### Scheme of Examination for M.Sc. (Chemistry)

#### Semester IV

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<th>Internal Assessment</th>
<th>Total Marks</th>
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<tr>
<td>CH-401</td>
<td>Paper XIII (Spectroscopy)</td>
<td>20 Marks</td>
<td>80 Marks</td>
<td>4 Credits</td>
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<tr>
<td>CH-402</td>
<td>Paper XIV (Special I-Inorganic/Organic/Physical/Analytical)</td>
<td>20 Marks</td>
<td>80 Marks</td>
<td>4 Credits</td>
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<td>CH-403</td>
<td>Paper XV (Special II-Inorganic/Organic/Physical/Analytical)</td>
<td>20 Marks</td>
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<td>CH-404</td>
<td>Paper XVI (Elective - Applied Analytical/Nuclear/Environmental/Polymer/Medicinal)</td>
<td>20 Marks</td>
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<td>CH-405</td>
<td>Practical VII- Special (Inorganic/Organic/Physical/Analytical)</td>
<td>20 Marks</td>
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<td>CH-407</td>
<td>Seminar-IV</td>
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**Total:** 120 Marks 505 Marks 25 Credits

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**General scheme for distribution of marks in practical examination**

- **Time:** 6-8 h (One day Examination) **Total Marks:** 80
  - Exercise-1: 30 Marks
  - Exercise-2: 20 Marks
  - Viva-Voce: 15 Marks
  - Record: 15 Marks
Syllabus prescribed for M.Sc. Chemistry Semester IV

CH-401: Paper XIII (Spectroscopy)

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

**Unit I:**


B] Photoelectron spectroscopy: Basic principles, photoelectric effect, ionization process, Koopman theorem, PES and XPES, PES of simple molecules, ESCA, chemical information from ESCA, Auger electron spectroscopy.

**Unit II: Nuclear magnetic Resonance Spectroscopy**

Magnetic properties of nuclei, resonance condition, NMR instrumentation, chemical shift, spin spin interaction, shielding mechanism, factors affecting chemical shift, PMR spectra for different types of organic molecules, effect of deuterium, complex spin spin interaction (1st order spectra), stereochemistry, variations of coupling constant with dihedral angle, electronegativity, Karplus equation etc., classification of molecules as AX, AX₂, AMX, A₂B₂, Shift reagents. NMR studies of ¹³C, chemical shift in aliphatic, olefinic, alkyne, aromatic, heteroatomic and carbonyl compounds, ¹⁹F, ³¹P. Structure determination of organic molecules by NMR spectroscopy,

**Unit III:**

A] Application of NMR spectroscopy: FT-NMR, advantages of FT-NMR, use of NMR in medical diagnosis, 2 dimensional NMR spectroscopy-COSY, NOSEY, DEPT, INEPT, APT, INADEQUATE techniques, Nuclear overhauser effect, nuclear quadrupole resonance spectroscopy: quadrupole nuclei, quadrupole moment, electric field gradient, coupling constant, splitting, applications.

B] Problems based on structure determination of organic molecules by using combined spectral techniques.

**Unit IV: Diffraction techniques**

X-ray diffraction: Bragg’s condition, Miller indices, Laue method, Bragg method, Debye Scherrer method, identification of unit cells from systematic absences in diffraction pattern, structure of simple lattices and x-ray intensity, structure factor and its relation to intensity and electron density, absolute configuration of molecules, Ramachandran diagram.
Electron diffraction: scattering intensity vs scattering angle, Wierl equation, measurement techniques, elucidation of structure of simple gas phase molecules, low energy electron diffraction and structure of surfaces.

Neutron diffraction: Scattering of neutrons by solids and liquids, magnetic scattering, measurement techniques, elucidation of structure of magnetically ordered unit cell.

List of books
1] Spectroscopic identification of organic compound-RM Silverstein, GC Bassler and TC Morril, John Wally
6] Organic Spectroscopy-RT Morrison and RN Boyd
7] Practical NMR Spectroscopy-ML Martin, JJ Delpench, and DJ Martin
8] Spectroscopic Methods in Organic Chemistry-DH Wilson, J 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-Ray H Bible
15] Interpretation of IR spectra-NB Coulthop
18] Spectroscopy- H. Kaur
INORGANIC CHEMISTRY SPECIALIZATION

CH-402: Paper XIV (Special I-Inorganic Chemistry)

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

Unit-I 15h


B) Solid State Reaction: General principles, reaction rates, reaction mechanism, reaction of solids, factors influencing reactivity, photographic process.

