

# **Syllabus**

**For**  
**M.Sc.**

# **Industrial Chemistry**

(Session: 2018-19)



**Kutir Post Graduate College**  
**Chakkey, Jaunpur**  
**U.P., 222 146**

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SYLLABUS AND COURSES OF READING FOR  
M.Sc. (INDUSTRIAL CHEMISTRY) w.e.f. 2018-19

## M.Sc. (Previous Year)

S. No.	Name of Paper	M.M.
1.	Inorganic Chemistry	75
2.	Organic Chemistry	75
3.	Physical Chemistry	75
4.	Analytical Chemistry	75
5.	Biological Chemistry	75
6.	Spectroscopic Methods in Chemistry	75
	Practical (Five sections)	
A.	Inorganic Chemistry	40
B.	Organic Chemistry	40
C.	Physical Chemistry	40
D.	Project Work	20
E.	Viva-voce	10

**Total Marks of Theory Papers:**

**450**

**Total Marks of Practical:**

**150**

**Total Marks:**

**600 Marks**

(Note: Total time of Practical Examination is 18 hours spreaded over three days.)

## M.Sc. (Final Year)

S. No.	Name of Paper	M.M.
1.	C1 Chemistry in Industrial Processes-I	75
2.	C2 Chemistry in Industrial Processes-II	75
3.	C3 Common Chemicals in Industries	75
4.	C4 Unit Processes in Organic Chemistry	75
5.   6.	E1 Water Management in Industries	75
Any two of elective can be opted as 5 <sup>th</sup> and 6 <sup>th</sup> paper	E2 Pharmaceutical Chemistry	75
	E3 Heterocyclic Chemistry	75
	E4 Polymer Chemistry	75
	Practical (Five sections)	
A.	Inorganic Chemistry	40
B.	Organic Chemistry	40
C.	Physical Chemistry	40
D.	Industrial Tour	20
E.	Record/Viva-Voce	10

**Total Marks of Theory Papers:**

**450**

**Total Marks of Practical:**

**150**

**Total Marks:**

**600 Marks**

(Note: Total time of Practical Examination is 18 hours spreaded over three days.)

**M.Sc. (P) Industrial Chemistry**  
**Paper-I**  
**Inorganic Chemistry**

**M.M. 75**

**UNIT-I:**

**Symmetry and Group Theory in Chemistry**

Symmetry elements and symmetry operation, definitions of groups, subgroups, relation between orders of a finite group and its sub-group, Conjugacy, relation and classes, Point symmetry group, Schonflies symbols, representation of groups by matrices (representation of the  $C_n$ ,  $C_{nv}$ ,  $C_{nh}$ ,  $D_{nh}$  etc groups to be worked out explicitly), Characters of a representation, Character tables and their use in spectroscopy.

**Stereochemistry and Bonding in Main Group Compounds**

VSEPR Theory, Walsh diagrams (tri and penta-atomic Molecules),  $d\pi$ - $p\pi$  bonds, bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules.

**UNIT-II:**

**Metal-Ligand Bonding**

Introduction of crystal field theory, limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes,  $\pi$  -bonding and molecular orbital theory.

**Metal-Ligand Equilibria in Solution**

Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectro-photometry.

**UNIT – III:**

**Reaction mechanism of Transition Metal Complexes**

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

**UNIT- IV:**

**Electronic spectra and Magnetic Properties of Transition Metal Complexes:**

Spectroscopic ground states; Orgel energy level and Tanabe-Sugano diagrams for transition metal complexes ( $d^1$ - $d^9$  states); Charge transfer spectra; electronic spectra of octahedral and tetrahedral Co(II) and Ni(II) complexes and calculation of ligand-field parameters.

**Metal  $\pi$ -Complexes and Clusters**

Metal carbonyls, structure and bonding, vibrational spectra of Metal carbonyls for bonding and structural elucidation, important reactions of Metal carbonyls, preparation, bonding, Structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes, tertiary phosphine as ligand, Higher boranes, carboranes, metallocarboranes, B- Isopoly and heteropoly acids and salts

### **Books Recommended:**

1. F.A. Cotton and G. Wilkinson Advanced Inorganic Chemistry, 6th Edn.(1999), John Wiley & Sons, New York.
2. James E. Huheey, Inorganic Chemistry, 4th Edn. (1993), Addison-Wesley Pub. Co., New York.
3. Chemistry of the elements, N. N. Greenwood and A. Earnshaw, Pergammon.
4. Inorganic Electronic Spectroscopy, A. B. P. Lever, Elsevier.
5. Comprehensive Coordination Chemistry eds., G Wilkinson, R. D. Gillars and J. A. McCleverty, Pergammon.
6. Magneto Chemistry, R. L. Carlin, Springer Verlag.
7. F.A. Cotton and G. Wilkinson Advanced Inorganic Chemistry, 6th Edn.(1999), John Wiley & Sons, New York.
8. James E. Huheey, Inorganic Chemistry, 4th Edn. (1993), Addison-Wesley Pub. Co., New York.
9. Chemistry of the elements, N. N. Greenwood and A. Earnshaw, Pergammon.
10. Inorganic Electronic Spectroscopy, A. B. P. Lever, Elsevier.
11. Comprehensive Coordination Chemistry eds., G Wilkinson, R. D. Gillars and J. A. McCleverty.

**M.Sc. (P) Industrial Chemistry**  
**Paper-II**  
**Organic Chemistry**

**M.M. 75**

**UNIT-I:**

**Nature of bonding in Organic Molecules**

Resonance, hyper-conjugation, Aromaticity in benzenoid and non-benzenoid compounds, Huckel's rule, energy level of pi-molecular orbitals, annulenes, antiaromaticity.

**Stereochemistry**

Conformational analysis of mono and disubstituted cyclohexane, effect of conformation on reactivity, elements of symmetry, stereospecific and stereoselective synthesis, Asymmetric synthesis, Optical activity in the absence of chiral carbon, biphenyls, allenes and spiranes.

Methods for determination of reaction mechanism, isotope effect, generation, structure, stability and reactivity of benzynes, carbenes and nitrenes, effect of structure on reactivity: resonance and field effect, steric effect, quantitative treatment.

**UNIT-II:**

**Aliphatic nucleophilic substitution**

The  $SN^2$ ,  $SN^1$ , mixed  $SN^1$  and  $SN^2$ , the neighboring group mechanism, neighboring group participation by Pi and Sigma bonds, anchimeric assistance Classical and non classical carbocations, The  $SN^1$  mechanism nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon, Reactivity, effects of substrate structure, attacking nucleophile, leaving group and reaction medium, ambident nucleophile, regioselectivity.

**Aromatic electrophilic substitution**

The arenium ion mechanism, orientation and reactivity, energy profile diagrams, The Ortho/Para ratio, ipso attack, orientation in other ring systems, Vilsmeier reaction, Gattermann-Koch reaction.

**Aromatic nucleophilic substitution**

The  $ArSN^1$ , Benzyne and  $ArSN^1$  mechanism, Reactivity effect of substrate structure, leaving group and attacking nucleophile, The Von Richter, Sommelet-Hauser, and Smiles rearrangements.

**UNIT- III:**

**Addition to carbon-carbon multiple bond:**

Mechanistic and stereochemical aspects of addition reactions involving electrophile, nucleophile and free radicals, regio and chemo selectivity, orientation and reactivity, Hydrogenation of aromatic rings, Hydroboration, Michael reaction, Sharpless asymmetric epoxidation.

**Addition to carbon heteroatom multiple bonds:**

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles, Wittig reaction mechanism of condensation reactions involving enolate, Knoevenagel, Mannich, Stobbe reactions, Hydrolysis of esters and amides, ammonolysis of esters.

