KOLHAN UNIVERSITY, CHAIBASA
JHARKHAND

Revised Curriculum and Credit Frame Work

As Per FYUGP, NEP – 2020

For UG Chemistry (w.e.f. 2022)

University Department of Chemistry
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UNIVERSITY DEPARTMENT OF CHEMISTRY
KOLHAN UNIVERSITY, CHAIBASA
JHARKHAND

Revised Curriculum and Credit Frame Work
As Per FYUGP, NEP – 2020
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Syllabus of U.G. Chemistry has been prepared by the following members of Board of Studies (BOS)

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Kolhan University
Department of Chemistry
Semester wise course code & credit point as per FYUGP NEP – 2020

Index			
Sem	**Code**	**Papers**	**Credits (Th +P)**
I	MJ-1	Major Paper-1 (Inorganic Chemistry - 1)	3 + 0
	MJ-1 Practical	Practical of MJ-1	0 + 1
	MN-1A	Minor Paper-1A (Inorganic Chemistry)	3 + 0
	MN-1A Practical	Practical of MN-1A	0 + 1
	MDC/IRC-1	Multi-Disciplinary/Introductory Regular Course	3 + 0
II	MJ-2	Major Paper -2 (Organic Chemistry - 1)	3 + 0
	MJ-3	Major Paper -3 (Physical Chemistry - 1)	3 + 0
	MJ-2 Practical	Practical of MJ-2 & MJ-3	0 + 2
	MN-2A	Minor Paper – 2A (Chemistry in Everyday Life)	3 + 0
	MN-2A Practical	Practical of MN-2A	0 + 1
III	MJ-4	Major Paper - 4 (Inorganic Chemistry - 2)	3 + 0
	MJ-5	Major Paper -5 (Organic Chemistry - 2)	3 + 0
	MJ-3 Practical	Practical of MJ-4 & MJ-5	0 + 2
	MN-1B	Minor Paper – 1B (Physical Chemistry)	3 + 0
	MN-1B Practical	Practical of MN-1B	0 + 1
IV	MJ-6	Major Paper-6 (Inorganic Chemistry - 3)	3 + 0
	MJ-7	Major Paper -7 (Organic Chemistry - 3)	3 + 0
	MJ-8	Major Paper -8 (Physical Chemistry - 2)	3 + 0
	MJ-4 Practical	Practical of MJ-6, MJ-7 & MJ-8	0 + 3
	MN-2B	Minor Paper –2B (Analytical Chemistry)	3 + 0
	MN-2B Practical	Practical of MN-2B	0 + 1
V	MJ-9	Major Paper - 9 (Inorganic Chemistry - 4)	3 + 0
	MJ-10	Major Paper - 10 (Molecular Spectroscopy)	3 + 0
	MJ-11	Major Paper - 11 (Physical Chemistry - 3)	3 + 0
	MJ-5 Practical	Practical of MJ-9, MJ-10 & MJ-11	0 + 3
	MN-1C	Minor Paper – 1C (Organic Chemistry)	3 + 0
	MN-1C Practical	Practical of MN-1C	0 + 1
VI	MJ-12	Major Paper -12 (Analytical Chemistry)	3 + 0
	MJ-13	Major Paper -13 (Green Chemistry)	3 + 0
	MJ-14	Major Paper -14 (Heterocyclic Chemistry)	3 + 0
	MJ-15	Major Paper -15 (Biochemistry)	3 + 0
	MJ-6 Practical	Practical of MJ-12, MJ-13, MJ-14 & MJ-15	0 + 4
	MN-2C	Minor Paper – 2C (Bio-Inorganic Chemistry)	3 + 0
	MN-2C Practical	Practical of MN-2C	0 + 1
VII	MJ-16	Major Paper -16 (Environmental Chemistry)	3 + 0
	MJ-17	Major Paper -17 (Organic Chemistry – 4)	3 + 0
	MJ-18	Major Paper -18 (Group Theory & Bioinorganic Chemistry)	3 + 0
	MJ-19	Major Paper-19 (Physical Chemistry - 4)	3 + 0
	MJ-7 Practical	Practical of MJ-16, MJ-17, MJ-18 & MJ-19	0 + 4
	MN-1D	Minor Paper – 1D (Biochemistry)	3 + 0
	MN-1D Practical	Practical of MN-1D	0 + 1

VIII	MJ-20	Major Paper-20 (Application of Spectroscopy)	3 + 0
	AMJ-1	Advanced Major Paper-1 (Medicinal Chemistry)	3 + 0
	AMJ-2	Advanced Major Paper-2 (Polymer Chemistry)	3 + 0
	AMJ-3	Advanced Major Paper-3 (Material Chemistry)	3 + 0
	MJ-8 + AMJ-1 Practical	Practical of MJ-20, AMJ-1, AMJ-2 & AMJ-3	0 + 4
	MN-2D	Minor Paper – 2D (Bio-Organic Chemistry)	3 + 0
	MN-2D Practical	Practical of MN-2D	0 + 1

Semester-I

PAPER Title: Major Paper-1 (MJ-1)

Credits -03

Learning objective:

- Atomic theory and its evolution
- Elements in periodic table; physical and chemical characteristics, periodicity
- Characterize bonding between atoms, molecules, interaction and energetic, hybridization and shapes of atomic, molecular orbital's, bond parameters, bond-distances and energies.

Inorganic Chemistry-1

FM−60 Marks **Time 3hrs**

Unit	Content	Hours
1	**Atomic Structure:** Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de' Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.	10h
2	**Periodicity of Elements:** s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s and p-block. (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van'der Waals) (c) Ionic and crystal radii. (d) Covalent radii (octahedral and tetrahedral) (e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (f) Electron gain enthalpy, trends of electron gain enthalpy. (g)Electro negativity, Pauling, Mullikan, Allred Rachow scales, electro negativity and bond order, partial charge, hybridization, group electro negativity. Sanderson electron density ratio.	10h
3	**Chemical Bonding:** **(i) Ionic bond:** General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation, expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy. **(ii) Covalent bond:** Lewis structure, Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions containing lone-and bond-pairs of electrons multiple bonding, sigma and pi-bond approach, Valence Bond theory, (Heitler-London approach). Hybridization containing s, p and s, p, d atomic orbitals, shapes of hybrid orbitals, Bents rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of simple homonuclear and heteronuclear diatomic molecules, MO diagrams of simple tri and tetra-atomic molecules, e.g., N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, HCHO, (idea of s-p mixing and orbital interaction to be given). Covalent character in ionic compounds, polarizing power and polarizability. Fajan rules, polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Ionic character from dipole moment and electro negativities.	20h
4	**Metallic bonding and Weak chemical forces:** Metallic Bond: Qualitative idea of free electron model, Semiconductors, Insulators. Weak Chemical Forces: van 'der Waals, ion-dipole, dipole-dipole, induced dipole-dipole interactions, hydrogen bond, effects of hydrogen bonding on melting and boiling points, solubility, dissolution.	05h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

- Advanced Inorganic Chemistry by Cotton and Wilkinsons
- Principles of Inorganic Chemistry by Puri, Sharma and Kalia
- Inorganic Chemistry, by Moillers
- Pradeep's Inorganic Chemistry, Vol.- I, II and III
- Dinesh Inorganic Chemistry, Vol.- I, II and III
- Text Book of Inorganic Chemistry by P.L. Soni
- Selected Topics in Inorganic by Satyaprakash, Malik, Madan and Tuli
- Advanced Inorganic Chemistry by Gurdeep and Harish

Semester-I

PAPER Title: Chemistry Practical - MJ-1 LAB

Credits - 01

FM-25 Marks **Pass Marks - 10**

Content

Titrimetric Analysis

(A) Preparation of solutions of different Morality/Normality of titrants.

(B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.
(ii) Estimation of carbonate and bicarbonate present together in a mixture.

(C) Oxidation-Reduction Titration

(i) Estimation of Fe (II) and oxalic acid using standardized KMnO4 solution.
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe (II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

(D) Iodometry

(i) Estimation of Cu using standardized solution of Sodium Thiosulphate Solution.

Experiments – 15 Marks
Viva-Voice – 05 Marks
Notebook – 05 Marks

Semester-I

PAPER Title: Minor Paper-1 (MN-1A)
Credits - 03

Learning objective:

- Atomic theory and its evolution
- Elements in periodic table; physical and chemical characteristics, periodicity
- Characterize bonding between atoms, molecules, interaction and energetic, hybridization and shapes of atomic, molecular orbital's, bond parameters, bond-distances and energies.