Unit-II 15h


B) Characterization of coordination polymers on the basis of:
   i) Spectra (UV, Visible, IR and NMR)
   ii) Magnetic and thermal (TGA,DTA and DSC) studies

Unit-III 15h

Catalysis: Basic principals, thermodynamic and kinetic aspects, industrial requirements, classification, theories of catalysis, homogeneous and heterogeneous catalysis. Introduction, types & characteristics of substrate-catalyst interactions, kinetics and energetic aspects of catalysis, selectivity, stereochemistry, orbital symmetry and reactivity. Catalytic reactions of coordination and Organometallic compounds including polymerization activation of small molecules, addition to multiple bonds, hydrogenation Zeigler-Natta polymerization of olefins, hydroformylations, oxidations, carbonylations and epoxidation.

Unit-IV 15h

A) Supramolecular chemistry: Molecular recognition: Molecular receptors for different types of molecules including arlsonic substrate, design nad synthesis of co receptor molecules and multiple recognition. Supramolecular reactivity and catalysis. Transport processes and carrier design. Some examples of self-assembly in supramolecular chemistry.
B) **Thin films and languir-Biodgett films:** Preparation technique, evaporation/sputtering, chemical processes, MOCVD, solgel etc. Languir-Biodgett(LB) film, growth techniques, photolithography properties and applications of thin and LB films.

**List of books:**

CH-403: Paper XV (Special II-Inorganic Chemistry)

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

Unit-I


B) Properties of excited states: Photochemical kinetics, Calculation of rates of radiative processes.

C) Excited States of Metal Complexes: Electronically excited states of metal complexes, charge transfer spectra, charge transfer excitations, methods for obtaining charge transfer spectra.

Unit-II

A) Ligand field Photochemistry: photosubstitution, photo oxidation & photoreduction. Liability and selectivity, zero vibrational levels of ground state and excited state, energy content of excited state, zero-zero spectroscopic energy, development of the equations for redox potentials of the excited states.

B) Redox reactions by Excited Metal Complexes: Energy transfer under conditions of weak interaction & strong interaction – exciplex formation, conditions of excited states to be useful as redox reactants, excited electron transfer, metal complexes as attractive candidates (2,2-bipyridine & 1,10-Phenanthroline complexes.), illustration of reducing and oxidizing character of ruthenium (II); role of spin-orbit coupling, lifetime of these processes. Application of redox processes of electronically excited states for catalytic purposes, transformation of low energy reactants into high energy products, chemical energy into light.

C) Metal Complex Sensitizers: Metal Complex Sensitizers, electron relay, metal colloid systems, and semiconductor supported metal or oxide systems, water photolysis, nitrogen fixation & carbon dioxide reduction.

Unit-III


Unit-IV

Transition Metal Pi Complexes-Carbon multiple bonds. Nature of bonding, structural characteristics & synthesis, properties of transition metal pi- Complexes with unsaturated organic molecules, alkenes alkynes,
allyl, diene, dienyl, arene & trienyl complexes. Application of transition metal, organometallic intermediates in organic synthesis relating to nucleophilic & electrophilic attack on ligands, role in organic synthesis.

**List of books:**
6. Wells,Introduction of Photochemistry
7. Paulson,Organometallic Chemistry,Arnold
8. Rochow,Organometallic Chemistry,Reinhold
9. Zeiss,Organometallic Chemistry,Reinhold
11. Turro N.J.and Benjamin W.A.,Molecular Photochemistry
CH-405: Practical-VII (Inorganic Chemistry Special)

9 h /week            Marks: 80

A) Preparation and characterization of the following complexes/organometallic compound including their structural elucidation by the available physical methods. (Element analysis, molecular weight determination, conductance and magnetic measurement and special studies) Selection can be made from the following:

i) Cis and trans isomers of bis(glycinato) copper(II) monohydrate.
ii) N,N-bis (salicylaldehyde) ethylene diaminato nickel(II)
iii) Trinitrotoluene cobalt(III)
iv) Cis and trans disubstituted octahedral Cr (III) complexes \([\text{CrF}_2(\text{en})_2]\).
v) Preparation of Grignard reagent
vi) Ferrocene and its acetylation
vii) Sodium amide
viii) Synthesis of trichlorodiphenylantimony(V) hydrate.
ix) Synthesis of metal acetylacetonate: magnetic moment, IR, NMR.
x) Magnetic moment of Cu(acac)$_2$H$_2$O
xi) Determination of Cr (III) complexes: \([\text{Cr(H}_2\text{O)}_6\text{NO}_3\cdot3\text{H}_2\text{O}, [\text{Cr(H}_2\text{O)}_4\text{Cl}_2]\cdot\text{Cl}\cdot2\text{H}_2\text{O}, [\text{Cr(en)}_3]\text{Cl}_3\]
xii) Preparation of N,N bis (salicylaldehyde) ethylenediamine, (salen), Cobalt and copper complexes.

