisoning. Poisonous effects of kerosene and cooking gas.

Unit-III:Analysis of petroleum and petroleum products **15h**

Introduction, determination of flash and fire point, Pensky Marten's apparatus, cloud and pour point, aniline point, drop point, viscosity and viscosity index, Redwood and Saybolt viscometer, API specific gravity, water and sulphur in petroleum products, carbon residue, corrosion stability, decomposition stability, emulsification, neutralization and saponification number.

Unit-IV: Analysis of alloys **15h**

Definition of alloy. Iron-carbon phase diagram. Types of steel: hypoeutectic, hypereutectic steels, mild steel, and stainless steel. Uses of steel. Composition and uses of brass, bronze and soldering alloy. Analysis of iron, nickel, chromium and manganese in steel. Analysis of copper in brass, zinc in bronze and lead in soldering alloy. Industrial applications of alloys.

CH-306: Practical VI–Elective (Applied Analytical Chemistry)

9 h per week (Marks-80)

1. Analysis of ores: Ca and Mg in Dolomite, Al in Bauxite, Mn in Pyrolusite.
2. Analysis of cement: Silica, alumina, ferric oxide, calcium and magnesium oxide, sodium and potassium oxide.
3. Alloy analysis: Mn in steel-colorimetry, Cu in brass-colorimetry, Ni in alloy- back titration/ extraction-spectrophotometry.
4. Analysis of oils: Carbon residue, Acid value, Saponification value, Iodine value, Viscosity, Flash point, Cloud point, Aniline point.
5. Analysis of soils: pH, alkalinity, conductivity, nitrogen, phosphorous and potassium.
6. Ambient air analysis: SPM, RSPM, SO_x and NO_x in ambient air.
7. Analysis of drugs: Fe in capsule, ascorbic acid in vitamin-C tablet, sulpha drug by diazotization, Mg in milk of magnesia tablet.
8. Bleaching powder: Available chlorine, break point chlorination.
9. Polymer analysis: Molecular weight, Saponification value, Iodine value.
10. Cosmetics analysis: Talcum powder, tooth paste, shampoo.
11. Food: Moisture content by Karl-Fischer titrator, phosphoric acid in cola beverages by pH titration.

List of books

1. ISI Handbook of Food Analysis: Vol.I to X (Bureau of India Standards Publication, New Delhi)
2. Food Analysis: A. G. Woodman (McGraw-Hill)
3. Milk and Milk Products: Eckless, Comb and Nacy (Tata McGraw-Hill)
4. Hand Book of Analysis and Quality Control for Fruit and Vegetable Products: Ranganna (Tata McGraw-Hill)
5. Insecticides- Action and Metabolism: O. Brian (Academic Press)
6. Chemistry of Insecticides and Fungicides: Sree Ramalu, Oxford, IBH,Pub.
7. Analytical Methods for pesticides and plant growth regulators and food additives-(Vol.I to X)Ed. G. Zweing (Academic press)

8. Practical Pharmacognosy: T. N. Vassudevan
9. Aids of analysis of food and drugs: Wicholls
10. Indian Pharmacopoeia-1985
11. British Pharmacopoeia-1990
12. Handbook of Drugs and cosmetics aids: Mehrotra
13. Lynch's medical laboratory technology: S. S. Raphel
14. Basic Food Chemistry: F. Lee (AVI publishing company)
15. Industrial chemistry: B. K. Sharma
16. Parikh's text book of medical jurisprudence, forensic medicine and toxicology, 6th Edn.: C.K.Parikh (CBS publishers and distributors)
17. Clarke's analysis of drugs and poisons: Anthony C Moffat, M David Osselton, Brian Widdop (Pharmaceutical press)
18. A Practical Course in polymer chemistry: S. J. Punea (Pergamon press).
19. The Text book on Petrochemical by Dr. B. K. Bhaskar Rao (Khanna Publishers).
20. Analytical chemistry: A. Gupta (Pragati Prakashan)
21. Applied Chemistry: Vermani and Narula (New Age International)

CH-304: Paper XII (Elective- Nuclear Chemistry)

60 h (4 h per week): 15 h per unit 80 Marks

Unit-I: Radioactive decay **15h**

Various modes of decay, natural radioactivity, successive radioactive decay and growth kinetics, radioactive equilibrium, half life, half life of mixed radioisotopes, decay schemes, its determination by experimental methods, statistical nature of nuclear radiation, treatment of nuclear data and calculation of standard deviation, probability

Unit-II: Nuclear structure **15h**

mass-energy relationship, nuclear binding energy, semi-empirical mass formula, nuclear stability rules, nuclear properties, mass size, spin and parity, nature of nuclear forces, liquid drop model, shell model, its evidence and advantages, comparison of the two models, calculations based on above.