**Free radical reactions:**

Free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance, Reactivity for aliphatic and aromatic substrates at a bridgehead, The effect of solvent on reactivity, Arylation of aromatic compounds by diazonium salt, Hunsdiecker reaction.

**UNIT- IV:**

**Elimination reactions:**

The  $E^2$ ,  $E^1$  and  $E^1_{CB}$  mechanism, Orientation of double bond, Reactivity effect of substrate structures, Attacking base, the leaving group and the medium, Mechanism and orientation on Pyrolytic elimination.

**Pericyclic reactions:**

Molecular orbital symmetry, frontier orbitals of ethylene, 1, 3-butadiene, 1,3,5-hexatriene and allyl system, Classification of pericyclic reactions, Woodward-Hoffmann correlation diagrams. FMO approach, Electrocyclic reactions- conrotatory and disrotatory motions,  $4n$ ,  $4n+2$  and allyl systems, Cycloadditions-antarafacial and Suprafacial additions,  $4n$  and  $4n+2$  system, Sigmatropic rearrangements-suprafacial and antarafacial shift of H, sigmatropic shifts involving carbon moieties, 3, 3 and 5, 5 sigmatropic rearrangements, Claisen- Cope and Azacope rearrangement, Fluxional tautomerism, Ene reaction.

**Books Recommended:**

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University press.
5. Organic Chemistry, R.T. Morrison and R.N. Boyd. Prentice Hall.
6. Modern Organic Chemistry H.O. House, Benjamin
7. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic and professional.
8. Pericyclic Reactions. S.M. Mukherji, Macmillan India.
9. Reaction Mechanism in Organic Chemistry : S.M. Mukherji and S.P. Singh, Macmillan.
10. Stereochemistry of Organic Compounds D. Nasipuri, New Age International.
11. Stereochemistry of Organic Compounds, P.S Kalsi, New Age, International.

**M.Sc. (P) Industrial Chemistry**  
**Paper-III**  
**Physical Chemistry**

**M.M. 75**

**UNIT-I:**

**Unifying Principles**

Electromagnetic radiation, interaction of electromagnetic radiation with matter-absorption, emission, transmission, reflection, refraction, dispersion, polarization and scattering. Uncertainty relation and natural line width and natural line broadening, selection rules, intensity of spectral lines, Born Oppenheimer approximation, rotational, vibrational and electronic energy levels.

**Microwave Spectroscopy**

Classification of molecules, rigid rotor model, Effect of isotopic substitution on the transition frequencies intensities, non rigid rotor, Stark effect, Applications.

**Vibrational Spectroscopy**

Infrared Spectroscopy, Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero point energy, force constant and bond strength; anharmonicity, P.Q.R. branches, vibrations of polyatomic molecules, Selection rules, normal modes of vibration, factors affecting, the band positions and intensities.

Classical and quantum theories of Raman effect, Pure rotational, vibrational and vibrational-rotational Raman spectra, selection rules, mutual exclusion principle, Applications of Raman spectroscopy.

**UNIT- II:**

**Quantum Chemistry**

Operators, Postulates of Quantum Mechanics, Hamiltonian for different systems, Angular momentum, The Schrodinger equation, discussion of solutions of the Schrodinger equation to some model system viz, particle in a box, the harmonic oscillator, the rigid rotar, the hydrogen atom. Approximate Methods: The Variation theorem, linear variation principle, Perturbation theory (First order and nondegenerate), Application of variation method and perturbation theory to the Helium atom.

Electronic structures of Atoms: Russel-Saunders terms and coupling schemes, term symbols for the  $p^n$  and  $d^n$  configurations, Spin orbit coupling and Zeeman splitting, introduction to the methods of self-consistent field, Slaters type orbitals.

**Chemical Dynamics**

Methods of determining rate law, collision theory of reaction rates steric factors Activated complex theory, Arrhenius equation and the activated complex theory, Ionic reactions kinetic salt effect, steady state kinetics. Dynamic chain( hydrogen-bromine reaction, pyrolysis of acetaldehyde) photochemical (hydrogen bromine reactions) and oscillatory reactions (Belousav Zhabotinsky reaction) homogeneous catalysis, kinetics of enzyme reaction General features of fast reaction study of fast reaction by relaxation method, flash photolysis and the nuclear magnetic resonance method.

**UNIT- III:**

**Thermodynamics**

- A. Classical Thermodynamics: Brief resume of concepts of laws of thermodynamics, free energy and chemical potential. Partial, molar properties partial molar free energy, partial molar volume and its determination, Gibbs–Duhem equation, concept of fugacity (by graphical method), Activity and Activity coefficient.
- B. Statistical Thermodynamics: Concept of distribution, thermodynamic probability and most probable distribution, Canonical, grand canonical and microcanonical ensembles, The Boltzmann distribution law, Partition Functions-translational, rotational, vibrational and

electronic partition function. Calculation of thermodynamic properties and equilibrium constant in terms of partition function. Fermi-Dirac and Bose-Einstein statistics.

- C. Non-Equilibrium Thermodynamics: Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, Entropy balance equation for different irreversible processes (e.g heat flow chemical reaction etc. Transformation of the generalized fluxes and forces non-equilibrium stationary, phenomenological equations, Onsager's reciprocity relation, electro kinetic phenomena.

Surface chemistry:

- A. Adsorption: Gibbs adsorption isotherm estimation of surface area (BET equation), surface films on liquids (Electro kinetic phenomenon), catalytic activity at surfaces.
- B. Micelles: Surface active agents, classification of surface active agents, micellization hydrophobic interactions, Critical micellar concentration (CMC), Factors affecting CMC of surfactants counter ion binding to Micelles, solubilization, micro emulsion reverse micelles.

#### **UNIT- IV:**

Macromolecules:

Polymer-definition, types of polymer, electrically conducting fire resistant, liquid crystal polymer, Kinetics of polymerization, Molecular mass, number and mass average molecular mass, molecular mass determination (Osmometry, Viscometry, diffusion and light scattering method) sedimentation chain configuration of macromolecules, Calculation of average dimension of various chain structures.

Electrochemistry:

Debye- Huckel theory of activity coefficient of electrolytic solutions, applicability and limitations of Debye-Huckel limiting law, ionic strength, structure of electrified interfaces, Helmholtz- Perrin, Guoy-Chapman and Stern models, Over potentials, exchange current density, derivation of Butler- Volmer equation, Tafel plot. Electrocatalysis, Influence of various parameters, Hydrogen electrode, Polarography theory, interpretation of a polarographic curve, instrumentation, limiting current, residual and charging current, diffusion current. Supporting electrolytes, Elkovic equation, half wave potential and its significance. Introduction to corrosion, homogeneous theory, forms of corrosion, corrosion monitoring and prevention methods.

#### **Books Recommended:**

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Physical methods in Chemistry, R.S. Drago, Saunders College.
3. Introduction to Molecular Spectroscopy G.M. Barrow, Mc Graw Hill.
4. Physical Chemistry P.W. Atkins, ELBS.
5. Introduction to Quantum Chemistry, A.K. Chandra, Tata Mc Graw Hill.
6. Quantum Chemistry, Ira N. Levine. Prentice Hall.
7. Coulson's Valence, R.McWeeny, ELBS.
8. Chemical Kinetics, K.J. Laidler, McGraw-Hill.
9. Kinetics and Mechanism of Chemical Transformations J. Rajaraman and J .Kuriacose Mc Millan.
10. Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum .
11. Modern Electrochemistry Vol. I and Vol. II J.O.M. Bockris and AK.N. Reddy, Plenum.
12. Introduction to Polymer Science V.R. Gowariker, N.V. Vishwanathan and J.Sridhar, Wiley Eastern.