B) Solid State:
1) Preparation of oxides and mixed oxides (Mn$_2$O$_3$, NiO, Cu$_2$O, Fe$_3$O$_4$, ZnFe$_2$O$_4$, ZnMn$_2$O$_4$, CuMn$_2$O$_4$ and NiFe$_2$O$_4$)
2) Preparation of Silica and Alumina by sol-Gel technique.
3) To study the electrical conductivity of ferrites, Magnetites, doped oxides and pure samples and determine band gap.

A) Bioinorganic Chemistry
1) Extraction and absorption spectral study of chlorophylls from green leaves of students choice
2) Separation of Chlorophyll and their electronic spectral studies.
3) Complexation study of Cu(II) with biologically important amino acids

B) Inorganic reaction mechanism:
Kinetics and mechanism of following reactions:
1) Substitution reactions in octahedral complexes (Acid/Basehydrolysis)
2) Redox reactions in octahedral complexes.
3) Isomerization reaction of octahedral complexes.

**D) Inorganic Photochemistry:**

i) Synthesis of potassium ferrioxalate and determination of intensity of radiation

ii) Photooxidation of oxalic acid by UO$_2^{2+}$ sensitazation

iii) Photo decomposition of HI and determination of its quantum yield.

**List of books:**

2. Inorganic Experiments, J. Derck Woollins, VCH.
5. EDTA Titrations. F. Laschka
6. Instrumental Methods of Analysis, Willard, Merit and Dean (CBS, Delhi).
7. Inorganic Synthesis, Jolly
8. Instrumental Methods of Chemical Analysis, Yelri Lalikov.
11. Solid state Chemistry, N.B. Hanney
12. Introduction to Thermal Analysis, Techniques and Applications, M. E. Brown, Springer
ORGANIC CHEMISTRY SPECIALIZATION
CH-402: Paper XIV (Special II-Organic Chemistry)

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

Unit I:

A] Carbanions in organic Chemistry 15 h
Ionization of carbon hydrogen bond and prototopy, Base and acid catalysed halogenation of ketones, keto-enol equilibria, structure and rate in enolisation, concerted and carbanion mechanism for tautomerism, carbanion character in phenoxide and pyrrolyl anions, geometry of carbanions, kinetic and thermodynamic control in the generation of enolates, LDA, hydrolysis of haloforms, use of malonic and acetoacetic esters, Aldol, Mannich, Cannizzaro, Darzens, Dieckmann, Claisen Baylis-Hillman reactions, Knoevenagel, benzoin condensation, Favorski reaction, alkylation of enolates and stereochemistry thereof, Conjugate additions.

B] Organometallic reagents -I
Synthesis and applications of organo Li and Mg reagents, nucleophilic addition to aldehyde, ketones, ester, epoxide, CO$_2$, CS$_2$, isocyanates, ketenes, imines, amides, lactones, Stereochemistry of Grignard addition to carbonyl compounds, o-metallation of arenes using organolithium compounds.

Unit II:

A] Organometallic reagents-II 15 h
Organozinc reagents: Preparation and applications, Reformatsky reaction, Simon-Smith reaction. Organocupper reagents: Preparation and applications in C-C bond forming reaction, mixed organocuprates, Gilman’s reagent. Organo Hg and Cd reagents in organic synthesis.

B] Transition metals in organic synthesis
Transition metal complexes in organic synthesis-Introduction-oxidation states of transition metals, 16-18 rule, dissociation, association, insertion, oxidative addition, reductive elimination of transition metal Organopalladium in organic synthesis-Heck reaction, allylic activation, carbynylation, wacker oxidation, isomerization formation N-aryl and N-alkyl bond transmetalation, allyl deprotection in peptides, coupling reactions: Kumada Reaction, Stille coupling, Sonogashira and Suzuki coupling reactions and their importance Applications of Co$_2$(CO)$_8$, Ni(CO)$_4$, Fe(CO)$_5$ in organic synthesis. Wilkinson, Noyori, Knowls catalyst of Ruthenium and Rhodium – synthesis and uses its use in hydrogenation reactions-deallylation, C-C, C-O, C-N bond cleavages. Olefin metathesis by $1^{st}$ and $2^{nd}$ generation catalyst, reaction mechanism and application in the synthesis of homo and heterocyclic compounds
Unit III:  

A] Advanced Stereochemistry:  
Conformation of sugars, monosaccharides, disaccharides, mutarotation, Recapitulation of Stereochemical concepts- enantiomers, diastereomers, homotopic and heterotopic ligands, Chemo-, regio-, diastereo- and enantio-controlled approaches; Chirality transfer, Stereoselective addition of nucleophiles to carbonyl group: Re-Si face concepts, Cram’s rule, Felkin Anh rule, Houk model, Cram’s chelate model. Asymmetric synthesis use of chiral auxiliaries, asymmetric hydrogenation, asymmetric epoxidation and asymmetric dihydroxylation,  

B] Protection and Deprotection of functional groups: Protection and deprotection of functional groups like, hydroxyl, amino, carbonyl and carboxylic acids groups, Solid phase peptide synthesis.  