Inorganic Chemistry-1

FM−60 Marks **Time 3hrs**

Unit	Content	Hours
1	**Atomic Structure:** Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de' Broglie equation, Heisenberg's Uncertainty Principle and its significance. Shapes of s, p, d and f orbital's. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations, Variation of orbital energy with atomic number.	12h
2	**Periodicity of Elements:** s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s and p-block. (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van'der Waals) (c) Ionic and crystal radii. (d) Covalent radii (octahedral and tetrahedral) (e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (f) Electron gain enthalpy, trends of electron gain enthalpy. (g)Electro negativity, Pauling, Mullikan, Allred Rachow scales, electro negativity and bond order, partial charge, hybridization, group electro negativity. Sanderson electron density ratio.	12h
3	**Chemical Bonding:** **(i) Ionic bond:** General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation, expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy. **(ii) Covalent bond:** Lewis structure, Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions containing lone-and bond-pairs of electrons multiple bonding, sigma and pi-bond approach, Valence Bond theory, (Heitler-London approach). Hybridization containing s, p and s, p, d atomic orbitals, shapes of hybrid orbitals, Bents rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of simple homonuclear and heteronuclear diatomic molecules, MO diagrams of simple tri and tetra-atomic molecules, e.g., N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, HCHO, (idea of s-p mixing and orbital interaction to be given). Covalent character in ionic compounds, polarizing power and polarizability. Fajan rules, polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Ionic character from dipole moment and electro negativities. **(iii) Metallic bonding:** Metallic Bond: Qualitative idea of free electron model, Semiconductors, Insulators.	21h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

- Advanced Inorganic Chemistry by Cotton and Wilkinsons
- Principles of Inorganic Chemistry by Puri, Sharma and Kalia
- Inorganic Chemistry, by Moillers
- Pradeep's Inorganic Chemistry, Vol.- I, II and III
- Dinesh Inorganic Chemistry, Vol.- I, II and III
- Text Book of Inorganic Chemistry by P.L. Soni
- Selected Topics in Inorganic by Satyaprakash, Malik, Madan and Tuli
- Advanced Inorganic Chemistry by Gurdeep and Harish

Semester-I

PAPER Title: Chemistry Practical - MN-1A LAB

Credits - 01

FM-25 Marks **Pass Marks - 10**

Content

Titrimetric Analysis

(A) Preparation of solutions of different Morality/Normality of titrants.

(B) Acid-Base Titrations
(i) Estimation of carbonate and hydroxide present together in mixture.
(ii) Estimation of carbonate and bicarbonate present together in a mixture.

(C) Oxidation-Reduction Titration
(i) Estimation of Fe (II) and oxalic acid using standardized KMnO4 solution.
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe (II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Experiments – 15 Marks
Viva-Voice – 05 Marks
Notebook – 05 Marks

Semester-I

Course Title: Multi – Disciplinary/Introductory RegularCourse-1 (MDC/IRC)

Credits -03

FM−75 Marks **Time 3hrs**

Unit	Content	Hours
1	**Group A- Inorganic Chemistry**	
	• **Atomic Structure and Periodic Properties:** Bohr's Model. Dual nature of matter; de Broglie concept. Heisenberg uncertainty principle; its significance. Atomic orbital's, Quantum numbers, shapes of s, p and d orbital's. Aufbau energy diagram, Pauli's exclusion principle. Hund's rule of maximum multiplicity. Electronic configuration of elements (s block, p block and first series of d-block elements).	15h
	• **Periodic properties** The general idea of Modern periodic table, atomic and ionic radii, ionization potential, electron affinity, electro negativity-definition.	
	• General Chemistry of Group IA, IIA, IB, IIB	
	• **Ionic Bond:** Lattice energy, Born- Haber cycle, factor favoring Ionic bond, Variable valency, properties of Ionic compounds.	
	• **Covalent bond** Formation of sigma and pi bond, Hybridization and directional bonding (VBT), Structure and shapes of BF_3, PCl_5, SF_4, $SnCl_2$, NH_3, and CH_4. Properties of covalent compounds	
2	**Group B - Organic Chemistry**	
	• Tetracovalency of carbon, Hybridization (sp^3, sp^2, sp). Classification & nomenclature of organic compounds.	15h
	• Detection and estimation of element (N, S, P & Halogen), determination of molecular weight of organic acid and organic bases.	
	• Elementary idea of electron displacement effect (Inductive, electrometric, resonance, mesomeric, Hyperconjucation).	
	• IUPAC nomenclature of branched and unbranched Alkanes, the alkyl group, classification of carbon atoms in Alkanes, Isomerism in Alkanes, sources, methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids), physical properties and chemical reactions of Alkanes.	
	• **Isomerism** Structural and stereoisomerism solution of racemiem mixtures. Elements of symmetry.	
	• Cycloalkanes-nomenclature, methods of formation, chemical reaction's Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane).	
3	**Group C-Physical Chemistry**	
	• **Gaseous State** Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waal's equation of states, relationship between critical constants and van der Waals constants. Molecular velocities: Root mean square, average and most probable velocities, Numerical problems.	15h
	• **Chemical Equilibrium:** Law of mass action and its Kinetic derivation, Equilibrium constant, Relation between K_P, K_C and equation. Le Chatelier's principle.	
	• **Dilute solution:** Colligative properties, Osmosis & Osmotic Pressure, Lowering of Vapour Pressure, Elevation of Boiling Point, Depression of Freezing Point.	
	• **Thermo chemistry** Hess law, Kirchhoff law, bond energy and their calculation.	

***Remarks -: No Internal Exam**

Books Recommended:

- Principles of Inorganic Chemistry by Puri, Sharma and Kalia
- Organic Chemistry by Bahl and Bahl
- Text Book of Physical Chemistry by Puri Sharma and Pathania
- Text Book of Physical Chemistry by Bhal and Tuli
- Pradeep's Inorganic, Organic, Physical Chemistry, Vol.- I
- Dinesh Inorganic, Organic, Physical Chemistry, Vol.- I

Semester-II
PAPER Title: Major Paper -2 (MJ-2)
Credits - 03

Learning objective:

- Basic of organic molecules, structure, bonding, reactivity and reaction mechanisms.
- Stereochemistry of organic molecules.
- Aromatic compounds and Aromaticity, mechanism of aromatic reactions
- Electrophilic, Nucleophilic, free radicals, electro negativity, resonance, and intermediates along the reaction pathways.

Organic Chemistry - 1

FM−60 Marks **Time 3hrs**

Unit	Content	Hours
1	**Basics of Organic Chemistry:** Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electrometric, resonance and mesmeric effects, hyper conjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophilic and Nucleophilic; Nucleophilicity and basicity; Types, shape and relative stabilities of reaction intermediates (Carbocations, Carbanions, Free radicals and Carbenes). Organic reactions and their mechanism: Addition, Elimination and Substitution reactions.	10h
2	**Isomerism: Structural & Stereoisomer** Concept of asymmetry, Fischer Projection, Newman and Sawhorse projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centers, Di stereoisomers, meso structures, Racemic mixtures, Relative and absolute configuration.	10h
3	**Chemistry of Aliphatic Hydrocarbons** **Alkanes and Cycloalkanes** Formation of Alkanes, Wurtz Reaction, Wurtz- Fittig Reactions, Free radical substitutions: Halogenations - relative reactivity and selectivity. **Cycloalkanes and Conformational Analysis** Cycloalkanes and stability, Baeyer strain theory, Conformation analysis, Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms. **Alkene, Diene and Alkynes** Formation of alkenes and alkynes by elimination reactions, Mechanism of E_1, E_2, E_1cb reactions. Saytzeff and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff's &Anti Markownikoff's addition), mechanism of oxymercuration demercuration, hydroboration- oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1, 2- and 1, 4- addition reactions in conjugated Dienes and, Diels- Alder reaction; Allylic and benzylic bromination and mechanism, e.g., propene, 1-butene, toluene, ethyl benzene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions.	15h
4	**Arenes and Aromaticity** Aromaticity: Huckel's rule, aromatic character of arenes, cyclic Carbocations/carbanions and heterocyclic compounds with suitable examples. Nomenclature of benzene derivatives. The aryl group Aromatic nucleus and side chain. Electrophilic aromatic substitution: halogenations, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of substituent groups. Structure of benzene: molecular formula and Kekule structure. Stability and carbon-carbon bond lengths of benzene, resonance structure. MO picture.	10h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks

A – Internal written Examination – 10 Marks (1 Hr)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

- Advanced Organic Chemistry by Bahl and Bahl
- Pradeep's Organic Chemistry by Pradeep Publication
- Dinesh Organic Chemistry
- Text Book of Organic Chemistry, Vol.- I and II by I.L. Finar
- Text Book of Organic Chemistry, Vol.- I and II by P.L. Soni
- Reactions and Reagents by O.P. Agarwal
- Reactions and Reagents by Gurdeep Raj Chatwal.
- Organic Chemistry by Morrison and Boyd

Semester-II
PAPER Title: Major Paper-3 (MJ-3)
Credits - 03

Learning objective:

- Familiarization with various states of matter
- Understanding Kinetic model of gas and its properties
- Ionic equilibria – electrolyte, ionization, dissociation

Physical Chemistry - 1

FM- 60 Marks **Time 3hrs**

Unit	Content	Hours
1	**Gaseous state** Behavior of real gases: Deviations from ideal gas behavior, compressibility factor, and its variation with pressure for different gases. Causes of deviation from ideal behavior. Van der Waals equation of state, its derivation and application in explaining real gas behavior, Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, critical and van der Waals constants, law of corresponding states.	10h
2	**Kinetic molecular model of a gas:** postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy.	10h
3	**Liquid state:** Structure and physical properties of liquids; vapor pressure, surface tension, viscosity, and their dependence on temperature, Effect of addition of various solutes on surface tension, cleansing action of detergents. Structure of water.	05h
4	**Ionic equilibria:** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di- and tri-protic acids. Salt hydrolysis, hydrolysis constants, degree of hydrolysis and pH for different salts. Buffer solutions; Henderson equation, buffer capacity, buffer range, buffer action, applications of buffers in analytical chemistry, Solubility and solubility product. Bronsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, leveling solvents, Lewis's acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolytes.	10h
5	**Solid state:** Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, Various types of defects in crystals, Glasses and liquid crystals.	10h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks

A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press (2006).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
5 G. M. Barrow, Tata McGraw Hill (Fifth Edition) (2007)
6 Khosla, B. D.; Garg, V. C. &Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
7 Roy, B. N. Fundamentals of Classical and Statistical Thermodynamics Wiley, 2001

Semester-II

PAPER Title: Chemistry Practical - MJ-2 LAB

Credits - 02

FM-50 Marks **Pass Marks – 20**

Time: 03 hrs

Content

1. Detection of element [N, S, P and halogens] and detection of functional group in organic compounds containing one functional group including monosaccharides. COOH, Phenolic – OH, Aldehydic, Ketonic, Nitro, Amino and amides.