**M.Sc. (P) Industrial Chemistry**  
**Paper-IV**  
**Analytical Chemistry**

**M.M. 75**

**Unit –I**

**Spectrophotometry:**

Types of electronic transitions, theory of spectrophotometry, Laws of absorption, deviation from Beer's law, instrumentation for absorption measurements, criteria for satisfactory colorimetric analysis, choice of solvent, applications of spectrophotometry to qualitative and quantitative analysis, spectrophotometric titrations, study of composition of complex, determination of instability constant, an introduction to derivative spectrophotometry.

**Turbidimetry/Nephelometry:**

Principle and instrumentation for nephelometry and turbidimetry, effect of concentration, particle size and wavelength on intensity of scattered light, applications to analysis, turbidimetric titrations, determination of molecular weight of a polymer.

**Unit –II**

**Flame photometry:**

Introduction, principle and instrumentation of flame photometry, experimental techniques – standard addition method and internal standard method, interferences in flame photometry and applications.

**Solvent Extraction:**

Distribution law, batch and continuous extractions, synergistic extraction, ion-association complexes, Soxhlet extraction, Extraction of drug from the biological matrix -Solid Phase Extraction.

**Unit –III**

**Buffer Solution:**

pH and its importance, buffer solutions, measurement of pH.

**Chromatography:**

Classification, theories of chromatographic methods, principles and methods of chromatographic separation by paper, TLC, preparative TLC, HPTLC, column, HPLC, gas chromatography and ion-exchange chromatography. Instrumentation of HPLC and GC, types of columns and detectors for GC, Applications of chromatographic methods, an introduction to LC-MS technique.

**Unit –IV**

**Polarography:**

Principle and instrumentation, concept and expressions of diffusion current, half-wave potential, residual current, DME, current-potential curve and reversible reactions, qualitative and quantitative applications of polarography, types and advantages of amperometric titrations.

**Thermal analysis:**

Introduction to thermal analysis, Differential Thermal Analysis (DTA), Thermogravimetry (TG) and Differential Thermogravimetry (DTG), static and dynamic thermogravimetry; Instrumentation and applications, Introduction to Differential Scanning Calorimetry (DSC), types and its applications.

## **BOOKS RECOMMENDED:**

1. "Vogel's Textbook of Quantitative Chemical Analysis", Bassette and coworkers, Longman Group UK Ltd.
2. "Instrumental methods of analysis", M.H. Willard, L.L. Merrit, J.A. Dean & F.A. Settle.
3. 'Fundamentals of molecular spectroscopy', C.N. Banwell.
4. "Principles of polarography", R.C. Kapoor and B.S. Aggarwal, Wiley Eastern Ltd.
5. "Principles and practice of analytical chemistry", F.W. Fifield and D. Kaley, Blackie Academic & Professional 4<sup>th</sup> Ed. (1995).
6. Introduction to thermal analysis and calorimetry, M. E. Brown, 2<sup>nd</sup> Edn, Kluwer Academic Publishers.
7. Differential Thermal Analysis, R. C. Mackenzie, Academic Press.

**Paper-V****Biological Chemistry****Unit –I****Living Matter:**

History of cell, brief idea of structural organization of prokaryotic, eukaryotic and plant cells, cell wall and membrane, nucleus, ribosomes, storage granules, mitochondrion, golgi complex, endoplasmic reticulum, lysosome, microbody, chloroplast, vacuole.

**Molecular components of cell:**

Bio molecules, chemical and biological evolution, level of organization.

**Regulation of cell functions:**

Genetic level, hormones, secondary messenger.

**Unit –II****Peptides & Proteins:**

Structures of standard amino acids, classification, essential and non-essential amino acids, properties and biological functions, Peptides: Structure, Nomenclature, Classification, Synthesis-solution phase and solid phase, sequencing of peptides.

**Proteins:**

Classification, level of organization and biological functions.

**Enzymes:**

History, nomenclature, classification, general characteristics, difference between inorganic catalyst and enzyme, Theories of enzyme action, Enzyme kinetics (Michael's Menton equation and its modification), Mechanism of action-factors contributing the catalytic efficiency.

**Enzyme Inhibition:**

Reversible and irreversible.

**Unit -III****Nucleic Acids:**

Nucleosides, Nucleotides, Biological importance of nucleotides and pentose sugar structure and properties of uracil, thymine, guanine, cytosine, adenine. Structures of different forms of RNA, DNA (Watson and Crick Model), concept of gene, Nucleic acid metabolism – central dogma, features of genetic code, A brief introduction of replication, transcription and translation.

**Carbohydrates:**

Conformation of monosaccharides, Delta 2 instability factors. Structure and functions of important derivatives of monosaccharides – glycosides, deoxysugars, polysaccharides – Structural polysaccharides – cellulose and chitin, Storage polysaccharides – starch and glycogen, carbohydrates of glycoproteins and glycolipids, role of sugars in biological recognition, blood group substances.

**Carbohydrate metabolism:**

Glycolysis & Kreb's cycle.

**Unit –IV****Lipids:**

Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, cholesterol, sphingolipids, bile acids, prostaglandins, lipoproteins – composition and function, role in atherosclerosis properties of lipid aggregates – micelles, bilayers, liposomes and their possible biological functions, lipid metabolism - oxidation of fatty acids and its significance.

**Metal Ions in Biological Systems:**

Essential and trace metals, Role of metal ions in biological processes, Na<sup>+</sup>/K<sup>+</sup> Pump, Bioenergetics and ATP cycle, DNA polymerization, glucose storage, metal complexes in transmission of energy: chlorophylls

**BOOKS RECOMMENDED:**

1. Cell and Molecular Biology by D. Robertis.
2. Molecular Biology of Cell by Albertis.
3. Biochemistry by Lehninger, Kalyani Publishers.
4. Biochemistry by Voet and Voet.
5. Biochemistry by U. Stayanarayana and U. Chakrapani, Books and Allied (P) ltd
6. Biochemistry by Stryer.
7. Organic Chemistry, I. L Finar, vol. I, and vol. II, Orient Longman, ELBS
8. Outline of Biochemistry, Conn and Stumpf Biochemistry by J.H. Well.
9. Biochemistry by Zubey.
10. Peptide synthesis, Bondensky & Bondensky.
11. Fundamental of biochemistry by J L Jain, Sunjay Jain and Nitin Jain, S Chand & Co Ltd.
12. Biochemistry: The Chemical Reactions of Living Cells. D.E. Metzler. Academic Press.

**M.Sc. (P) Industrial Chemistry**  
**Paper-VI**  
**Spectroscopic Methods in Chemistry**

**M.M. 75**

**Unit -I**

**Atomic Absorption Spectroscopy (AAS):**

Introduction, principle, instrumentation, detection limits, sensitivity, interferences, comparison of AAS with flame photometry, applications.

**Fluorescence and Phosphorescence:**

Basic principles filter fluorometer and double beam monochromator instruments, working, analysis of rare earths, pharmaceuticals, optical brightness, ultra trace analysis, new materials.

**Mössbauer Spectroscopy:**

Introduction, principle, Mössbauer nuclides, parameters required for evaluation, instrumentation, applications.