Energetics of nuclear reaction, cross reaction, comparison with chemical reactions, various types of nuclear reactions, photonuclear, spallation and thermonuclear reaction

Unit-III: Interaction of radiations with matter, detectors **15h**

Interaction with matter and detection of gamma rays with matter by photoelectric, Compton and pai production, interaction of beta particles, neutrons and heavy charged particles, various methods of

detecting nuclear radiations, gas filled counters, ionization chamber, proportional and GM counters, scintillation detector and solid state detector

Unit-IV: Nuclear fission and Fusion **15h**

Probability, mass and charge distribution, release of energy and neutrons, spontaneous fission, nuclear reactors and their uses for power production, brief idea about thermal and fast breeder reactors, reprocessing of nuclear fuel, PUREX process, heavy water- manufacturing and use in reactors. accelerators, nuclear fusion.

Production of isotopes by nuclear reactions, production of new elements, radioactive waste management and disposal

CH-306: Practical VI–Elective (Nuclear Chemistry)

9 h per week (Marks-80)

1. Working of GM counter, plateau, statistics, geometry effects, dead time, energy of beta particle, back scattering
2. Working of gas flow proportional counter, plateau, statistics, geometry effects, dead time, energy of beta particle
3. Working with scintillation counter, gamma ray spectra, energy calibration and resolution, half life determination of single and composite nuclei.
4. Radiochemical separation of ^{234}Th from natural uranium salt and its half life determination
5. Experiment on Neutron Activation Analysis by non-destructive method
6. Dose measurement by Fricke and other chemical dosimeters
7. Radiolysis of potassium nitrate, methyl iodide, carbon tetrachloride-iodine systems
8. Szilard-Chalmers reactions with inorganic and organic systems, potassium permanganate and methyl iodide
9. Some trace experiments like partition coefficient, solubility product, isotopic exchange, isotope dilution analysis, radiochromatography, ion exchange.

List of books:

1. H. J. Arnikar - Essentials of Nuclear Chemistry (Willey Eastern Ltd)
2. G. Friendlander, J. W. Kennedy,E. S. Macias and J. M. Miller-Nuclear and Radiochemistry (Wiley Intersciences, New York)

3. G. R. Choppin and J. Rydberg- Nuclear Chemistry-Principles and Applications(Pergamon press, London)
4. B. G. Harvey-Introduction to Nuclear Physics and Chemistry(Prentice Hall of India)
A. N. Nesmeyanov - Radiochemistry- (Mir Publications)
5. M. N. Sastry-Introduction to Nuclear Science, Affiliated East-West Press, New Delhi
6. G. Hughes- Radiation Chemistry- Oxford University Press, London
I. V. Verschinskii and A. K. Pikeav-Introduction to Radiation Chemistry, Israel Publication, Jerusalem-Robinson (Marcol Dekker)
7. Farhat Aziz and M. A. J. Radgers-Radiation Chemistry-Principles and Applications, VCH Publishers FRC.
8. M. Hassinsky-Nuclear Chemistry and its application, Addison Wesley

CH-304: Paper XII (Elective- Environmental Chemistry)

60 h (4 h per week): 15 h per unit 80 Marks

Unit -I: Concept and scope of Environmental Chemistry **15 h**

Biosphere, Lithosphere, Hydrosphere and Atmosphere, Ecological principles- aspects of ecology, classification, types of ecosystems. Biogeochemical cycles- carbon, nitrogen, phosphorous, oxygen, hydrogen, sulphur, iron, sodium, potassium, magnesium, cobalt, mercury, lead, zinc and cadmium.

Thermal pollution—sources, harmful effects and prevention of thermal pollution.

Noise pollution --- sources, effects and control of noise pollution.