Unit IV: Designing the synthesis based on retrosynthetic analysis  

(A) Disconnection Approach: An introduction to synthons and synthetic equivalents, disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reactions, amine synthesis  

(B) One Group C-C Disconnections: Alcohols and carbonyl compounds, regioselectivity, alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis  

(C) Two Group C-C Disconnections: Diels-Alder reaction, 1,3-difunctionalised compounds, α,β-unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalised compounds, Michael addition and Robinson annelation, Methods of ring synthesis  

List of books  
2) Modern Synthetic Reaction. H. O. House and W. A. Benjamin  
3) Organic Synthesis: The Disconnection Approach-S. Warren  
4) Designing Organic Synthesis-S. Warren  
5) Some Modern Methods of Organic Synthesis-W. Carruthers  
6) Advance Organic Reaction. Mechanism and Structure-Jerry March  
8) Organic Reaction and their Mechanism-P. S. Kalsi  
9) Protective Groups in Organic Synthesis-T. W. Greene  
11) Organo Silicon Compound-C. Eabon  
12) Organic Synthesis via Boranes-H. C. Brown  
13) Organo Borane Chemistry-T. P. Onak  
14) Organic Chemistry of Boron-W. Gerrard
Unit I: Enzyme chemistry

A] Enzymes: Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer’s lock and key and Koshland’s induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling and enzyme modification by site-directed mutagenesis. Baker’s yeast catalyzed reactions, Applications of enzymes in food and drug chemistry

B] Mechanism of Enzyme Action: Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Example of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase A.


Unit II: Heterocycles

A] Azoles: Structural and chemical properties; Synthesis of pyrazole, isothiazole and isoxazole; Synthesis of imidazoles, thiazoles and oxazoles; Nucleophilic and electrophilic substitutions; Ring cleavages


C] Diazines: Structural and chemical properties; Synthesis of pyridazines, pyrimidines, pyrazines; Nucleophilic and electrophilic substitutions.

Unit III:

A] Nucleic Acids: Primary, secondary and tertiary structure of DNA; DNA replication and heredity; Structure and function of mRNA, tRNA and rRNA. Purines and pyrimidine bases of nucleic acids and their preparation.

B] Lipids: Fatty acids, essential fatty acids, structures and functions of triglycerols, glycerophospho lipids, sphingolipids, lipoproteins, composition and function, role in atherosclerosis

Properties of lipid aggregates, micells, bilayers, liposomes and their biological functions, biological membranes, fluid mosaic model of membrane structure, Lipid metabolism, β-Oxidation of fatty acids

C] Vitamins: Structure determination, synthesis and biosynthesis of vitamin A, E and H.
Unit IV:  15h

A] Dyes:
General Introduction, classification on the basis of structure and methods of application dying mechanism, methods of dying, such as direct dying, vat dying, dispersive dying, formation of dye in fibre, dying with reactive dyes, study of quinoline yellow, cyamine dye, ethyl red, methylene blue, Alizarin, cyamine-green, fluorescein, cosin, erythrosine, Rhodamines and Indigo.

B] Pharmaceutical chemistry:
History, medical terms in pharmaceutical chemistry, classification of drugs, antibacterial and antifungal drugs, specific clinical applications, Serendipity and drug development, Synthesis and applications of: Benzocaine, Methyl dopa, dilantin, ciprofloxacin, acyclovir, terfenadine, salbutamol.


List of books
5] Understanding Enzymes, Trevor Palmer, Prentice Hall
8] Introduction to Medicinal Chemistry, A. Gringuage, Wiley-VCH
CH-405: Practical-VII (Organic Chemistry Special)

9 h /week                  Marks: 80

[A] Quantitative Analysis based on classical and instrumental technique (any 9-10)

1] Estimation of nitrogen.

Spectrophotometric/calorimetric and other instrumental methods of estimation

8] Estimation of carbohydrates.
9] Estimation of Ascorbic acid.
11] Solvent extraction of oil from oil seeds and determination of saponification value, iodine value of the same oil.

[B] Organic multi-step preparations (Two/Three steps): Minimum 10-12 preparations

[1] Aniline → Diaminoazobenzene → p-aminodiamobenzene

[2] Benzoin → Benzyl → Dibenzyl


[5] Benzaldehyde (thiamine hydrochloride) → benzoin → benzil → benzilic acid

[6] p-Nitrotoluene → p-nitrobenzoic acid → PABA → p-iodobenzoic acid


[8] Benzaldehyde → benzilidene acetophenone → 4,5-dihydro-1,3,5-triphenyl-1H-pyrazole

[9] Aniline → phenylthiocarbamide → 2-aminobenzthiazole (Microwave in step I)

[10] Chlorobenzene → 2,4- Dinitrochlorobenzene → 2,4- Dinitrophenyldiazine.