**Unit –II**

**Ultraviolet (UV) Spectroscopy:**

Introduction, Origin of UV band spectrum, types of electronic transition, selection rules, presentation of UV spectra, solvents effects on UV absorption, chromophores and auxochromes, effect of conjugation, conformation and geometry on UV absorption of polyenes, Woodward Fieser rules for dienes, -axial haloketone rule, Woodwards rule for enones, unsaturated aldehydes, the UV spectra of benzenoids, polynuclear aromatic hydrocarbons and heterocycles.

**Infrared (IR) Spectroscopy:**

Introduction, principles of IR spectroscopy, sample handling, various modes of vibrations, presentation of spectra, functional group and finger print region, combination and overtones, Fermi resonance, bond properties and absorption trends, factors influencing vibration frequencies, interpretation of IR spectra, introduction of FT-IR spectroscopy.

**Unit –III**

**Nuclear Magnetic Resonance (NMR) Spectroscopy:**

Principles of NMR spectroscopy, nuclear spin states, nuclear magnetic moments, absorption of energy, chemical shift and its measurements, shielding and deshielding of protons, anisotropy, chemical shift and chemical equivalence, integrals, spin-spin splitting, N+1 rule, mechanism of coupling and coupling constants, presentation of spectra, magnetic equivalence, allylic coupling, exchangeable protons, Interpretation of NMR spectra of simple organic compounds, effect of enantiotopic, diastereotopic protons, Karplus curves- Variation of coupling constant with dihedral angles. Techniques of simplifying NMR spectra, double resonance, shift reagents and deuteration, elementary idea of C<sup>13</sup> NMR, Introduction to FT-NMR spectroscopy.

**Unit –IV**

**Mass Spectrometry:** Electron impact line diagram of mass spectrometer, mass spectrum, metastable ion, nitrogen rule, molecular weight determination, molecular formula from isotopic ratio data, isotopic profile of halogen compounds, factors effecting reaction pathways, fragmentation patterns – simple cleavage, retro – Diels Alder, hydrogen transfer, Rearrangement – like scrambling, ortho effect, McLafferty rearrangement. Fragmentation pattern of hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, esters, carboxylic acids, amines, nitro, amides, nitriles. An elementary idea of chemical ionization and negative Ion mass spectrometry. A brief introduction to LC-MS technique.

Simple structural problems based upon UV, IR, NMR and Mass spectrometry.

## **BOOKS RECOMMENDED:**

1. Introduction to spectroscopy by D.L. Pavia et. al. Saunders Golden Sunburst Series 1996.
2. "Spectrometric identification of organic compounds", R.M. Silverstein, G.S. Bassler & T.C. Morrill, John Wiley & Sons, New York.
3. "An Introduction to spectroscopy methods for identification of organic compounds." F. Scheinman, Vol. I & II, Pergamon Press.
4. "Organic Spectroscopy", William Kemp, John Wiley & Sons.
5. "Spectroscopic methods in organic chemistry", D.H. Williams and Ian Fleming.
6. "Spectroscopy of organic compound", P.S. Kalsi, Wiley Eastern, New Delhi.
7. "Organic Mass Spectrometry", K.G. Das & E.P. James, Oxford & IBH Publishing Co.
8. "Instrumental methods of analysis", M.H. Willard, L.L. Merritt, J.A. Dean and F.A. Settle, 7th Ed. (1988).
9. Absorption Spectroscopy of Organic Molecules (D.Van Nostrand), V. M. Parikh
10. "Spectroscopy' Pragati Prakashan by H.Kaur.

# M.Sc. (P) Industrial Chemistry

## Practical

M.M.: 150  
Time: 18 Hrs

- A. Inorganic Chemistry** **40 Marks**
1. Qualitative analysis of mixture containing trace elements Tl, Mo, W, Zr, Ti, Th, V, U (Two metal ions in cationic/anionic forms) and insoluble oxides, sulphates and halides. The mixture should not contain more than five cations and should be analyzed by semi micro technique. 12 Marks
  2. Thin layer chromatography separation of a mixture of the following and measurements of  $R_f$  values. 8 Marks  
(a)  $Pb^{+2}$ ,  $Ag^+$ ,  $Hg^{+2}$  (b)  $Co^{+2}$ ,  $Ni^{+2}$ ,  $Cu^{+2}$  (c)  $Ba^{+2}$ ,  $Ca^{+2}$ ,  $Sr^{+2}$
  3. Quantitative estimation of industrial brass sample volumetrically for Cu and Zn by gravimetric methods. 10 Marks
  4. Preparation of selective inorganic compounds (any one). 10 Marks  
(a).  $VO(acac)_2$ ,  
(b).  $Na[Cr(NH_3)_2(SCN)_4]$   
(c).  $K_3[Fe(C_2O_4)_3]$   
(d). Prussian Blue  
(e).  $[Co(Py)_2Cl_2]$   
(f).  $[Cu(NH_3)_4]SO_4 \cdot H_2O$
- B. Organic Chemistry** **40 Marks**
1. Separation, purification, and identification of binary mixture. Preparation of derivatives, if possible. 15 Marks
  2. Organic Synthesis: 15 Marks
    - i. Eosin from phthalic anhydride.
    - ii. Benzene azo- $\beta$ -naphthol(Dye)
    - iii. Bakelite (Polymer).
    - iv. Acetyl salicylic acid (Aspirin).
    - v. Synthesis of p-hydroxyacetanilide (Paracetamol).
    - vi. Oil of wintergreen (Methyl Salicylate)
    - vii. Hippuric acid (Benzoyl Glycine).
    - viii. Nerolin ( $\beta$ -Naphthyl methyl ether)
  3. Quantitative Analysis (Any two): 10 Marks
    - A. Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation method.
    - B. Estimation of amine/phenols using bromate bromide solution or acetylation method.
    - C. Determination of iodine and saponification values of an oil sample.
    - D. Determination of DO, COD and BOD of water sample.
- C. Physical Chemistry (Any two from followings):** **40 Marks**
1. Study the adsorption of acetic acid on charcoal and draw the Freundlich isotherm. 20+20 Marks
  2. Show that the order of reaction between acetone and Iodine is zero with respect to Iodine.
  3. Determination of congruent composition and temperature of a binary mixture e.g. diphenylamine-benzophenone system.
  4. Determination of glass transition temperature of a given salt (e.g.,  $CaCl_2$ ) conductometrically.
  5. Determination of the velocity constant of hydrolysis of an ester / ionic

- reaction in micellar media.
6. Determination of the velocity constant of decomposition of Benzene diazonium chloride.
  7. Determination of molecular weight of nonvolatile and nonelectrolyte/ electrolyte by cryoscopic method and to determine the activity coefficient of an electrolyte.
  8. Determination of the degree of dissociation of weak electrolyte and to study the deviation from ideal behaviour that occurs with a strong electrolyte.
  9. Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically.
  10. Determination of solubility and solubility product of sparingly soluble salts (e.g  $\text{PbSO}_4$ ,  $\text{BaSO}_4$ ) conductometrically.
  11. Determination of the strength of strong and weak acids in a given mixture conductometrically.

**D. Record/Project Work**

**20 Marks**

**E. Viva-Voce**

**10 Marks**



**M.Sc. (F) Industrial Chemistry**  
**Compulsory Paper-I**  
**Chemistry in Industrial Processes-I**

**M.M. 75**

**Unit-I**

**Material and energy balance:**

**Material balance:** Process classification, Choice of system and basis of molecular processes with chemical reactions, Material balance calculations, Multiple unit processes, Recycle and bypass.

**Energy balance:** Forms of energy, Energy balance, Energy changes in physical processes, Energy changes in reactions, Energy balance Calculations.

**Unit-II**

**Equipment Design:**

**Material of constructions:** Mechanical properties, Corrosion resistance, Plastics.

**Ceramics:** Metals and alloys, Stainless steel, Special material for food and pharmaceutical equipment, Protective coatings, Surface treatment to metals for corrosion resistance.