Unit-II: Water **15 h**

Origin, physico-chemical properties of water, sources of water, hydrological cycle, criteria of water quality, Water management- water shed management, rain water harvesting, waterpollution- sources, consequences and harmful effects of water pollution, strategies for water pollution control.

Unit-III: Air **15 h**

Major regions of the atmosphere, composition of the atmosphere, temperature inversion and air pollution episodes, photochemistry of the atmosphere, depletion of the stratospheric ozone, green house effect, green house gases, remedial measures for reversion of green house effect, acid rain, photochemical smog, particulate matter.

Unit-IV: **15 h**

Soil

Chemical and mineralogical composition of soil, classification of soil, types of soil- saline and alkaline, physical properties – texture, bulk density, permeability, chemical properties—Ion exchange capacity, soil pH and micro and macro nutrient availability. Soil management—Management of saline and alkaline soil, soil indicator plants,

Radioactive Pollution

Introduction to radiation chemistry, sources of radioactive pollution, effects of radioactivepollution, nuclear disasters in the two decades, protection from radiation, control of radiation.

CH-306: Practical VI–Elective (Environmental Chemistry)

9 h per week (Marks-80)

1. Sampling of water- tap water, well water, over head storage tank water pond water and lake water.
2. Physico-chemical and organoleptic characteristics of the above water samples.
3. Statistical evaluation of the data obtained for optimization of results.
4. Determination of Total solids, Total dissolved solids and total suspended solids and its significance.
5. Determination and comparison of chlorine content in tap water, storage tank and swimming pool.
6. Determination of acidity and alkalinity in water samples.
7. Determination of total, permanent and temporary hardness of water sample.
8. Determination of DO, COD and BOD of water sample.
9. Analysis of chemicals used in water and waste water treatment-Alum, bleaching powder, activated carbon.
10. Analysis of nutrients – Nitrogen (total, ammonia,nitrite and nitrate), Phosphate total
11. Analysis of iron and manganese in a water sample by visual titrimetry.
12. Analysis of copper and nickel in a water sample by spectrophotometry
13. Analysis of different types of soil- pH, conductivity, alkalinity
14. Determination of N,P,K of soil
15. Determination of macro and micro nutrients in soil.

List of books

1. Water analysis : J. Rodier
2. A Text book of Inorganic Analysis : A.I.Vogel
3. Colorimetric Determination of metals : E.B.Sandell
4. Environmental Chemistry : Moore J W and Moore E A. Academic Press, New York, 1976.

5. Environment and Man Vol VII: The Chemical Environment Edited by J Lenihar and W Fleecher Vlackie Publication, 1977.
6. The Chemistry of Environment: R A Horne, Wiley Interscience Publication 1978.
7. Fundamentals of Air Pollution: A C Stern
8. Instrumental Methods of Analysis: Willard,Merrit and Dean
9. Analytical Chemistry: Meites and Thomas
10. Standard Methods for Examination of water and waste water: A E Greenberg, A D Eaton, APHA, AWWA,WEF
11. Chemistry for Environmental Engineering and Science: C N Sawyer, P L McCarty and G F Parkin
12. Laboratory Manual for the Examination of Water, waste water and soil: H H Rupa and H Krist, V C H Pub.
13. Manual on Water and Waste water analysis: D S Ramteke and C A Moghe, NEERI
14. Environmental Chemistry: B K Sharma and H Kaur
15. Environmental Chemistry: A K De
16. Environmental Pollution- Management and control for sustainable Development: R K Khatoliya
17. Environmental Chemistry: A K Bhagi and G R Chatwal

CH-304: Paper XII (Elective- Polymer Chemistry)

60 h (4 h per week): 15 h per unit 80 Marks

Unit-I:Introduction to polymers **15h**

Nomenclature and classification of polymers. Types of polymers- linear, branched, crosslinked, ladder, thermoplastic, thermosetting, fibres, elastomers, natural polymers, addition and condensation polymers.

Stereoregular polymers- atactic, syndiotactic and isotactic.

Unit-II:Molar mass and its determination **15h**

Molecular mass and molar distribution. Number average, mass average, viscosity, average molecular mass and relation between them. Molecular mass distribution. Determination of molecular mass- Osmometry (membrane and vapour phase), light scattering, gel permeation chromatography, sedimentation and ultracentrifuge, viscosity method and end-group analysis.