2. Surface tension measurements.

a. Determine the surface tension by (i) drop number (ii) drop weight method.

b. Study the variation of surface tension of detergent solutions with concentration.

3. Viscosity measurements using Ostwald's viscometer.

a. Determination of viscosity of aqueous solutions of

(i) polymer

(ii) ethanol and

(iii) sugar at room temperature.

b. Viscosity of sucrose solution with the concentration of solute.

- **pH metry**

a. Effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.

b. Preparation of buffer solutions of different pH

I. Sodium acetate-acetic acid

ii. Ammonium chloride-ammonium hydroxide

c. pH metric titration of

(I) strong acid vs. strong base,

(ii) Weak acid vs. strong base.

d. Determination of dissociation constant of a weak acid.

One Experiment – 30 Marks
Viva-Voice – 10 Marks
Notebook & Regularity – 10 Marks

Semester-II
PAPER Title: Minor Paper-2A (MN-2A)
Credits - 03

Learning objective:

- To understand the importance of science in everyday life.
- To understand the preparation of soaps and detergents.
- To know about kinds of Biofuel and its uses.
- To know about uses Fibers in day-to-day life.

Chemistry in Everyday Life

FM−60 Marks **Time 3hrs**

Unit	Content	Hours
1	**Respiration and energy production in human body:** Brief outline of haemoglobin and myoglobin, oxygen transport mechanism in body, co-operativity. Energy production in body, ATP; enzyme responsible for food digestion, mechanism of food digestion, active site of cytochrome c-oxidase.	10h
2	**Vitamins and minerals:** Need for vitamin in body, types of vitamins, water soluble and fat-soluble vitamins, Vitamin B-12, vitamin C (Cyanocobalamine), D, Vitamin K. Role of minerals in body, iodine deficiency and remedy.	10h
3	**Significance of Radical chemistry in living system:** Radical production in environment, superoxide and peroxide, health impact, action of radicals, cell mutation, diseases caused by free radical, cancer, radical quencher, anti-oxidants, natural anti-oxidants like vegetables, beverages like tea and coffee, fruits. Radical destroying enzymes: superoxide dismutase, catalase, peroxidase, mechanism of action.	10h
4	**Chemistry of Materials:** Soaps and Detergents – their action, Biofuels – production of biofuels and its utility as alternative fuel source, Fibers: natural fibres, cotton, wool, silk, rayon, artificial fibres, polyamides, acrylic acid, PVC, PVA; Examples of natural biodegradable polymers, cellulose, cellulose acetate, cellophane, soy protein, corn, zein protein, wheat gluten protein, synthetic biodegradable polymers. Use of polymeric materials in daily life.	15h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr)
B – Over All Performance including Regularity – 05 Marks
Books Recommended:

1. Kaim W, Bioinorganic Chemistry, Vol 4, Brigitte Scwederski, Wiley, 1994.
2. Crichton R. H. Biological Inorganic Chemistry – An Introduction, Elsevier, 2008.
3. Berg J. M., Tymoczeko J. L., Stryer l. Biochemistry, W. H. Freeman, 2008.
4. Bertini, I., Gray, H. B., Lippard, S. J. and Valentine, J. S. (1994) Bioinorganic Chemistry. University Science Books (1994)
5. Lippard S., Berg J. M. Principles of Bioinorganic Chemistry; University Science Books 1994.
6. Polymer science, V. R. Gowariker, N. V.Viswanathan, J. Sreedhar, New Age International.

Semester-II

PAPER Title: Chemistry Practical - MN-2A LAB

Credits - 01

FM-25 Marks **Pass Marks - 10**

Content

- Analysis of soaps and detergents.
- Analysis of Biofuels - flash point, pour point, cloud point.
- Preparation of Nylon6/6,6
- Testing of adulterant in food, oil and vegetable
- Vitamin-C preparation.

Experiments – 15 Marks
Viva-Voice – 05 Marks
Notebook – 05 Marks

Semester-III
PAPER Title: Major Paper-4 (MJ-4)
Credits - 03

Learning objective:

- Oxidation-Reductions and their use in metallurgy.
- Chemistry of s and p-block elements.
- Inorganic polymers and their use.
- Chemistry of noble gases and their compounds; application of VSEPR theory in explaining structure and bonding.

Inorganic Chemistry - 2

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Oxidation-Reduction and general principle of metallurgy:** Redox equations, Standard Electrode Potential and its application to inorganic reactions. Occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon or carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel- de Boer process and Mond's process, Zone refining.	12h
2	**Noble Gases:** Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF2, XeF4 and XeF6; Bonding in noble gas compounds (Valence bond and MO treatment for XeF2), Shapes of noble gas compounds (VSEPR theory).	08h
3	**Chemistry of s and p Block Elements:** Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behavior of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate. Structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Per-oxo acids of Sulphur inter-halogen compounds, polyhalide ions, pseudo-halogens, properties of halogens.	15h
4	**Inorganic Polymers:** Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.	10h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

(i) Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
(ii) Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
(iii) Greenwood, N.N., Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
(iv) Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
(v) Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.
(vi) Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry Fourth Ed., Pearson, 2010.
(vii) Atkins, P. W and Shriver D. N. Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010).

Semester-III
PAPER Title: Major Paper-5 (MJ-5)
Credits - 03

Learning objective:

- Basic uses of reaction mechanisms.
- Name reactions, uses of various reagents and the mechanism of their action.
- Organometallic compounds and their uses
- Use of reagents in various organic transformation reactions

Organic Chemistry - 2

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Chemistry of Halogenated Hydrocarbons:** Alkyl halides: Methods of preparation, Nucleophilic substitution reactions – SN_1, SN_2 and SN_i mechanisms with stereochemical aspects and effect of solvent etc.; Nucleophilic substitution vs. elimination. Aryl halides: Preparation, including preparation from diazonium salts. Nucleophilic aromatic substitution; SN_{Ar}, Benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards Nucleophilic substitution reactions. Organometallic compounds of Mg and Li and their use in synthesis.	12h
2	**Alcohols, Phenols, Ethers and Epoxides:** Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Preparation and properties of glycols: Oxidation by periodic acid and lead tetra acetate, Pinacol-Pinacolone rearrangement. Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism. Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxies with alcohols, ammonia derivatives and $LiAlH_4$	10h
3	**Carbonyl Compounds:** Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff- Kishner, LiAlH4, NaBH4, MPV, PDC and PGC); Addition reactions of unsaturated carbonyl compounds: Michael addition. Active methylene compounds: Keto-enoltautomerism.	10h
4	**Carboxylic Acids and their Derivatives:** Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids; Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann bromamide degradation and Curtius rearrangement.	10h
5	**Sulphur containing compounds:** Preparation and reactions of thiols, thioethers and sulphonic acids.	03h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

(i) Solomons, T.W G., Fryhle, B. Craig. Organic Chemistry, John Wiley & Sons, Inc (2009).
(ii) McMurry, J.E. Fundamentals of Organic Chemistry, Seventh edition Cengage Learning, 2013.
(iii) P Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman, New Delhi.
(iv) Morrison R. T. and Boyd R. N. Organic Chemistry, Sixth Edition Prentice Hall India, 2003.
(v) Ahluwalia, V.K. &Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparationand Quantitative Analysis, University Press (2000).
(vi) Kalsi, P. S. Organic reacations and their mechanisms, New Age Science (2010).
(vii) Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press Inc., New York (2001).

Semester-III

PAPER Title: Chemistry Practical - MJ-3 LAB
Credits- 02

FM - 50 **Pass Marks- 20**

Content

(A) Iodo / Iodimetry Titrations
(i) Estimation of Cu (II) using sodium thiosulphate solution.
(ii) Estimation of Arsenite and Antimony Iodimetrically
(iii) Estimation of available chlorine in bleaching powder iodometrically.

(**B) Inorganic preparations**
(i) Cuprous Chloride, Cu_2Cl_2
(ii) Preparation of Aluminum potassium sulphat (Potash alum) or Chrome alum.
(iii) Preparation of Sodium Nitroprusside.