[12] Benzil → benzoindene benzoate → 2,4,5-triphenyl oxazole


[14] Benzophenone → Benzophenone oxime → Benzanilide → Benzoic acid + aniline
[15] Aniline → aniline hydrogen sulphate → sulphanilic acid → Orange II
[16] Aniline → N-arylglycine → indoxyl → indigo
[17] Phthalimide → Anthranilic acid → Phenyl glycine-o-carboxylic acid → Indigo
[18] Phalic anhydride → Phthalimide → Anthranilic acid → α-chlorobenzoic acid
[19] Phalic anhydride → Phthalimide → Anthranilic acid → Diphenic acid
[20] Ethyl acetoacetate → 3-methyl-pyrazol-5-one → 4,4-dibromo-3-methyl-pyrazol-5-one → Butanoic acid
[21] Biosynthesis of ethanol from sucrose
[22] Enzyme catalyzed reactions

[C] SPECTRAL INTERPRETATION
Structure Elucidation of organic compounds on the basis of spectral data (UV, IR, \(^{1}H\) and \(^{13}C\)NMR and Mass) (Minimum 12 compounds are to be analysed during regular practicals)
PHYSICAL CHEMISTRY SPECIALIZATION
CH-402: Paper XIV (Special I-Physical Chemistry)

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

UNIT-I SURFACE CHEMISTRY 15h


C] Modern techniques for investigating surfaces-Low energy electron diffraction (LEED), PES, Scanning tunneling and atomic force microscopy (STM and AFM)

UNIT II CORROSION AND CORROSION ANALYSIS 15h
A] Scope and economics of corrosion, causes (Change in Gibbs free energy) and types of corrosion, electrochemical theories of corrosion, dry and wet corrosion, Different types of corrosion-Pit, Soil, chemical and electrochemical, intergrannular, waterline, microbial corrosion, measurement of corrosion by different methods, factors affecting corrosion, passivity, galvanic series, protection against corrosion, design and material selection.

B] Thermodynamics of corrosion, corrosion measurements (Weight loss, OCP measurements, polarization methods), passivity and its breakdown, corrosion prevention (electrochemical inhibitor and coating methods).

UNIT III: RADIATION CHEMISTRY 15h
Measurement of dose. Dosimetric terms and units (Roentgen, REM, Rad, Gray, Sievert), inter conversions, calculation of absorbed dose-various types of dosimeters, chemical dosimeters (Fricke and Ceric sulphate), experimental methods, TLD badges, Radiolysis-definition, process, Radiolysis of water and aqueous solutions, hydrated electron, Effect of radiation on biological substances, genetic effects, radiation effects on organic compounds (Halides-carboxylic acids), polymers, nitrates and solid thermoluminescence.

UNIT IV: LIQUID STATE 15h
A] Theory of liquids:- Theory of liquids, partition function method or model approach, single cell models, communal energy and entropy, LTD model, significant structure model.

Books Suggested:
7. Radiochemistry: A. N. Nesmeyanov (Mir Publications)
UNIT I: ELECTRICAL AND MAGNETIC PROPERTIES OF SOLIDS

A] Metals, insulators and semiconductors, electronic structure of solids-band theory, fermi gas model, electrical conductivity, thermal conductivity, Lorenz number, periodic potential, band structure of metals, insulators and semiconductors, intrinsic and extrinsic semiconductors, doping semiconductors, semiconductor p-n junctions, colors in solids.semi-conductors, meissner effect, LTSC, HTSC.

B] Behaviour of substances in magnetic field, effect of temperature: Curie and Curie-weiss law, calculation of magnetic moments, magnetic materials, their structure and properties, Applications: structure/ property relations, numericals.

UNIT II: ELECTRICAL PROPERTIES OF MOLECULES

Dipole moments of molecules, basic ideas of electrostatic interactions, polarizability, orientation polarization, Debye equations, limitation of the Debye theory, Clausius-Mossotti equation. Electrostatic of dielectric medium, molecular basis of dielectric behavior, structural information from dipole moment measurements, use of individual bond dipole moments, application to de substituted benzene derivatives, dipole moment and ionic character of a molecule, determination of dipole moment from dielectric measurements in pure liquids and in solutions. The energies due to dipole-dipole, dipole induced dipole and induced dipole-induced dipole interaction. Dispersion, dielectric loss and refractive index. Lennard-Jones potential.

Unit III: LIQUID CRYSTALS


Unit IV:

A] Liquid gas and liquid interfaces: Surface tension, methods of determination of surface tension, surface tension across curved surfaces, vapor pressure of droplet (Kelvin equation), surface spreading, spreading coefficient, cohesion and adhesion energy, contact angle, constant angle hysteresis, wetting and detergency.