Unit III: Physical characteristics of polyemers **15h**

Morphology and order in crystalline polymers. Configuration of polymer chains, crystal structure of polymers. Morphology of crystalline polymers, strain-induced morphology, crystallization and melting. The glass transition temperature (Tg), relationship between T_g and T_T, Effect of molecular weight,

dilments, chemical structure, chain topology, branching and cross linking. Methods of determination of glass transition and crystallinity of polymers.

Unit IV: Commercial polymers **15h**

A) Organic polymers: Commercial polymers, synthesis and and application of polyethylene, polyvinyl chlorides, polyaimdes, polyesters, phenolic resins and eposy resins.

B) Functional polymers: Fire retarding polymers and conducting polymers.

CH-306: Practical VI–Elective (Polymer Chemistry)

9 h per week (Marks-80)

1. Synthesis of polymers:
    a) Synthesis of Thiokol rubber (condensation)
    b) Urea-formaldehyde (condensation)
    c) Glyptal resin: glycerine phthalic acid (crosslinked Polymer Chemistry)
    d) Polyacryonitril (bulk polymerization)
    e) Polyacryonitril (emulsion polymerization)
    f) Polymethylomethacrylate (emulsion of suspension Polymer Chemistry)
    g) Nylon-66 (interfacial polycondensation)
    h) Coordination polymers
    i) Conducting polymer (electro- or peroxodisulphate oxidation)
2. Characterization of polymers:
    a) End-group analysis
    b) Viscosity and molecular mass
    c) Density of polymer by flotation methods
    d) IR spectra.
3. Purification and fractionation of polymer, polystyrene, Nylon 66, PMMA.
4. Magnetic and electrical properties of polymers, magnetic susceptibility and electrical conductivity of coordination and conducting polymers.
5. Thermal analysis and degradation of polymers
    TGA: Isothermal and non-isothermal
    DTA: Glass transition temperature and melting point
6. Crystallinity of polymers by density measurement.

7. Swelling and solubility parameters of polymers.
8. Synthesis of Graft-Polymers and its characterization by density and IR spectra.
9. Dielectric behavior of polymers.
10. Kinetics of polymerization:
    a) Polycondensation
    b) Peroxide initiation polymerization.

List of books:

1. Textbook of polymer science: F.W. Billmayer Jr. Wiley.
2. Polymer science: V.R. Gowarikar, N. V. Viswanathan and J. Sreedhar, Wiley-Eastern.
3. Fractional monomers and polymers: K Takemoto, Y. Inaki, and R.M. Ottam Brite.
4. Contemporaty polymer chemistry: H.R. Alcock and F. W. Lambe, Prentice Hall.
5. Principles of polymer Chemistry: Flory, Cornell Univ. press.
6. Introduction to polymer chemistry: R. B. Seymour, McGraw Hill.
7. Principles of polymerization: Odian.
8. A first course in polymer chemistry: A. Strepikheyew, V. Derevistkay and G. Slonimasky, Mir Publishers, Moscow.
9. Laboratory preparation of macro chemistry: EMM effery, McGraw Hill Co.
10. A practical course in polymer chemistry: S.J. Punea , Pergamon Press.

CH-304: Paper XII (Elective- Medicinal Chemistry)

60 h (4 h per week): 15 h per unit 80 Marks

UNIT-I: **15 h**

A] Biological response to drug, significance of drug metabolism in medicinal chemistry ,Prodrugs, computer aided drugs, molecular modelling and drug design, Clinical studies, medical formulations ,Stereochemistry and drug development

B]Cardiovascular Drugs: Introduction, cardiovascular diseases, Synthesis of nitrate,verapami, methyldopa, atenolol.

UNIT-II: **15 h**

A] Antineoplastic Agent: Introduction, classification,cancer chemotherapy, cancer causing chemicals, role of alkylating agents and antimetabolites in treatment of cancer, hormone and natural products. Synthesis of melphalan , thiotepa, lomustine

B] Antidiabetic Agents- Type-I and Type-II diabetes, Insulin, thiazolidinediones, Synthesis of ciglitazone.

UNIT-III: **15h**

A] Local Anti-infective drug: Introduction and general mode of action. Synthesis of sulphonamides, ciprofloxacin, norfloxacin, dapsone ,amino salicylic acid, isoniazid, ethionamide, ethambutal, econozole, griseofulvin.