(C) Organic preparations
Acetylation
(i) Preparation of Acetanilide from aniline
(ii) Preparation of Aspirin from salicylic acid
Benzoylation
(i) Preparation of Benzanilide from aniline
(ii) Preparation of Benzoyl p – toluidine
Nitration
(i) Preparation of m-dinitrobenzene
(ii) Preparation of picric acid from Phenol

Experiments – 30 Marks
Viva-Voice – 10 Marks
Notebook – 10 Marks

Semester-III
Course Title: Minor Paper-1B (MN-1B)
Credits -03

Learning objective:

- Familiarization with various states of matter
- Understanding Kinetic model of gas and its properties
- Ionic equilibria – electrolyte, ionization, dissociation

Physical Chemistry

FM-60 **Time- 3hrs**

Unit	Content	Hours
1	**Chemical kinetics:** Rate of reaction, order and Molecularity of reaction. First and second order reaction. Determination of order of reaction effect of temperature on reaction rate. Activation energy. **Catalysis** Characteristics of catalysts, types of catalysts, enzyme catalyst. Theory of catalysis, autocatalysis.	05h
2	**Thermodynamics-I:** System & surrounding, types of system, heat, work and internal energy. First law of Thermodynamics, Enthalpy, Heat Capacities, Relation between Cp and Cv. Calculation of W, Q, E and H in isothermal and adiabatic expansion of gases.	08h
3	**Thermodynamics-II:** Second law of thermodynamics. Conversion of heat into work. Carnot theorem and camot cycle. Entropy, entropy changes in reversible and irreversible processes Entropy of expansion of ideal gases. Entropy of mixing of gases.	08h
4	**Colloidal chemistry** Classification, preparation, purification and properties of colloidal solution. Peptization of colloids. Protection of colloids. Origin of charge on colloids. Electrophoresis, coagulation, dialysis, Brownian movement, Gold number.	04h
5	**Electrochemistry** Specific, Equivalent and molecular conductivities. Effect of dilution on different types of conductivities. Experimental determination of conductivities. Conductivity cell and cell constant. Ionic mobilities, Kohlrausch's law, Transference number. Arrhenius theory of electrolytes. Dissociation of weak and strong electrolytes.	10h
6	**Gaseous State:** Kinetic theory of gases Postulates, Kinetic gas equation, Deduction of gas laws from kinetic gas equation, R.M.S. Velocity, Aver-age velocity and Kinetic Energy of Gas molecules, Deviations from ideal behaviour. Vender Waal's equation of state. **Liquid State:** Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals : difference between liquid crystal, solid and liquid. Classification, structures of nematic, smectic and cholesteric phases. Thermography and seven segment cell.	10h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

- Pradeep's Physical Chemistry, Vol.-I, II and III
- Dinesh Physical Chemistry, Vol.-I, II and III
- Text Book of Physical Chemistry by Puri Sharma and Pathania
- Advanced Physical Chemistry by D.N. Bajpai
- UGC Advanced Physical Chemistry by J.N. Gurtu and A. Gurtu, Vol.-I, II and III

Semester-III
Course Title: Chemistry Practical - MN-1B LAB
Credits- 01

FM - 25 **Pass Marks- 10**

Content

Determination of surface tension of liquids using Stalagmometer.
Determination of co-efficient of viscosity liquids using Ostwald's viscometer.
Determination of Heat of solution.
Determination of Heat neutralization of strong acid and strong base.
Determination of Partition co-efficient of solute between two immiscible liquids.
e.g., Iodine between carbon tetrachloride and water.

Experiments – 15 Marks
Viva-Voice – 05 Marks
Notebook – 05 Marks

Semester-IV
PAPER Title: Major Paper- 6 (MJ-6)
Credits -03

Learning objective:

- Coordination compounds – its nomenclature, theories, d-orbital splitting in complexes, chelate.
- Transition metals, its stability, color, oxidation states and complexes.
- Bioinorganic chemistry – metal ions in biological system, its toxicity; hemoglobin.

Inorganic Chemistry -3

FM-60 **Time- 3hrs**

Unit	Content	Hours
1	**Coordination Chemistry:** Werner's theory, EAN rule, valence bond theory (inner and outer orbital complexes), Crystal field theory, d-orbital splitting, , weak and strong fields, pairing energies, factors affecting the magnitude of (Δ). Octahedral vs. tetrahedral coordination, square planar complexes, d orbital splitting in trigonal bipyramidal, square pyramidal and cubic Ligand field environments, CFSE, Qualitative aspect of Ligand field theory, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with the coordination number 4 and 6, Chelate effect.	15h
2	**Transition Elements:** General group trends with special reference to electronic configuration, color, variable valency, magnetic and catalytic properties, and ability to form complexes. Difference between the first, second and third transition series. Chemistry of Ti, V, Cr, Mn, Fe and Co in various oxidation states (excluding their metallurgy).	10h
3	**Lanthanides and Actinides:** Electronic configuration, oxidation states, color, spectra and magnetic behavior, lanthanide contraction, separation of lanthanides (ion-exchange method only).	10h
4	**Bioinorganic Chemistry:** Metal ions present in biological systems, Sodium / K-pump, Toxicity of metal ions (Hg, Pb, Cd and As), chelating agents in medicine. Iron and its application in biosystems, Hemoglobin.	10h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

- Purcell, K.F &Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977.
- Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
- Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
- Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry Wiley-VCH, 1999
- Basolo, F, and Pearson, R.C. Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
- Greenwood, N.N. &Earnshaw A. Chemistry of the Elements, Butterworth-Heinemann, 1997.

Semester-IV
PAPER Title: Major Paper- 7 (MJ-7)
Credits - 03

Learning objective:

- Nitrogen containing functional groups and their reactions.
- Familiarization with Polynuclear hydrocarbons and their reactions.
- Alkaloids and Terpenes

Organic Chemistry - 3

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Nitrogen Containing Functional Groups** Preparation and important reactions of nitro and compounds, nitriles and isonitriles Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3°. Diazonium salts: Preparation and synthetic applications.	10h
2	**Heterocyclic Compounds:** Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction Derivatives of furan: Furfural and furoic acid.	15h
3	**Polynuclear Hydrocarbons:** Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.	10h
4	**Alkaloids** Natural occurrence, General structural features, Isolation and their physiological action, Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.	05h
5	**Terpenoids** - Occurrence, classification, isoprene rule. Elucidation of stucture and synthesis of Citral, Nerol and α-terpineol.	05h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

(i) Morrison, R. T., Boyd, R. N., Bhatterjee, S.K., Organic Chemistry, 7th Edn., Pearson.
(ii) Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly& Sons (1976).
(iii) Solomons, T.W., Fryhle Craig, Organic Chemistry, John Wiley & Sons, Inc (2009).
(iv) McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
(v) Kalsi, P. S. Organic reacations and their mechanisms, New Age Science (2010).
(vi) Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press Inc., New York (2001).
(vii) Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Prajati Parakashan (2010).
(viii) Bansal R. K. Heterocyclic Chemistry: Syntheses, Reactions and Mechanisms, New Age, Third Edition (1999).
(ix) Clayden J., Greeves N., Warren S., Organic Chemistry, (2nd Ed)., (2012), Oxford University Press.

Semester-IV
PAPER Title: Major Paper-8 (MJ-8)
Credits- 03

Learning objective:

- Understanding the application of thermodynamics: Joule Thompson effects, partial molar quantities.
- Understanding the concept of heat of reactions and use of equations in calculations of bond energy, enthalpy, etc.
- Dilute solution and its properties.

Physical Chemistry - 2

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Introduction to thermodynamics:** Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. **First law of thermodynamics:** Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.	10h
2	**Thermo chemistry:** Heats of reactions: standard states; enthalpy of formation and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermo chemical data, effect of temperature (Kirchhoff's equations), pressure on enthalpy of reactions.	05h
3	**Second Law of thermodynamics:** Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics. Calculation of entropy change for reversible and irreversible processes.	05h
4	**Third law of thermodynamics:** Third Law of thermodynamics, calculation of absolute entropy of molecules.	03h
5	**Free Energy Functions:** Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.	08h
6	**Partial molar quantities:** Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs- Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.	05h
7	**Dilute solutions:** Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Thermodynamic derivation using chemical potential to derive relations between the four Colligative properties: [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal dissociated and associated solutes in solution.	09h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

(i) Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press (2006).
(ii) Ball, D. W. Physical Chemistry Thomson Press, India (2007).
(iii) Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
(iv) Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
(v) G. M. Barrow, Tata McGraw Hill (Fifth Edition) (2007).
(vi) Khosla, B. D.; Garg, V. C. &Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
(vii) Levine, I .N. *Physical Chemistry* 6th Ed., Tata McGraw Hill, 2010.
(viii) Metz, C.R. *2000 solved problems in chemistry,* Schaum Series, 2006.
(ix) Khosla, B. D.; Garg, V. C. and Gulati, A. *Senior Practical Physical Chemistry,* R. Chand New Delhi, 2011.