B] Solid - Solid interfaces: Surface energy of solids, adhesion and adsorption, sintering and sintering mechanism, Tammann temperature and its importance, surface structure and surface composition.
List of books
CH-405: Practical-VII (Physical Chemistry Special)

9 h /week            Marks: 80

Adsorption:
1. To verify Freundlich adsorption isotherm.
2. To verify Langmuir adsorption isotherm.
3. To verify Gibbs adsorption isotherm and to find surface excess concentration of solute.
4. To determine CMC of the given surfactant by surface tension method.
5. Study of variation of surface tension of solution of n-propyl alcohol with concentration and hence determine the limiting cross section area of alcohol molecule.

Kinetics:
6. Clock reaction- activation energy of bromide-bromate reaction.
7. Temp dependence of persulfate-iodide reaction by iodine clock method and calculation of thermodynamic and Arrhenius activation parameters. Study of ionic strength effect on persulfate-iodide reaction.
9. Investigate the Autocatalytic reaction between potassium permanganate and oxalic acid.
10. Determination of PKa value of a weak acid by chemical kinetic method(formate-iodine reaction)

Potentiometry and Conductometry:
11. Transport number by potentiometry.
12. Hydrolysis constant by aniline-hydrochloride by potentiometry and conductometry.
13. pKa of weak acids by potentiometry and conductometry.
14. Complexation between Hg^{2+} and I conductometrically.
ANALYTICAL CHEMISTRY SPECIALIZATION

CH-402: Paper XIV (Special I-Analytical Chemistry)

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

Unit-I: Radioanalytical Chemistry-II 15h
Preparation of some commonly used radioisotopes, Use of radioactive isotopes in analytical and physico-chemical problems, Industrial applications, Neutron sources, Neutron Activation Analysis, Isotope Dilution Analysis, Radiometric titrations (Principle, Instrumentation, applications, merits and demerits), Radiochromatography, Carbon dating, Numericals based on above.

Unit-II: Optical methods of analysis-IV 15h
Particle induced X-ray emission (PIXE): Basic principle, Instrumentation and applications.
Electron microscopy: Principle, instrumentation and applications of scanning electron microscopy (SEM) and transmission electron microscopy (TEM)

Unit-III: Electrochemical methods of analysis-III 15h
Electrochemical microscopy: Introduction to scanning probe microscopy (SPM), scanning tunneling microscopy (STM), atomic force microscopy (AFM) and scanning electrochemical microscopy (SECM).

Unit-IV: Thermal methods of analysis 15h
CH-403: Paper XV (Special II-Analytical Chemistry)

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

Unit-I: Pharmaceutical and clinical analysis
Requirements of a quality control laboratory for pharmaceutical units, a general idea about following classes of drugs and their analysis-

a. Antibiotics-Chloroamphenol, ampicilline, terramycine
b. Vitamins-Thymine hydrochloride (Vitamin-B1) Riboflavin (Vitamin-B2), Ascorbic acid (Vitamin-C)
c. Sulpha drugs- sulphaguanidine, sulphapyrazine, sulphanilamide
d. Narcotics and dangerous drugs- screening by GC and TLC and spectrophotometric measurements.

Composition of blood, sample collection for blood and urine, clinical analysis, Immuno Assay-RIA, Setting up of RIA and applications, Fluorescence Immunoassay, Enzyme immunoassay, Blood gas analyzer, Trace elements in the body.

Unit-II: Soil analysis and coal analysis

Soil analysis- Classification and composition, pH and conductivity, analysis of constituents such as nitrogen, phosphorous, potassium and microconstituents.


Unit-III: Corrosion and corrosion analysis

Definition, draw backs and theories of corrosion-dry and wet corrosion, Different types of corrosion-Pit, Soil, chemical and electrochemical, intergrannular, waterline, microbial corrosion, measurement of corrosion by different methods, factors affecting corrosion, passivity, galvanic series, protection against corrosion, design and material selection.

Unit-IV: Automation in analytical chemistry

Automation in the laboratory, Principle of automation, automated instruments, classification, continuous analyzer, automatic instruments, semiautomatic instruments GeMSAEC Analyzer, Flow Injection Analysis (FIA), Dispersion coefficient, Factors affecting Peak Height, microprocessor based instruments, Numericals based on above.

Hyphenated techniques: Introduction to GC-MS, LC-MS, ICP-MS and MS-MS (Tandem) spectrometry.
CH-405: Practical-VII (Analytical Chemistry Special)

9 h /week Marks: 80

A. Organoanalytical chemistry
1. Estimation of sulphur, nitrogen, phosphorous, chlorine in organic compound.
2. Estimation of phenol.
3. Estimation of aniline.