**Design of Vessels:** Classification of chemical reactors, pressure vessels for internal or external pressure, Maintenance, Storage vessels for liquids and gases, Design of chemical reactors, Reactors with chemical addition, agitation, heating, removal of vapours, gas addition.

**Unit-III**

**Industrial Instrumentation:**

Measurement of temperature, Thermo couples and pyrometers, High temperature thermometers, Optical pyrometers, Measurement of pressure and vacuum, Manometric and Bourdon gauges, Vacuum gauges, Ionization and pirani gauges. Flow measurement, Pitot tube, Rotameters, Liquid level indicators. Hook Type, Sight glass, Float type, Capacitance level indicator, Radiation level indicator.

**Unit-IV**

**Industrial Waste Management:**

Definition, Classification, sources and composition of solid, liquid and gaseous wastes, hazardous and non-hazardous wastes, special waste materials, Storage and transport of wastes, Transportation and collection systems, Management of wastes, minimization, reuse and recycling, waste utilization and materials recovery.

**Treatment of wastes:** biological treatment, composting, anaerobic digestion, combustion, incineration and landfills, ultimate disposal.

**Recommended Books:**

1. H.S. Peavy: D.R. Rowe and G. Techbanoglous: Environmental Engineering, McGraw Hill Books Co.
2. R.A. Corbitt: Started Handbook: A Environmental Engineering; McGraw Hill New York.
3. A.M. Martin: Bio-conservation of waste Materials to Industrial Products; (ed), Elsevier, Amsterdam.
4. O.P. Kharbanda and E. A. Stellworthy: Waste Management- towards a Sustainable Society, Gower.
5. E. Mortensen: Introduction to Solid Waste, Lecture Notes to Graduate Diploma in Environmental Engineering, University College, Ireland.
6. R.K. Somasekhar and Mariyengar (ED): Solid Waste Management- Current Status and Stratagies for Future, , Allied Publishers, Mumbai.
7. F. A. Henglein; Chemical technology (Pergamon)

8. J. M. Coulson, J. F. Richardson: Chemical Engineering, Vol. I, II, III (Pergamon)
9. R. N. Shreve: The Chemical Process Industries (MGH)
10. W. I. Badger and J. T. Bandchero: Introduction to Chemical Engineering (MGH)
11. O. A. Hougen, R. M. Watson and R. A. Ragetz: Chemical Process Principles (Vol. I, II (JW))  
11
12. P. H. Groggins: Unit processes in organic synthesis (MGH)
13. A. A. Frost and R. G. Pearson: Kinetics and Mechanism
14. P. W. Atkins and Julio de Paule: Physical Chemistry, VII<sup>th</sup> Edn. ( Ostord Union press, 2002)
15. S. Glasstone: Textbook of Physical Chemistry, II<sup>nd</sup> Edn. (McMillan India LTD. 1996)
16. W. J. Moore: Physical Chemistry, X<sup>th</sup> Edn(Orient Longmans, 1993)
17. Thermodynamics, A core course, by R. C. Srivastava, S. K. Saha, A. K. Jain Prentice Hall of India Pvt. Ltd, 2004
18. Industrial Instrumentation and Control by S. K. Singh Tata McGraw-Hill Publishing Company Limited, New Delhi.
19. Chemical Kinetics by G. L. Agarwal

**M.Sc. (F) Industrial Chemistry**  
**Compulsory Paper-II**  
**Chemistry in Industrial Processes-II**

**M.M. 75**

**Unit –I**

**Distillation:** Boiling and distillation, vapor-liquid equilibria, Raoult's law & Henry's law, relative volatility, azeotropic mixtures, flash distillation, steam distillation, vacuum distillation, fractional distillation, plate columns (Bubble cap, Sieve plate & Valve plate).

**Extractions:** Liquid equilibria, Extraction with reflux, Extraction with agitation, equipment, its use and performance, continuous contact equipment, agitator extractors, packed spray extractors, Leaching, flow sheets of solid-liquid extraction, continuous leaching, counter current extraction.

**Unit -II**

**Filtration:** Classification of filters, Sand filters, filter press, plates & frame press, filter aids, principles of leaf filters.

**Flow of Heat:** Introduction, Conduction (Fourier law, Thermal conductivity, thermal insulation & problems), Convection (rate of heat transfer and heat transfer coefficients), Radiation (Absorptivity, Reflectivity, & Transmissivity, Kirchoff's law concept of black body & examples)

**Heat Exchange Equipments:** Introduction, Double Pipe, Shell & tube, Fixed tube, U tube heat exchangers.

**Unit -III**

**Crystallization:** Growth of Crystal, saturation, nucleation supersaturation, (Mier's theory), Caking of crystals, effect of impurities, Classification of crystallizers, Agitated tank, Swenson walkers, Krystal, Oslo, continuous vacuum crystallizers.

**Drying:** General Principles (Significance, moisture content), Rate of drying (Constant & falling rate period, factors affecting drying), Drying equipments, Tray dryers, Rotary dryers, Single Drum dryer & Spray dryers.

**Unit IV**

**Evaporation:** Types of evaporators, jacketed, horizontal and vertical tube evaporators, forced circulation evaporations, entrainment separators (upturned, deflector type, tangential type), effect of scale formation, multiple effect evaporators.

**Gas Absorption:** Definition, examples, comparison of absorption and distillation, conditions of liquid- gas equilibrium, solution criteria for gas absorption, mechanically agitated vessels. Packed columns, and plate columns, (Characteristics of tower packing, Types of packing) merits of plate & packed tower.

**Recommended Books:**

1. F. A. Henglein: Chemical Technology (Pergamon).
2. J. M. Coulson, J. F. Richardson: Chemical Engineering, Vol. I, II, III (Pergamon).
3. R.N. Shrove: The Chemical Process Industries (MGH).
4. W.L. Badger and J.T. Bandchero: Introduction to Chemical Engineering (MGH).
5. O.A. Hougen, K.M. Watson and R.A. Ragetz: Chemical Process Principles, Vol. I, II (JW).
6. P.H. Groggins: Unit Processes in Organic Synthesis (MGH)
7. G.H. Morrison & H. Freiser: Solvent extraction in Analytical Chemistry (John Wiley)
8. K.A. Gavhane: Unit operations II (Nirali Prakashan, Pune)

**M.Sc. (F) Industrial Chemistry**  
**Compulsory Paper-III**  
**Common Chemicals in Industries**

**M.M. 75**

**Unit –I:**

**Dairy Chemistry:** Milk and milk products, composition and structure of milk, milk proteins, enzymes, vitamins, minerals, density and viscosity of milk, effect of heat on milk, milk processing, basic milk categories, butter, ghee and clarified butter.

**Leather Chemistry:** Introduction, constituents of animal skin, manufacture and preparation of hides, cleaning, soaking, limiting and degreasing, finishing and sharing, tanning; leather, vegetable, chrome, tanning effluents; pollution and control.

**Phosphorus industries:** Calcium phosphate, manufacture of phosphoric acid, single and triple super phosphate, baking powder and DAP.

**Sulphur and Sulphuric acid:** Mining and manufacture of sulphur and manufacture of sulphuric acid by contact process.

**Nitrogen Industries:** Manufacture of Urea, calcium cyanamide, ammonium nitrate, nitric acid.

**Unit – II**

**Dyes and Pigments:** Classification of Dyes, Methods of preparation of commercial dyes of different classes with suitable examples. Typical manufacturing processes of few dyes, Fluorescent brightening agents, Photosensitive dyes, dyes as food additives, natural dyes.