Semester-IV
PAPER Title: Chemistry Practical - MJ-4 LAB
Credits- 03

FM - 75 **Pass Marks- 30**

Content

(A) INORGANIC

- Gravimetric estimation of Ag^{+}, Ba^{2+}, Ni^{2+}, Cu^{2+}, Cl^{-}, SO_4^{2-}.
- Synthesis of amine complexes of Ni (II) and its Ligand exchange reactions (e.g. bidentate Ligand like acetyl acetone, DMG, glycine) by substitution method.

(B) PHYSICAL

1. Study the kinetics of the following reactions.
a. Acid hydrolysis of methyl acetate with hydrochloric acid.
b. Saponification of ethyl acetate.
2. To find the partion Coefficient of Solution Between the two Immiscible Liquid
a. Carbon Tetrachloride and water
b. Benzoic acid and water

(C) ORGANIC

1. Qualitative analysis of unknown organic compounds containing monofunctional groups.
2. Preparation of methyl orange.
3. Extraction of caffeine from tea leaves.

Experiments – 45 Marks
Viva-Voice – 15 Marks
Notebook – 15 Marks

Semester-IV
PAPER Title: Minor Paper-2B (MN-2B)
Credits - 03

Learning objective:

- Expresses the role of analytical chemistry in science.
- Compare qualitative and quantitative analyses.
- Expresses the quantitative analysis methods.
- Expresses the qualitative analysis methods.

Analytical Chemistry

FM−60 Marks **Time 3hrs**

Unit	Content	Hours
1	**Qualitative analysis of Inorganic salts:** Principle involved in the separation of cations. Application of solubility product and common ion effect. Detection and removal interfering radicals (eg. PO_3^{-3}, BO_3). Special tests for the mixture of acid radicals – Carbonate in presence of sulphite, Nitrate in presence of Nitrite. Nitrate in presence of bromide and iodide. Chloride, Bromide and Iodide in presence of each other.	10h
2	**Principles involved in volumetric analysis –** Acidimetry and alkalimetry. Principles involved in the red-ox titrations: uses of $KMnO_4$ and $K_2Cr_2O_7$, Iodometry and Iodimetry.	07h
3	**Detection of elements and functional groups in the organic compounds.** Elements: N, P, S and halogens. Functional groups: -OH (alcoholic), Nitro, $-NO_2$, Amide – $CONH_2$, Ketonic >C=O, Aldehydic –CHO, Carboxylic – COOH, Phenolic– OH, Amino – NH_2.	08h
4	**Spectroscopy:** Ultraviolet and visible spectra (electronic spectra). Uses of UV and visible spectra. Infra-red (IR), Nuclear magnetic resonance (NMR). Uses of IR and NMR spectra.	10h
5	**Organic reagents in inorganic analysis:** (i) Dimethyl glyoxime (ii) 8-hydroxy quinoline (iii) α- nitroso–β-naphthol (iv) Cupron (v) Cupferron (vi) αα – Dipyridyl (vii) Salicylaldoxime (viii) Nitron (ix) Dithiazone	10h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1. General Chemistry by Sanyal & Sanyal
2. General Chemistry by F. M. Miller
3. Industrial Chemistry by B.K. Sharma
4. Inorganic Practical Chemistry by P.K. Banerjee
5. Organic Practical Chemistry by Banerjee & Mukhopadhaya

Semester-IV

PAPER Title: Chemistry Practical - MN-2B LAB

Credits - 01

FM-25 Marks **Pass Marks - 10**

Content

- Gravimetric estimation of Ag^{+}, Ba^{2+}, Cl^{-} and SO_4^{2-}
- Preparation of potash alum.
- Preparation of chrome alum.

Experiments – 15 Marks
Viva-Voice – 05 Marks
Notebook – 05 Marks

Semester-V
PAPER Title: Major Paper- 09 (MJ-09)
Credits - 03

Learning objective:

- Stereochemistry, Metal ligand bond
- Metal $\boldsymbol{\pi}$ Complexes

Inorganic Chemistry – 4

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Stereochemistry and Bonding in Main Group Compounds** Quantum mechanical treatment of hydrogen molecule, important features and limitations of heitler London theory, Pauling and Slater's theory. VSEPR theory: limitation and applications, molecular orbital theory, Bent rule and energetic of hybridization, some simple reactions of covalently bonded molecules	10h
2	**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.	08h
3	**Reaction Mechanism of Transition Metal Complexes** Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories. Kinetics of octahedral substitution. Acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, reactions without metal ligand bond cleavage. Substitution reaction in square planer complexes, the trans effect, mechanism of substitution reactions.	12h
4	**Metal – Ligand Bonding** Limitations of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes, Jahn-Teller effect, $\pi - bonding$ and molecular orbital theory.	08h
5	**Metal $\boldsymbol{\pi}$ Complexes** Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls, preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes, tertiary phosphines as ligand.	07h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1 Laideler K. J. and Meiser J. M. Physical Chemistry Third Edition (International)1999

2. Levine I. N., Physical Chemistry, Fourth Edition), McGraw-Hill (International), 1995.

3. McQuarrie D. A. and Simon J. D. Physical Chemistry- A Molecular Approach, University Science Books, 1998.

4.Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).

5. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004)

Semester-V
PAPER Title: Major Paper- 10 (MJ-10)
Credits - 03

Learning objective:

- Interaction of electromagnetic radiation with molecules
- spectroscopy

Molecular Spectroscopy

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**UV Spectroscopy** General principles Introduction to absorption and emission spectroscopy. Types of electronic transitions, λ_{max}, Chromophores and Auxochromes, Bathochromic and Hypochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λmax for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.	13h
2	**IR Spectroscopy** Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.	08h
3	**NMR Spectroscopy** Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds.	08h
4	**Mass Spectrometry** Introduction, ion production – EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement, Nitrogen rule. High resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.	08h
5	Applications of IR, UV, NMR and Mass for identification of simple organic molecules.	08

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1 Laideler K. J. and Meiser J. M. Physical Chemistry Third Edition (International)1999

2. Levine I. N., Physical Chemistry, Fourth Edition), McGraw-Hill (International), 1995.

3. McQuarrie D. A. and Simon J. D. Physical Chemistry- A Molecular Approach, University Science Books, 1998

4. Rohatgi-Mukherjee K. K. Fundamentals of Photochemistry, New age (revised second edition).

5. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).

Semester-V
PAPER Title: Major Paper- 11 (MJ-11)
Credits - 03

Learning objective:

- Phases, components, Gibbs phase rule, Phase diagrams and applications.
- Chemical kinetics, Catalyst
- Adsorption isotherms

Physical Chemistry - 3

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Phase Equilibria:** Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; phase diagram for one component systems, Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.	15h
2	**Chemical Kinetics:** Order and Molecularity of a reaction, rate laws, differential and integrated rate laws for first, second and fractional order reactions, pseudo-unimolecular reactions, determination of the order, (limited to first order): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.	15h
3	**Surface chemistry:** Physical adsorption, chemisorption's, adsorption isotherms (Freundlich, Temkin, Derivation of Langmuir adsorption isotherms, surface area determination), BET theory of multilayer adsorption (no derivation), Adsorption in solution.	08h
4	**Catalysis:** Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaels- Menten mechanism, acid-base catalysis.	07h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1. Atkins P. W. and De Paula J., Physical Chemistry, (tenth edition) Oxford University Press, 2014.
2. Castellan, G. W. Physical Chemistry, 4th Ed., Narosa , 2004.
3. McQuarrie, D. A. & Simon, J. D., Molecular Thermodynamics, Viva Books, 2004.
4. Engel, T. & Reid, P. Physical Chemistry Third Edition, Prentice-Hall,2012.
5. Zundhal, S.S. Chemistry concepts and applications Cengage India, 2011.
6. Ball, D. W. Physical Chemistry Cengage India, 2012.
7. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP, 2009.
8. Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill, 2011.

Semester-V
PAPER Title: Chemistry Practical - MJ-5 LAB
Credits- 03

FM - 75 **Pass Marks- 30**

Content

(A) Conductometry

1. Determination of cell constant
2. Conductometric titrations of
   (i) Strong acid Vs. strong base
   (ii) Weak acid vs. strong base,
   (iii)Weak acid vs. strong base, Strong acid vs. weak base.

(B) Potentiometry Potentiometric titrations of:

(i) Strong acid vs. strong base
(ii) Weak acid vs. strong base
(iii)Potassium dichromate vs. Mohr's salt.

(C) Verification of Beer's Law - Determination of concentration of solution by colorimetry. (Instructor may explain the principle of using colorimeter, its handling drawing standard calibration curve, and its application in finding unknown concentration of dyes, concentration of metal solutions (e.g., Ni, Cu using appropriate reagent) from standard calibration curve.

(D) Qualitative analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given on understanding of the chemistry of different reactions.

Following radicals may be analyzed:

Carbonate, nitrate, nitrite, sulphides, sulphat, sulphite, acetate, fluoride, chloride, bromide, iodide, borate, oxalate, phosphate, ammonium, potassium, lead, copper, cadmium, bismuth, tin, iron, aluminum, chromium, zinc, manganese, cobalt, nickel, barium strontium, calcium, magnesium.