B. Separation techniques

Ion exchange
1. Separation and estimation of zinc and magnesium/cadmium in a mixture on anion exchanger.
2. Separation and estimation of chloride and iodide in a mixture on anion exchanger.
3. Determination of total cation concentration in water.

Solvent extraction
1. Estimation of Copper using Na-DDC.
2. Estimation of Iron using 8-hydroxyquinoline.
3. Estimation of Nickel using DMG.
4. Estimation of Cobalt using 8-hydroxyquinoline.
5. Estimation of Nickel by synergistic extraction with 1,10-phenanthroline and dithizone.

Paper chromatography
1. Separation and estimation of copper and nickel in a mixture.
2. Separation and estimation of cobalt and nickel in a mixture.

Thin layer chromatography
Separation and estimation of bromophenol blue, congo red and phenol red in a mixture.

C. Water analysis

Mineral analysis: Temperature, pH, conductivity, turbidity, solids, alkalinity, chloride, fluoride, sulphate, hardness

Demand analysis: DO, COD

Heavy metals: Fe, Cd and Pb

D. Demonstrations
1. Gas chromatography
2. HPLC

List of books:
1. Essentials of Nuclear Chemistry: H. J. Arnikar (Willey Eastern Ltd)
3. Thermal analysis: Blazek (translated by J. F. Tyson, Van Nostrand)
4. Instrumental Methods of Analysis: Willard, Meriit and Dean (Van Nostrand)
7. Advanced Analytical Chemistry: Meites and Thomas (McGraw-Hill)
8. Atomic Absorption Spectroscopy: Robinson (Marcel Dekker)
10. Radiochemistry: A. N. Nesmeyanov (Mir Publications)
11. Analysis of Water: Rodier
12. Ion selective electrodes: Koryta (Cambridge University Press)
13. Instrumentation in analytical chemistry: Borman (American Chemical Society)
16. Electroanalytical Chemistry: Bard (Dekker)
17. Analytical Chemistry by Open Learning (Wiley)
18. An Introduction to Electron Diffraction: Beeston (North Holland Publishing Co.)
19. Material Science and Engineering: V. Raghavan (Printice-Hall of India)
20. Practical Physical Chemistry: J. B. Yadav (Goel Publishing House)
**CH-404: Paper XVI (Elective- Applied Analytical Chemistry)**

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

**Unit-I: Water treatment** 15h


**Unit-II: Polymer chemistry and Glass analysis** 15h

**Polymer chemistry:** Definition, classification, co-polymers, conducting polymers, determination of molecular weight, acid value, saponification value, iodine value and hydroxyl groups of polymers, TGA and DTA studies of polymers, LDC polymers. Rubbers, elastomers, silicones.

**Glasses:** Introduction. Physical and chemical properties. Composition of ordinary glass and special glasses. Determination of silicon, calcium, magnesium, aluminium, chloride, sulphur, barium, arsenic, antimony, chromium, cobalt, copper, iron, manganese, nickel, titanium in glasses.

**Unit-III: Cosmetic technology and leather analysis** 15h


**Analysis of leather:** Determination of moisture, acid, free sulphur, total ash, chromic oxide in leather, tensile strength and stretch of leather.

**Unit-IV: Explosives and propellants** 15h

Classification of explosives, characteristics of TNB, TNT, RDX, dynamite, lead azide, ammonium nitrate, ammonium picrate. Pyrotechniques.

CH-404: Paper XVI (Elective- Nuclear Chemistry)

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

Unit-I: Radiation Chemistry, Radiolysis 15h
Measurement of dose. Dosimetric terms and units (Roentgen, REM, Rad, Gray, Sievert), inter conversions, calculation of absorbed dose-various types of dosimeters, chemical dosimeters (Fricke and Ceric sulphate), experimental methods, TLD badges, Radiolysis-definition, process, Radiolysis of water and aqueous solutions, hydrated electron,
Effect of radiation on biological substances, genetic effects, radiation effects on organic compounds (Halides-carboxylic acids), polymers, nitrates and solid thermoluminescence.

Unit-II: Hot Atom Chemistry and Radiochemistry 15h
Recoil energy and calculations, Szilard Chalmers effects, Kinetics, primary and secondary retention-effect of various factors on retention and its uses, Mossbauer effect, principle, instrumentation and chemical applications,

Unit-III: Radioanalytical techniques 15h
Neutron sources, Neutron activation analysis, principle, methodology and application for trace analysis, Isotope dilution analysis-principle and application, Isotopic exchange reaction, mechanism and application in use of radioisotopes and tracers, radioactive dating based on carbon-14 and lead isotopes.