**Oils, Soaps and Detergents:** Refining of edible oils, Manufacturing of soaps, Detergents, Liquid Soaps. Manufacturing of fatty Acids and glycerol, greases from fatty acids, turpentine oil.

**Soil Chemistry:** Introduction, formation, classification and reactions of soil, soil acidity, alkalinity, productivity and fertility, chemical fertilizers and their effect, organic manures, micronutrients, bio-fertilizers.

**Unit-III**

**Food Chemistry:** Classification, chemical composition and nutritional value of common food stuffs, properties of foods, food preservation and processing, food deterioration, methods of preservation and processing by heat, cold, chill storage, deep freezing, drying, concentration, fermentation, and radiation, Food quality; sensory evaluation, objective methods, non-nutritional constituents and food safety.

Permitted food additives and their role; Antioxidants, coloring agents, flavours, emulsifiers, curating agents, non-curative sweeteners, flour improvers, leavening agents, stabilizers, thickeners and preservatives.

**Glass and Refractory materials:** Raw materials, Soda glass, borosilicate glass, Lead Glass, Colored Glass, Refractory: Raw materials, clay pots, Zeolites.

**Unit – IV**

**Agrochemicals:**

**Organophosphorus pesticides:** Malathion, Monocrotophos, dimethoate, chloropyrifos, Dichloropyrifos, Dichlorodimethyl phosphorothioate.

**Carbamates:** Carbonyl, Bygon, Ziran, Zineb, Maneb, Alacarb.

**Pyrethroids:** Natural pyrethrins, Isolation and structures, synthetic Pyrethroids; Allethrin, cypermethrin, Phenvalerate.

**Insect Pheromones and Repellants:** Pheromones, general introduction and applications in integrated pest management (No Synthesis).

Repellents: Survey and synthesis of the repellents: N,N, Diethyl - 3methyl Benzamide, N,N-Diethyltoluamide, 2 – Ethyl -1,6- hexanedial, Butopytranexyl, Dimethylcarbonate, Dimethylterphthalate, Use Pheromones in pest management.

### **Recommended Books:**

1. N. N. Melnikow: Chemistry of Pesticides, Springer
2. M. B. Green, G. S. Hartley West: Chemicals for Crop Protection and Pest Management, Pergamon.
3. R. Cremlyn: Pesticides
4. K.H. Buchel: Chemistry of Pesticides.
5. H.B. Scher: Advances in pesticides formulation Technology (ACS)
6. K. Venkatraman: The Chemistry of Synthetic Dyes Vol. 1-7 (A.P)
7. Abranart: Dyes and Their intermediates (Pergaman).
8. Beech: Fiber reactive Dyes (Logos Press).
9. Frig and David – Dyes intermediate.
10. Allan: Color Chemistry
11. Kent-Riegels: Industries Chemistry.
12. M Ash & I Ash: A formulary of paints & other coatings.
13. L. W. Aurand, A. E. Woods, Food Chemistry, AVI Publishing Inc.
14. L. H. Mayer, Food Chemistry, Affiliated East-West Press Ltd., New Delhi.
15. N. Shakuntala Manay, M. Shadakhsara Swamy, Foods-Facts and Principles.
16. John M. deMan, Principles of Food Chemistry.
17. F A Henglein: Chemical Technology (pergamon).
18. R.W. Thomas and P. Farago: Industrial Chemistry (HEB).
19. K. Bhogavathi Somdavi: Applied Chemistry, MJP Publications, 2006.
20. C.K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut, 2011

**M.Sc. (F) Industrial Chemistry**  
**Compulsory Paper-IV**  
**Unit Process in Organic Chemistry**

**M.M. 75**

**Unit-I**

**Nitration:** Nitrating agents, Kinetics and mechanism of nitration of aromatic compounds, Nitration of paraffinic hydrocarbons, Nitrate esters, N-nitro compounds, Process equipment, Typical industrial manufacturing processes.

**Sulphonation:** Sulphonating agents, Kinetics and mechanism. Desulphonation Workup procedures. Industrial equipment and technique, Batch and continuous processes, Manufacturing processes for detergents, dye intermediates, turky red oil etc.

**Unit-II**

**Halogenation:** Kinetics and mechanism, Survey of methods, Catalytic chlorination, photohalogenation, Manufacturing processes for chlorohenzene, BHC, Chlorinated methanes, monochloroacetic acid, chloral, vinyl chloride.

**Esterification:** Kinetics and mechanism. Esterification of carboxylic acid derivatives, Esters by addition to unsaturated systems, Industrial esterifications, Ethyl acetate, butyl acetate, Vinyl acetate, methyl methacrylate, Cellulose acetate, xanhate and nitroglycerin.

**Unit III**

**Amination by reduction and ammonolysis:** Methods of reduction to give amino compounds, Aminating Agents, Manufacture of amino compounds by reduction as well as by Ammonolysis

**Hydrogenation:** Catalytic hydrogenation and hydrogenolysis, Different types of catalysts, Hydrogenation equipment, Industrial hydrogenation processes.

**Alkylation and acylation:** Alkylation and acylation at carbon, oxygen and nitrogen, Friedel-Crafts reaction, Applications of active methylene compounds like diethyl malonate, ethyl acetoacetate etc in Industrial processes.

**Unit IV**

**Petrochemicals:** petroleum refining, outline of chemicals derived from ethylene, xylene and naphalene.

**Oxidation:** Oxidising agents with typical applications of each, Liquid phase oxidation with oxidising compounds, Typical manufacturing processes.

**Hydrolysis:** Definition and Scope, Kinetics and mechanism, Manufacture of soap, fatty acids, furfural Dextrose, Ethanol, ethylene glycol, glycerol and phenol

**Recommended Books:**

1. P. H. Groggins: Unit Processes in Organic Synthesis (MGH)
2. F. A. Henglein: Chemical Technology (Pergamon)
3. M. G. Rao and M. Sittings: Outlines of Chemical Technology (EWP)
4. Clausen, Mattson: Principles of Industrial Chemistry
5. H A. Lowenheim and M. K. Moran: Industrial Chemicals
6. Kirk and Othmer: Encyclopedia of Chemical technology.
7. Kent, Riegel's Industrial Chemistry (N-R).
8. S. D. Shukla and G. N. Pandey: A Textbook of Chemical Technology, Vol-II
9. J. K Stille: Industrial Organic Chemistry (P.I I).

**M.Sc. (F) Industrial Chemistry**  
**Elective Paper-I**  
**Water Management in Industries**

**M.M. 75**

**Unit I**

**Properties of water:** Introduction, chemistry, uses, sources and quality of water, water for industry, water in human body, effect of water on rocks and minerals, organic, humic and colloidal matter in water. **Water pollution:** Definition, types of water pollution (Physical, Chemical, biological and physiological), water pollutants. Ground water pollution and its protection, Surface, river, sea and lake water pollution, effect of excess nutrients and oil on water pollution, Marine pollution and episodes, measures against oil spills, Sewage, domestic, agricultural thermal, radioactive, industrial pollutants and siltation, Effect of toxic metals, fertilizers and detergents on water pollution, Inorganic and organic pollutants and their effects on pollution, eutrophication and pesticide pollution.

**Unit II**

**Water Management:** Introduction, use and conservation of water resources, water quality management, rainwater harvesting, water management in agriculture rain fed systems, irrigated systems, industries, Sea water for agriculture, remedial measures for water pollution.

**Industrial waste treatment:** Characteristics and types of industrial waste, principles of industrial waste treatment and disposal, protection of biosphere and surface water form industrial pollution.