B] Diuretics: Introduction, mode of action, loop diuretics. Synthesis of Bumetanide, Frusemide, Ethacrynic acid, clorexolone Quinethazone.

C] Analgesics and Antipyretics: Introduction, mode of action, evaluation of analgetic agents.

Synthesis of: Aspirin, salsalate, phenacetin, phenylbutazone, Indomethacin, Analgin.

UNIT-IV: **15 h**

A] Psychoactive drugs: Introduction, CNS depressants, Introduction and mode of action of Barbiturates, Benzodiazepenes, hydantoins, butyrophenones, buspirone, CNS Stimulants, Synthesis of Phenobarbital, thiopental sodium ,diazepam, lorazepam, bromazepam, ethosuximide

B]Coagulant and Anticoagulants: Introduction, factors affecting coagulant and anti-coagulant. Mechanism of Blood coagulation and Anticoagulation. Structure of Vitamin K1, Vitamin K2 and heparin. Synthesis of Coumarins and indanediones.

CH-306: Practical VI–Elective (Medicinal Chemistry)

9 h per week Marks-80)

1. Volumetric estimation of Ibuprofen.
2. Estimation of aspirin by volumetric and instrumental methods.
3. Analysis of ascorbic acid in biological/tablet sample.
4. Determination of paracetamol by colorimetry.
5. Analysis of ampicillin trihydrate.
6. Determination of vitamin B12 in commercial sample by spectrophotometry.
7. Determination of phenobarbitone in given cough syrup.
8. Determination of tetracycline in given capsule.
9. Determination of iron, calcium and phosphorus from milk or drug sample.
10. Determination of glucose by glucometer.
11. To perform I.P. monograph of tablet.

12. Estimation of uric acid in serum and urine.
13. Estimation of chloride in serum and Urine.
14. Estimation of liver glycogen.
15. Determination of blood cholesterol.
16. Determination of creatinine and creatine in blood/Urine.
17. Separation and determination of sulpha drugs in tablets or ointments.

Preparation of Drugs: Synthesis, purification and identification of (8-10) of the following drugs.

1. Benzocaine from p-nitrobenzoic acid.
2. Dapsone from diphenyl sulphone.
3. Paracetamol from p-nitro phenol.
4. Uracil from sulphanil amide.
5. Diphenyl hydantion from benzoin.
6. Aluminium asprin from salicylic acid.
7. 4,6-diphenyl-thiazine from chalcone.
8. 6/8 nitro coumarin from resorcinol.
9. Copper aspirin from salicylic acid.
10. N-acetyl parabanic acid.
11. Nerolin from 2-naphthol
12. Phenothiazine from diphenylamine
13. Umbelliferon from resorcinol
14. Benzylidene from benzaldehyde and aniline
15. 1-phenyl-1,2-pentadine-3-one from benzaldehyde
16. 1,5 diphenyl-1,3-pentadiene-2-one from benzaldehyde
17. 1,3-diphenyl-prop-2-ene-1-one
18. 3-methy pyrazol-5-one from ethylacetoacetate
19. 6-methyl uracil
20. Sulphanilamide from acetanilide

List of books:

1. Text book of organic medicinal chemistry-Wilson,Geswold
2. Medicinal chemistry Vil I and II-Burger
3. A textbook of pharmaceitical chemistry-Jayshree Ghosh
4. Introduction to medicinal chemistry-A Gringuadge

5. Wilson andGisvold text book of organic medicinal and pharmaceutical chemistry-Ed.Robert F Dorge
6. An introduction to drug design-SS Pandey,and JR Demmock
7. Goodman and Gilmans pharmacological basis of therapeutics- Stragies for organic drug sythesis and design-D Lednicer
8. Textbook of Medicinal Chemistry- A. Kar
9. Medicinal Chemistry – D Sriram and P.Yogeeswari

CH-307: Seminar-III

2 h /week Marks: 25

Seminar of 30 minutes duration will be a part of internal assessment for 20 marks (1 credit). Seminar should be delivered by the student under the guidance of concerned teacher on the topic allotted by the teacher. The topic will be related to the syllabus. Marks will be allotted by a group of teachers.