Unit-IV: Radiopharmaceuticals 15h
Radioimmunoassay (RIA), discovery, principle, set up of RIA, Principle of Immunoradiometric assay (IRMA), principle and set up, Radiopharmaceuticals, classification of products, preparations, quality control aspects, $^{99m}$Mo-$^{99}$Tc generator, Cylotron based products, PRT studies, Therapeutic applicatoryons, Radiotherapy
CH-404: Paper XVI (Elective- Environmental Chemistry)

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

Unit-I: Water Pollution 15h
Pollutants- Types of pollutants, sources of water pollution, sampling, preservation and storage of water sample, physico –chemical, organoleptic and chemical analysis of water, electro-analytical, optical (UC-visible spectrophotometry, AAS, flame photometry, XRF, ICPAES), chromatographic (GC and HPLC) and neutron activation methods of analysis of Co, Ni, Cu, Fe, Mn, Zn, Cd, Pb, Hg, As, Cl\(^-\), F\(^-\), SO\(_4\)\(^{2-}\), PO\(_4\)\(^{3-}\), NO\(_3\)\(^-\). Historical development of detergents, chemistry of soaps and detergents.

Unit-II: Air Pollution 15h
Natural versus polluted air, air quality standards, air sampling, analysis and control of Particulates, Chemistry and analysis of SOx, NOx, CO, ozone, hydrocarbons, CFCs. Chemistry of gaseous, liquid and solid fuels-gasoline and additives, antiknock agents. Air pollution control—control of automobile emission and control measures in thermal power stations.

Unit-III: Soil Pollution 15h
Types and sources of soil pollution, classification of soil pollutants, impact of soil pollution on air quality, Specifications for disposal of sewage and effluent on land for irrigation and ground water recharge. Methodology of waste water disposal on land in India. Impact of usage of land for solid waste disposal both municipal solid waste- and industrial solid wastes (fly ash from thermal power station, lime sludge from paper and pulp industry), cause of soil erosion, effects of soil erosion, conservation of soil, control of soil pollution.

Unit-IV: Solid waste pollution 15h
Sources, types and consequences, classification of wastes- domestic, industrial, municipal, hospital, nuclear and agricultural and their methods of disposal. Transfer and transport, Recycle, reuse, recovery, conversion of solid wastes -energy / manure. Analysis and monitoring of pesticides. Impact of toxic chemicals on enzymes, Biochemical effects of As, Cd, Pb and Hg, their metabolism, toxicity and treatment.
CH-404: Paper XVI (Elective- Polymer Chemistry)

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

Unit I: Polymerization

Types of polymerization, addition-chain, free radical, ionic polymerization, step polymerization, electropolymerization, ring-opening polymerization.

Unit II: Techniques of polymerization

Techniques of polymerization-suspension, emulsion and bulk polymerization, coordination, polymerization mechanism of Ziegler Natta polymerization, stereospecific polymerization, interfacial polycondensation, mechanism of polymerization.

Unit III: Characterization of polymers

Electronic, IR and NMR spectral methods for characterization of polymers (Block and Graft)

Thermal methods-TGA, DTA, DSC, thermomechanical and X-ray diffraction study, Block and Graft copolymers, random, block, graft co-polymers, methods of copolymerization.

Unit IV: Specific polymers

A) Biomedical polymers: Contact lens, dental polymers, artificial heart, kidney and skin.

B) Inorganic polymers: Synthesis and application of silicon, phosphorous and sulphur containing polymers.

C) Coordination polymers: Synthesis and applications of coordination polymers.
CH-404: Paper XVI (Elective- Medicinal Chemistry)

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

UNIT-I:


B] Chromatographic separation techniques for drugs: TLC, Paper chromatography, GC, HPLC, LCMS.

Dignostic agents: Radio Pharmaceuticals, Radiology and CT.

UNIT-II:

A]Statistical method: For sampling and interpretation of results, Statistic in quality control, T-Test, F-Test, Validation of analytical methods as defind proceding USP Radioimmununalysis, Investigational drugs.


UNIT-III:


UNIT-IV:

A) Anthelminitics and antiamoebic drugs: Introduction to Helminthiasis, Anthelminitics, drugs used in cestode infection, drugs used in trematode infection, origin of antiamoebic drug, drugs used in nematode infection. Synthesis of: Clioquinol, Iodoquinol, Haloquinol, Dichlorphen, Niclosamide.

CH-406: Practical VIII- Project

9 h/week 80 Marks

Project is a part of practical examination. Project should be carried out by the student under the supervision of Guide/Teacher. The examination shall be conducted by External and Internal Examiners. Students are supposed to present their work either on LCD Projector / OHP or blackboard.

The division of marks will be as follows:

External examiner: 40 marks

Internal examiner (Guide/ Teacher): 40 marks

(With Internal Assessment of 20 Marks)

Note: One external examiner shall be appointed for evaluation of group of 6 students.
CH-407: Seminar-IV

2 h /week            Marks: 25

Seminar of 30 minutes duration will be a part of internal assessment for 25 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.