**Unit III**

**Purification of water:** portability of water, removal of coarse, dispersed and colloidal impurities, clarification and coagulation (Contact and electrochemical ) of water, determination of hardness, Flocculants, Sterlization (Chemical and physical methods) fluoridation, defluoridation and disinfection of water, softening of water (Clark's, lime soda, modified lime soda, Permutit and ion exchange process) Demineralization, desalting (electro dialysis and reverse osmosis methods) and deoxygenation of water, removal of slime, algae, smack, iron, manganese, silicic acid and odour from water, Magnetic treatment of water.

**Unit IV**

**Prevention and analysis of water pollution:** Prevention, control of water pollution and its best use, Chemical and physical examination and measurement of quality of water, chemical substances affecting potability, odour, taste, temperature and electrical conductivity of water, suspended and dissolved solids, acidity and alkalinity of water, free carbon dioxide and chlorine. Chlorine demand. Analysis of calcium, magnesium, iron, manganese, silver and zinc in water. Determination of ammonia, nitrate, nitrite, cyanide, sulphate, sulphide, chloride and fluoride. Dtermination of arsenic, beryllium, chromium, copper, lead, selenium and mercury.

**Recommended Books:**

1. F. A. Henglein: Chemical safety Management and Engineering (Pergamon).
2. B. K. Sharma, Environment Chemistry.
3. M. K. Hill; Understanding Environmental Pollution A Primer, Cambridge University Press, 2004.
4. I. L. Pepper, C. P. Gerba, M. L. Brusseau, Environmental & Pollution Science, Elsevier, 2006.
5. G. M. Masters, Introduction to Environmental Engineering and Science, Perason, 2004.

**M.Sc. (F) Industrial Chemistry**  
**Elective Paper-II**  
**Pharmaceutical Chemistry**

**M.M. 75**

**Unit – I**

**Drug Design:** Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drugs, structureactivity relationship (SAR), factors affecting bioactivity, resonance, inductive effect, isosterism, non-isosterism, special considerations.

**Theories of drug activity:** occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship. History and development of QSAR. Concepts of drug receptors. Elementary treatment of drug receptor ionization constants, steric, Shelton and surface activity parameters and redox potentials. Free-Wilson analysis, Hansch analysis, relationships between Free-Wilson and Hansch analysis. LD-50, ED-50 (Mathematical derivations of equations excluded).

**Unit – II**

**Pharmacokinetics:** Introduction to drug absorption, disposition, elimination using pharmacokinetics, important pharmacokinetic parameters in defining drug disposition and in therapeutics. Mention of uses of pharmacokinetics in drug development process.

**Pharmacodynamics:** Introduction, elementary treatment of enzyme stimulation, enzyme inhibition, sulphonamides, membrane active drugs, drug metabolism, xenobiotics, biotransformation, significance of drug metabolism in medicinal chemistry.

**Antineoplastic Agents:** Introduction, cancer chemotherapy, special problems, role of alkylating agents and antimetabolites in treatment of cancer. Mention of carcinolytic antibiotics and mitotic inhibitors. Synthesis of mechlorethamine, cyclophosphamide, melphalan, uracil, mustards, and 6-mercaptopurine, Recent development in cancer chemotherapy, Hormone and natural products.

**Unit – III**

**Cardiovascular Drugs:** Introduction, cardiovascular diseases, drug inhibitors of peripheral sympathetic function, central intervention of cardiovascular output, Direct acting arteriolar dilators, Synthesis of amyl nitrate, sorbitrate, diltiazem, quinidine, verapamil, methyldopa, atenolol.

**Local Anti-infective Drugs:** Introduction and general mode of action, Synthesis of sulphonamides, furazolidone, nalidixic acid, ciprofloxacin, norfloxacin, dapson, amino salicylic acid, isoniazid, ethionamide, ethambutal, fluconazole, griseofulvin, chloroquin, primaquin.

**Unit – IV**

**Psychoactive Drugs- The Chemotherapy of Mind:** Introduction, neurotransmitters, CNS depressants, general anaesthetics, mode of action of hypnotics, sedatives, anti-anxiety drugs, benzodiazepines, buspirone, neurochemistry, of mental diseases. Antipsychotic drugs-the neuroleptics, antidepressants, butyrophenones, serendipity and drug development, stereochemical aspects of psychotropic drugs, Synthesis of diazepam, chlorazepam, alprazolam, phenytoin, ethosuximide, trimethadione, barbiturates, thiopental sodium, glutethimide.

**Antibiotics:** Cell wall biosynthesis, inhibitors,  $\beta$ -lactum rings, antibiotics inhibiting protein synthesis, Synthesis of penicillin G, ampicillin, amoxicillin, chloramphenicol, Cephalosporin, tetracycline and streptomycin.



### **Recommended Books:**

1. Introduction to medicinal chemistry, A Gringuage, Wiley- VCH.
2. Wilson Gisvold's Text book of organic Medicinal and pharmaceutical Chemistry, Ed., Robert F.Dorge.
3. An introduction to drug design, S. S. Pandeya and J. R. Dimmock, New age International.
4. Burger's Medicinal Chemistry and Drug Discovery Volume 1 (Chap. 9 and Chap.14), Ed., M.E. Wolff, John Wiley.
5. Goodman and Gilman's Pharmacological Basis of Therapeutics, Mc Graw-Hill.
6. The organic Chemistry of Drug Design and drug action, R.B. Silverman, Academic press.
7. Strategies for Organic Drug synthesis and Design, D. Lednicer, John Wiley.

**M.Sc. (F) Industrial Chemistry**  
**Elective Paper-III**  
**Heterocyclic Chemistry**

**M.M. 75**

**UNIT- I**

**A- Nomenclature of Heterocycles**

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

**B- Aromatic heterocycles**

General chemical behavior of aromatic heterocycles, classification (Structural type), criteria of aromaticity (bond lengths ring current and chemical shifts in <sup>1</sup>H-NMR- spectra. Empirical resonance energy) resonance energy, delocalization energy and deqar resonance energy, diamagnetic susceptibility exaltations). Heteroaromatic reactivity and tautomerism in aromatic heterocycles.

**C-Non-aromatic Heterocycles**

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

**UNIT- II**

**A- Heterocyclic Synthesis**

Principles of heterocyclic synthesis, cyclization reactions and cycloaddition reactions.

**B- Small Ring Heterocycles**

Three membered and four membered heterocycles-synthesis and reaction of aziridine, oxiranes, thiranes, azetidines, oxetanes and thietanes.

**UNIT- III**

**A- Benzo-Fused Five-membered Heterocycles**

Synthesis and reactions including medicinal application of benzopyrroles, benzofurans and benzothiophenes.

**B- Meso-ionic Heterocycles**

General classification, chemistry of some important mesoionic heterocycles of type A and B and their applications.

**C- Six-membered heterocycles with one hetero atoms**

Synthesis and reaction of pyrylium salts and pyrones and their comparison with pyridinium and thiopyrylium salts and pyridines. Synthesis and reactions of quinolizinium and benzpyrinium salts, coumarins and chromones.

**UNIT- IV**

**A- Six-membered Heterocycles with two or more Heteroatoms**

Synthesis and reaction of diazines, triazines and thiazines.

**B- Seven-and large –Membered Heterocycles**

Synthesis and reaction of azepines, oxepines, thiepinines, diazepines, thiazepines, azocine, diazocines, dioxocines and dithiocines.