Mixtures containing one interfering anion, or insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) or combination of anions e.g., $CO_3^{2-}$and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, Br-and I, NO_3^- and Br^-, NO_3^- and I^-.

Experiments – 45 Marks
Viva-Voice – 15 Marks
Notebook – 15 Marks

Semester-V
PAPER Title: Minor Paper- 1C (MN-1C)
Credits - 03

Learning objective:

- Basic of organic molecules, structure, bonding, reactivity and reaction mechanisms.
- Study of different functional group in Organic chemistry.

Organic Chemistry

FM-60 Marks **Time 3 Hrs.**

Unit	Content	Hours
1	**Stereochemistry of Organic Compounds** Concept of isomerism. Types of isomerism. Optical isomerism-elements of symmetry, molecular chirality, enantiomers, stereo genic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereo genic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism-determination of configuration of geometric isomers. E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Conformational isomerism-conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds. Conformation of mono substituted cyclohexane derivatives. Newman projection and Sawhorse formulae, Fischer and flying wedge formulae. Difference between configuration and conformation.	12h
2	**Alcohols:** Definition, Classification and Distinction between different types of alcohols. Trihydric alcohol-glycerol: (i) Total Synthesis from C and H (ii) Reactions.	04h
3	**Aldehydes and Ketones:** General Methods of Preparation, Properties, Electronic nature of >C=O Group.	04h
4	**Carboxylic acids:** General methods of Preparation, Properties of monocarboxylic acid and their derivatives (ester, acid chloride, an-hydride and amide). Origin of acidic properties and electronic nature of Carboxylic group and its derivatives.	08h
5	**Hydroxy acids:** Lactic acid, tartaric acid and citric acid-their isolation synthesis, properties, constitution. Isomerism of lactic acid and tartaric acid.	04h
6	**Aromatic compounds:** Benzene and its mono-substituted derivatives: Toluene, Nitrobenzene, Aniline, Benzene diazonium chloride, Phenol, Benzaldehyde. Benzene sulphonic acid, benzoic acid (preparation, properties and uses) Elementary idea of Electrophilic substitution in benzene ring.	08h
7	**Important reactions:** Perkin reaction, Friedel Crafts reaction, Cannizzaro's reaction, Kolbe's reaction, Sandmeyer's reaction, Reformatsky reaction, Reimer-Tiemann reaction.	05h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1. Advanced Organic Chemistry by Bahl and Bahl
2. Pradeep's Organic Chemistry by Pradeep Publication
3. Dinesh Organic Chemistry
4. Text Book of Organic Chemistry, Vol.- I and II by I.L. Finar
5. Text Book of Organic Chemistry, Vol.- I and II by P.L. Soni
6. Reactions and Reagents by O.P. Agarwal

Semester-V

Course Title: Chemistry Practical - MN-1C LAB
Credits- 01

FM-25 Marks **Pass Marks - 10**

Content

Detection of element [N, S, P and halogens] and detection of functional group in organic compounds containing one functional group including monosaccharides. –COOH, Phenolic – OH, Aldehydic, Ketonic, Nitro, Amino and Amide.

Organic preparations:

Aspirin from salicylic acid.
P-methyl acetanilide from p-toluidine.
Acetanilide from aniline.

Experiments – 15 Marks
Viva-Voice – 05 Marks
Notebook – 05 Marks

Semester-VI
PAPER Title: Major Paper- 12 (MJ-12)
Credits - 03

Learning objective:

- Familiarization with fundamentals of analytical chemistry.
- Basics of spectroscopic, thermal, electrochemical techniques.
- Understanding analytical tools, statistical methods applied to analytical chemistry.
- Understanding principles of thermo-gravimetric analysis and study of thermal decomposition of materials/characterization of materials.

Analytical Chemistry

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Separation techniques:** Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.	15h
2	**Chromatography techniques:** Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis using LC, GLC, TLC and HPLC.	15h
3	**Thermal analysis:** Theory of thermogravimetry (TG and DTG), instrumentation, estimation of Ca and Mg from their mixture. **Electroanalytical methods:** Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. determination of pKa values.	15h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1 Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
2 Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing California, USA, 1988.
3 Christian, G.D, Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4 Harris, D.C.: Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
5 Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Saunder College Publications, (1998).
6 Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood John Wiley 1979.
7 Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974.
8 Khopkar, S. M., Basic Concepts of Analytical Chemistry, New Age (Second edition)1998
9.Skoog D.A., Holler F.J., Nieman T.A., Principles of instrumental analysis, 5th Edn., Brooks & Cole (1997).

Semester-VI
PAPER Title: Major Paper- 13 (MJ-13)
Credits - 03

Learning objective:

- Green chemistry and its principles.
- Green synthesis and reactions.
- Green chemistry for sustainable solutions.
- Understanding principles of green chemistry.
- Understanding design of chemical reactions/chemical synthesis using green chemistry principles.
- Atom economy and design of chemical reactions using the principle.
- Understanding the use of green chemistry principle and processes in laboratory reactions.

Green Chemistry

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Introduction to Green Chemistry** Basic introduction and explaining goals of Green Chemistry. Limitations/Obstacles in the pursuit of the goals of Green Chemistry	05h
2	**Principles of Green Chemistry and Designing a Chemical synthesis** Twelve principles of Green Chemistry with their explanations and examples and special emphasis on Designing a Green Synthesis using these principles (Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products, 79 Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions).	10h
3	**Green Synthesis / Reactions:** 1. Green Synthesis of adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis). 2. Microwave assisted reactions in water: (Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols) and reactions in organic solvents (Diels-Alder reaction and Decarboxylation reaction). 3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine) 4 Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments. 5 Designing of Environmentally safe marine antifoulant. 6 An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn. 7 Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for production of no Trans-Fats and Oils	20h
4	**Future Trends in Green Chemistry** Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C_2S_3); Green chemistry in sustainable development.	10h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1 Ahluwalia, V.K., Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers (2005). 2. Anastas, P.T. & Warner, J.K, Green Chemistry- Theory and Practical, Oxford University Press (1998).

3. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).

4. Cann, M.C.and Connely, M.E. Real-World cases in Green Chemistry, ACS (2000). 80

5. Ryan, M.A. and Tinnesand, M. Introduction to Green Chemistry, American Chemical Society, (2002).

6. Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, Second Edition, 2010.

Semester-VI
PAPER Title: Major Paper -14 (MJ-14)
Credits - 03

Learning objective:

- understanding of heterocyclic chemistry, including alternative general methods for ring synthesis
- Application for the preparation of specific groups of heterocyclic systems.
- Properties and reactions for heterocycles as well as different systems of nomenclature.

Heterocyclic Chemistry

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Three-membered rings with one heteroatom:** Chemistry of oxiranes, aziridines and episulphides - synthetic approaches and reactivities. **Three-membered heterocycles with two heteroatoms:** oxaziranes, diaziridines and diazirines - synthetic approaches and reactivities. **Four-membered heterocycles:** oxitanes, azatidanes and thietanes - synthetic approaches and reactivities. natural products: synthesis of Penicillin and cephalosporine.	15h
3	**Five-membered aromatic heterocycles:** 1. With one heteroatom: furans, pyrroles and thiophenes - general synthetic approaches, properties and reactivities. 2. With two heteroatoms: oxazoles, isoxazoles, imidazoles, thiazoles, pyrazoles and isothiazoles - general synthetic approaches and reactivities. 3. With three and four heteroatoms: triazoles and tetrazoles - synthetic approaches, properties and reactivity.	10h
4	**Condensed five-membered Heterocycles:** Benzofuran, indoles and benzothiazoles - general synthetic approaches, with greater emphasis on the chemistry of Indoles.	10h
5	**Dyes** Classification, Color and constitution; Mordant and Vat Dyes; Chemistry of dyeing; Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet; Phthalein Dyes – Phenolphthalein and Fluorescein; Natural dyes –structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples.	10h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

- Heterocyclic Chemistry, J.A. Joule, K. Mills, Wiley, 2010.
- The essence of heterocyclic Chemistry, A. R. Parikh, H. Parikh, R. Khunt, New Age Int. Publication,
- Principles of Modern Heterocyclic Chemistry, L. A. Paquette, W. A. Benjamin, New York, 1968.
- Heterocyclic Chemistry, J.A. Joule and G. F. Smith, van Nostrand, London, 1978.
- Comprehensive Heterocyclic Chemistry. The structure, reactions, synthesis and use of Heterocyclic compounds, (Ed. A.R. Katritzky and C. W. Rees), Vol 1-8, Pergamon Press, 1984.
- Handbook of Heterocyclic Chemistry, A. R. Katritzky, Pergamon Press, 1985.
- Van der plas, H. C. Ring transformations of Heterocycles, Vols 1 and 2, Academic Press, 1974.

Semester-VI
PAPER Title: Major Paper -15 (MJ-15)
Credits - 03

Learning objective:

- Basics of carbohydrate, protein, enzymes lipids and DNA/RNA
- Develop understanding on metabolism of carbohydrate.
- Gene replication, Transcription and Translation.