**Books Suggested**

1. "Heterocyclic Chemistry" Vol, 1-3 R.R. Gupta, M. Kumar and V. Gupta, Springer, Verlag
2. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
3. Heterocyclic chemistry, J.A. Joule, K. Mills and G.F. Smith, Chapman and Hall.
4. Heterocyclic chemistry, T.L. Gilchrist, Longman Scientific Technical.
5. Contemporary Heterocyclic chemistry. G.R. Newkome and W.W. Poaudler, Wiley-Inter Science.
6. An Introduction to the Heterocyclic Compounds, R.M. Acheson, John Wiley.
7. Comprehensive Heterocyclic Chemistry, A. R. Katritzky and C.W. rees. Eds. Pergamon Press.

**M.Sc. (F) Industrial Chemistry**  
**Elective Paper-IV**  
**Polymers**

**M.M. 75**

**Unit- I**

Brief history of macromolecular science General characteristics of polymers in comparison with organic compound, Nomenclature, Distinction between plastics, Elastomers, Fibres and liquid resins, classification of polymers.

**TYPES OF POLYMERS AND POLYMERISATION:** Thermoplastics and thermosetting, functionality concept, Concept of cross-linking-linear, Branched and cross-linked polymers. Addition, Condensation, Ionic, Co-ordination, Addition-Polymerisation Mechanism (Initiation, propagation and termination processes), Initiators, Inhibitors, Mechanism of Ionic polymerization.

**METHODS OF POLYMERISATION:** Bulk, Suspension, Emulsion, Solution. Necessity of co-polymers and co-polymerization, block and graft co-polymers.

**Unit- II**

Molecular weight and molecular weight distribution-number, weight and Viscosity average molecular weights of polymers, Methods of determining, Molecular weight.

**PROPERTIES OF POLYMERS:** Viscosity, Solubility, Optical, Electrical, Thermal and mechanical properties of polymers.

**POLYMER PROCESSING:** Compression, Moulding, casting, Extrusion, Fibre spinning, Injection moulding, Thermoforming, Vulcanisation of elastomers.

**Unit- III**

Introduction, concepts of kinetics of polymerization and Arrhenius's relation, Glassy state, Glass transition temperature, TGA, Factors affecting GTT, Crystallinity in polymers. Degradation of polymers by thermal, oxidative, Mechanical and chemical methods.

Detailed study of the following thermosetting polymers with respect to synthesis, Chemistry properties and applications:

- (i) Phenol formaldehyde resins.
- (ii) Amino resins- urea-formaldehyde and melamine-formaldehyde reaction, polyurethanes.
- (iii) Epoxy resins –grades of epoxy resins, curing process and its importance with mechanism.
- (iv) Polycarbonates and silicones.
- (v) Elastomers- polyisoprene, Polybutadiene, Neoprene.

**UNIT- IV**

Detailed study of the following thermoplastic polymers with respect to synthesis, chemistry, properties and applications:

- (i) Polyolefins- Polyethylenes, Polypropylene, Ethylene-Propylene Copolymers.
- (ii) Polyvinyl Chlorides- Grades of PVC, Teflon, Polyvinyl acetates and polyacetals.
- (iii) Polystyrene- Homopolymers, copolymers such as SBR, ABS, SAN.
- (iv) Polyamines- Nylon-6, Nylon-66 and other Nylons.
- (v) Polyethers and polyesters- Terephthalates, Crown ethers.
- (vi) Cellulosics such as esters, ethers, acetates, butyrates, nitrates, CMC Regenerated celluloses.

### **Recommended Books:**

1. Billmeyer, Textbook of polymer science, John Wiley and sons.
2. D.D. Deshpande, Physical Chemistry of macromolecules, Vishal Publications, New Delhi, 1985.
3. Polymer Science, V.R. Gowariker, N.V. Vishwanathan and J. Sreedhan, Wiley Eastern Ltd., 1986.

# M.Sc. (F) Industrial Chemistry

## Practical

M.M.: 150  
Time: 18 Hrs

### A. Inorganic Chemistry

40 Marks

20 Marks

Any one analysis from the followings:

1. Analyse the given sample of **iron ore** & Determine **Silica** –Gravimetrically, **Iron-Volumetrically** and find out their percentages in the given sample.. Analyse the given sample of Copper Ferrite ( $\text{CuFe}_2\text{O}_4$ ) & Determine the amount and Percentage of copper Iodometrically, Iron Volumetrically.
2. Determine the capacity of **cation exchange resin** of given sample of cation exchange resin in terms of milliequivalent/g of dry resin.
3. Determine the capacity of **anion exchange resin** of given sample of anion exchange in terms of milliequivalent/g of dry resin.
4. Prepare **Copper Ferrite ( $\text{CuFe}_2\text{O}_4$ )** & Find out percentage practical yield of the Copper Ferrite ( $\text{CuFe}_2\text{O}_4$ ).
5. To prepare **potash alum** & find out the percentage of **Aluminium** in the alum.
6. Find out the percentage of '**Magnesium**' in a given sample of Talcum powder complexometrically.
7. Determine the concentration in mg/lit of sulphate ion in the given sample of water nephelometrically.

**Preparation of selective inorganic complex** (any one).

20 Marks

1. Metal acetylacetonate.
2. Ion exchange separation of oxidation state of V.
3. Preparation of Fe (II) Chloride.
4. Phosphine  $\text{Ph}_3\text{P}$  and its transition metal complexes.
5. Ferrocene
6. Copper glycine Complex

### B. Organic Chemistry

40 Marks

1. Separation, purification, and identification of Ternary mixture. Preparation of derivatives, if possible.

15 Marks

2. Organic Analysis: (Any one from followings)

15 Marks

- (i) Estimation of Phenol and Aniline by  $\text{KBr}/\text{KBrO}_3$  method.
- (ii) Estimation of Amino group.
- (iii) Estimation of Hydroxyl group.
- (iv) Estimation of Carbonyl group.
- (v) Estimation of Reducing and non-reducing sugars.
- (vi) Estimation of a drug in mixture using simple titration.

3. Elucidation of structure of organic compound by spectral data.

10 Marks

### C. Physical Chemistry (Any two from followings):

40 Marks

- (i) Conductometry: Determination of percentage of acetic acid in commercial vinegar solution
- (ii) Fluorimetry: To determine the amount of riboflavin in given B-complex tablet.
- (iii) Latent Heat of fusion: To determine the latent heat of fusion of given solid.
- (iv) Polarography: Study the effect of Oxygen supporting electrolyte and maximum suppressor and determine the half wave potential of Cd/Zn in given solution by Half wave potential method. Differential method and

20+20 Marks

- half wave equation method.
- (v) Potentiometry: To determine the dissociation constant of dibasic acid by potentiometric method.
  - (vi) pH – metry: To determine the dissociation constant of dibasic acid pH – metrically.
  - (vii) pH – metry: To determine pH value of various buffer using pH meter and determination of dissociation constant of acetic acid.
  - (viii) Spectrophotometry: To determine pK value of phenolphthalein indicator by spectrophotometric method.
  - (ix) Spectrophotometry: To study the stoichiometry and stability of ferric sulphate complex by Job's method and Mole ratio method.
  - (x) Phase Rule: To construct phase diagram for three component system contain  $C_2H_5OH$ ,  $C_6H_6$  &  $H_2O$ .
  - (xi) Colorimetry: To determine concentration of ammonia in given unknown solution colorimetry.
  - (xii) Conductometry:
  - (xiii) To determine solubility of sparingly soluble salt (e.g.  $PbSO_4$ ,  $AgIO_3$ ,  $Ag_2CrO_4$ ) conductometry.

**D. Industrial Tour**

**20 Marks**

**E. Record/Viva-Voce**

**10 Marks**