Biochemistry

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Carbohydrates:** Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.	08h
2	**Proteins:** Classification, biological importance; Primary, secondary and tertiary structures of proteins: α- helix and β- pleated sheets, Denaturation of proteins.	08h
3	**Enzymes:** Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Biocatalysts in Green Chemistry" and Chemical Industry	10h
4	**Lipids:** Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications.	10h
5	**Structure of DNA/RNA:** Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.	09h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VI the Edition. W.H. Freeman and Co.
- Nelson, D. L., Cox, M. M. and Lehninger, A. L. (2009) principles of Biochemistry.IV Edition. W.H. Freeman and Co.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange medical Books/ McGraw-Hill

Semester-VI
PAPER Title: Chemistry Practical - MJ-6 LAB
Credits- 03

FM - 100 **Pass Marks- 40**

Content

- Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}.
- Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values.
- Chromatographic separation of the active ingredients of plants, flowers and juices by TLC
- Density measurement of ionic liquids.
- Determining dynamic viscosities of given ionic liquids.
- Effect of pH on the action of salivary amylase
- Effect of temperature on salivary amylase
- Analysis of Carbohydrate Aldoses and Ketone, Reducing and Non-Reducing sugar using single lab procedure.

Experiments – 60 Marks
Viva-Voice – 20 Marks
Notebook – 20 Marks

Semester-VI
PAPER Title: Minor Paper-2C (MN-2C)
Credits - 03

Learning objective:

- Recognize the contribution of chemistry of metal molecules to the development of chemistry and other related fields.
- Evaluate the role of metal ions in biological systems.
- Know the function of metalloporphyrin's of Haemoglobin in oxygen binding by metal ions.
- Know how trace elements are involved in basic functions of the body.
- Know metal biomolecules' applications as photoactive drugs.
- Evaluate applications of metal biomolecules as diagnostic agents.
- Know the applications of metal molecules in toxicology.

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Bio-Inorganic Chemistry

FM−60 Marks **Time 3hrs**

Unit	Content	Hours
1	**Essential and trace elements in biological processes:** Metals like Fe, Cu, Se, Cr and Mo. Essential and trace non-metals: like P (in the form of Phosphate), Iodine and Chlorine.	08h
2	**Essential Bulk Elements:** Na and K, Ca and Mg in the form of Na^+ / K^+ and Ca^{2+} / Mg^{2+}. Biological roles of alkali and alkaline earth metal ions.	07h
3	**Metalloporphyrin's**	08h
4	**Transport and Storage of Dioxygen:** Haemproteins and oxygen uptake, Haemoglobin and myoglobin functions and co-operativity, structures of haemoglobin and myoglobin. Role of haemoglobin and myoglobin. Oxidation and oxygenation of Hb and Mb.	10h
5	**Nitrogenase:** Biological Nitrogen fixation.	05h
6	Metals in medicines, Metal deficiency and diseases, Toxic effects of metals.	07

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1. Bio Inorganic Chemistry by K. Hussain Reddy
2. Bio Inorganic Chemistry by Kalsi
3. General Chemistry by R.C. Sarkar

Semester-VI

PAPER Title: Chemistry Practical - MN-2C LAB

Credits - 01

FM-25 Marks **Pass Marks - 10**

Content

- Volumetric estimation of Oxalic acid using standard $KMnO_4$ solution.
- Volumetric estimation of Ferrous iron.
- Estimation of copper in copper sulphate solution using sodium thiosulphate solution.
- Estimation of Zinc in given solution using standard EDTA solution.

Experiments – 15 Marks
Viva-Voice – 05 Marks
Notebook – 05 Marks

Semester-VII
PAPER Title: Major Paper -16 (MJ-16)
Credits - 03

Learning objective:

- Composition of atmosphere
- Biogeochemical cycles, Hydrological cycle
- Water quality parameters
- Atmospheric chemical phenomena and environmental pollution
- Water pollution, parameters of water pollution, treatment of polluted water.

Environmental Chemistry

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Environment** Composition of atmosphere, temperature variation of earth atmospheric system (temperature vs. altitude curve), biogeochemical cycles of C, N, P, S and O system.	10h
2	**Hydrosphere:** Hydrological cycle, aquatic pollution and water quality parameters – Dissolve oxygen, biochemical oxygen demand, chemical oxygen demand, Analytical methods for the determination fluoride, chromium and arsenic, residual chlorine and chlorine demand, purification and treatment of municipal water and waste water.	12h
3	**Atmosphere** Chemical composition of atmosphere – particle, ions, and radicals in their formation, chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, and O and their effect, pollution by chemicals, CFC, Green House effect, acid rain, air pollution and control.	10h
4	**Aquatic chemistry** Water and its necessities, various water quality parameters (DO, BOD, COD, conductivity, pH, alkalinity, hardness) and its determination, Industrial, municipal water treatment processes, Waste water treatment procedure (primary, secondary and tertiary), Solid waste treatment. Soil pollution and Noise pollution.	13h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

- De.A.K. Environmental Chemistry, Wiley Eastern Ltd, 1990.
- Miller T.G. Jr., Environmental Science, Wadsworth publishing House, Meerut Odum.E.P.1971.
- Odum, E.P. (1971) Fundamentals of Ecology. Third Edition, W.B. Saunders Co., Philadelphia
- S. E. Manahan, Environmental chemistry, 1993, Boca Raton, Lewis's publisher
- Environmental chemistry, Sharma and Kaur, 2016, Krishna publishers
- Environmental Pollution, Monitoring and control, S.M. Khopker, 2007, New Age International.
- Environmental chemistry, C. Baird, M. Cann, 5th Edn, 2012, W.H.Freeman publication.
- G. S. Sodhi Fundamental Concepts of Environmental Chemistry (Third Edition) Narosa (2009).
- Principles of instrumental analysis: D. A. Skoog, Fifth Edition, Sauns College Publishing (London).
- Basic concepts of analytical chemistry: S. M. Khopkar, Wiley Eastern (1995)

Semester-VII
PAPER Title: Major Paper -17 (MJ-17)
Credits - 03

Learning objective:

- Understand the Bonding in organic Molecules
- Understand the mechanisms, types of reaction.
- Understand nucleophile and electrophile groups and their properties

Organic Chemistry - 4

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Nature of Bonding in organic Molecules and reaction mechanism** Delocalized Chemical bonding conjugation, cross conjugations inductive resonance effect, hype conjugation, tautomerism. Introduction to Aromaticity in benzenoid and non-benzenoid compounds, Three membered, five membered and seven membered compound, alternate and non-alternate hydrocarbon, Huckel's rule, energy level of π molecular orbitals, annulenes, azulenes, anti-aromaticity, Ψ–aromaticity, homo-aromaticity, PMO approach for aromaticity.	10h
2	**Rection Mechanism Structure and Reactivity** Type of mechanisms, types of reaction, thermodynamic and kinetic requirements, thermodynamic and kinetic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, Carbocation, carbon ion, Free radical, Carbene Nitrenes, Arynes – generation, structure and their stability, methods of determining mechanisms.	10h
3	**Aliphatic Nucleophilic Substitution** The SN^2, SN^1, mixed SN^1 and SN^2 and SET mechanisms. The neighboring group mechanism, neighboring group participation by π and σ bonds, an chimeric assistance. Classical and non-classical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements. The SN^1 mechanism. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon.	10h
4	**Aromatic Nucleophilic substitution** The SNAr, SN^1, benzyne and SRN_1 mechanisms. Reactivity-effect of substrate structure, leaving group and attacking nucleophile.	05h
5	**Aliphatic and aromatic Electrophilic substitution** Bimolecular mechanisms – SE^2 and SE^1 mechanism, electrophilic substitution accompanied by double bond shifts. Effects of substrates, leaving group and the solvent polarity on the reactivity. **Aromatic Electrophilic substitution:** The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring system. Quantitative treatment of reactivity in substrates and electrophics. Diazonium coupling, Gattermann-Koch reaction.	10h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1. Advanced Organic Chemistry - Reaction, 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 Reaction, H.O. House, Benjamin.
7. Principles of Organic Synthesis, R.O.C. Norman & J.M. Coxon, Blackle Academic & Professional.
8. Pericycllc Reaction, S.M. Mukherji, Macmillan, India.
9. Reaction Mechanism in Organic Chemistry, S.M. Mukharji 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.
12. Mechanism of Organic reactions, K.S. Mukherjee, Books and Allied (P) Ltd. Kolkata.
13. Photo chemistry and Pericyclic Reactions, Jagadamba Singh and Jaya Singh, New Age International Publishers.

Semester-VII
PAPER Title: Major Paper- 18 (MJ-18)
Credits - 03

Learning objective:

- Basic principles of symmetry and group theory
- The concept of Bioinorganic Chemistry and its biological applications.
- The concept of Chemistry and Bioenergetics.

Group Theory & Bioinorganic

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Symmetry and Group Theory in Chemistry** Symmetry elements and symmetry operation, definitions of group, subgroup, relation between order of a finite group and its subgroup. Conjugacy relation and classes. Point symmetry group. Schonflies symbols. Representation of groups by matrices (Representation for the Cn, Cnv, Cnh, Dnh etc. groups to be worked out explicitly) Character of a Representation. The great orthogonality theorem (without proof) and its importance. Character tables their use; spectroscopy.	12h
2	**Bio Inorganic** **Metal Ions in Biological Systems** Concept of essentiality. Essential & trace metals role of metals ion in biological process. Active and passive transport of metal ion, across bio membrane Na^+ /K^+ pump, Bio ligands, chemistry of physiological buffers.	07h
3	**Bioenergetics and ATP Cycle** DNA polymerization, glucose storage, phosphoglucomutase activity, Role of phosphate and glucose oxidation, Glycolysis, Krebs cycle and aconitageactivity, metal complexes in transmission of energy; chlorophylls, photosystem I and photosystem II in cleavage of water, Model system of chlorophyll, Dark reaction photosynthesis in bacteria.	06h
4	**Transport and Storage of Dioxygen** Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanics and hemerythrin, model synthetic complexes of iron, cobalt and copper, Bohr effect cyanide poisoning and its remedy.	08h
5	**Electron Transfer in Biology** Structure and function of metalloproteins in electron transport processes – cytochromes and ion-Sulphur proteins, synthetic models. Nitrogenase: Biological Nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenases model system.	06h
6	**Biochemistry of non-metals** Non-metals in structure use, biomineralization, biological role of some trace non-metal B, Si, S, Se, As, F, Cl, Br, biological importance of nitric oxide. (NO).	07h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1. Principles of Bio-inorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bio-inorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books
3. Inorganic Bio-Chemistry vols A and II, Ed. G.I……. Eichhorn, Elsevier.
4. Progress in Inorganic Chemistry, Vols 18 and 3S Ed. J.J. Lippard, Wiley.
5. Enzymatic Reaction Mechanisms, C. Walsh, W.H. Freeman.

Semester-VII
PAPER Title: Major Paper -19 (MJ-19)
Credits - 03

Learning objective:

- Use thermodynamic terminology correctly
- Derive and discuss the laws of thermodynamics.
- Gain knowledge on different aspects of quantum chemistry and its applicability in different bonding behaviour of atoms
- Gain problem-solving skills from spectroscopic data

Physical Chemistry - 4

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Quantum Chemistry**	18h

A. Introduction to Exact Quantum Mechanical Results

The Schrodinger question and the postulates of the postulates of quantum mechanics. Discussion of solutions of the Schrodinger equation to some model systems viz…, particle in a box, the harmonic oscillator, the rigid rotor. The hydrogen atom.

B. Angular Momentum

Ordinary angular momentum, generalized angular momentum, Eigen functions for angular momentum, Eigen values of angular momentum, operator using ladder operators, Commutation relations, addition of angular momenta, spin, antisymmetric and Pauli's exclusion principle.

C. Electronic Structure of Atoms

Electronic configuration, Russell – Saunders terms and coupling schemes, Slater – Condon parameters, term, separation, energies of the p^n configuration, term separation energies for the d^n configuration, magnetic effects: spin – orbit coupling and Zeeman splitting, introduction to the methods of self – consistent field. The virial theorem.

D. Molecular Orbital Theory

Huckel theory of conjugated systems, bond order and charge density calculations, Application to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene etc. Introduction to extended Huckel theory.

2	**Thermodynamics**	18h

A. Classical Thermodynamics

Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Partial molar properties; partial molar free energy, partial molar heat content and their significances. Determination of these quantities. Concept of fugacity and determination of fugacity. Non-ideal systems: Excess functions for non-ideal solution. Activity, activity coefficient.

B. Statistics Thermodynamics

Concepts of distribution, Thermodynamic probability and most probable distribution. Ensemble Averaging postulates of ensemble Averaging. Canonical, grand Canonical and microcanonical ensembles, corresponding distribution laws (using Lagrange's method of α, β undetermined multipliers). Partition function – translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions. Applications of partition functions. Heat capacity behavior of solids-chemical equilibria and equilibrium constant in terms of partition function, Fermi Dirac statistics – distribution law and applications to metal. Bose – Einstein statistics – distribution law and application to helium.

3 **Chemical Dynamics** 08h

Method of determining rate laws, collision theory of Bimolecular vacations. steric factor, activated complex theory, Arrhenius equation and the activated complex theory; ionic reaction, kinetic salt effects, steady state kinetics and thermodynamic control of reactions, Enzyme reactions, study of the fast reaction by various methods. Photochemical reaction of H_2 and Cl_2, H_2 and Br_2, pyrolysis of CH_3CHO, C_2H_6.

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1. Physical Chemistry, P.W. Atkins. ELBS.
2. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
3. Quantum Chemistry, Ira N. Levine, Prentice Hall.
4. Chemical kinetics, K.J. Laidler, Megraw-Hill.
5. Kinetics and Mechanism of Chemical Transformation, J. Rajaraman and J. Kuriacose, Mcmillan.
6. Modern Electrochemistry Vol.-II, J.O.M. Bockris and A.K.N. Reddy, Plenum.
7. Introduction to Polymer Science, V.R. Gowarikar, N.V. Vishwanathan and J. Sridhar, Wiley Eastern.
8. Advanced Physical Chemistry, Gurtu & Gurtu, Pragati Prakashan.
9. Quantum Chemistry, R.K. Prasad 10. Advanced Physical Chemistry, D.N. Bajpai.

Semester-VII
PAPER Title: Chemistry Practical - MJ-7 LAB

FM - 100 **Pass Marks- 40**

Credits - 04

Content

Determination of water quality parameters in following aspect:

- Determination of dissolved oxygen in given water (chemical method/instrumentation method).
- Determination of Biological Oxygen Demand (BOD_5).
- Determination of Chemical Oxygen Demand (COD).
- Finding out percentage of available chlorine in bleaching powder.
- Measurement of chloride, sulphate and salinity of water samples by titration method ($AgNO_3$ and potassium chromate).
- Estimation of total alkalinity of water samples (carbonate, bicarbonate) by titration method.
- Estimation of SPM in air samples.

- Rection of metal with halide – preparation of Grignard reagent. (only demonstration purpose)
- Grignard preparation of dye (malachite green (using methylbenoate)/crystal violet (using diethylcarbonate) (starting material as p-bromo N, N-dimethyl aniline) (only demonstration purpose)
- Preparation of various Schiff base-metal complexes and their identification using spectroscopy.
- Preparation of any two of the following complexes and measurement of their conductivity measurement:
  a. tetraamminecarbonatocobalt (III) nitrate
  b. tetraamminecopper (II) sulphate
  c. potassium trioxalatoferrate (III) trihydrate

1.Identification of hetero atoms (S, N, X) in given organic compounds in lab.
2. Identification/separation of simple organic compounds containing hetero atoms using column chromatography/TLC) in lab.
3. Spectroscopic identification of simple organic compounds (spectra may be provided to the students and teachers may help the students to identify the compounds using spectra). Melting point/boiling point of the compounds may be checked for its purity.
4. Teacher may guide the students for preparation of: Indigo (using aldol condensation reaction of 2-nitrobenzaldehyde with acetone in basic condition);
(Depending upon laboratory facilities, more preparation of heterocyclic group of compounds may be incorporated by teacher).

1.Determination of pH of a given solution using glass electrode.
2. Determination of cell constant.
3. Determination of equivalent conductance, degree of dissociation, and dissociation constant of weak acid.
4. Conductometric titration: strong acid vs. strong base, weak acid vs. strong base.
5. Potentiometric titration: strong acid vs. strong base, weak acid vs. strong base, potassium dichromate vs. mohr's salt.

Experiments – 60 Marks
Viva-Voice – 20 Marks
Notebook – 20 Marks

Semester-VII
PAPER Title: Minor Paper -1D (MN-1D)
Credits - 03

Learning objective:

- Basics of carbohydrate, protein, enzymes lipids and DNA/RNA
- Develop understanding on metabolism of carbohydrate.
- Gene replication, Transcription and Translation.

Biochemistry

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Carbohydrates:** Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.	08h
2	**Proteins:** Classification, biological importance; Primary, secondary and tertiary structures of proteins: α- helix and β- pleated sheets, Denaturation of proteins.	08h
3	**Enzymes:** Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Biocatalysts in Green Chemistry" and Chemical Industry	10h
4	**Lipids:** Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications.	10h
5	**Structure of DNA/RNA:** Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.	09h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VI the Edition. W.H. Freeman and Co.
- Nelson, D. L., Cox, M. M. and Lehninger, A. L. (2009) principles of Biochemistry.IV Edition. W.H. Freeman and Co.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange medical Books/ McGraw-Hill

Semester-VII

PAPER Title: Chemistry Practical - MN-1D LAB

Credits - 01

Content

- Quantitative estimation of protein using Lowry's method.
- Determine the concentration of the unknown sample.
- Action of salivary amylase at optimum conditions
- Effect of pH on the action of salivary amylase
- Effect of temperature on salivary amylase
- Effect of inhibitor on salivary amylase
- Study of the activity of Trypsin using fresh tissue extracts.
- Effect of temperature, organic solvents, on semi-permeable membrane.
- Isolation of Genomic DNA from E Col

Experiments – 15 Marks
Viva-Voice – 05 Marks
Notebook – 05 Marks

Semester-VIII
PAPER Title: Major Paper -20 (MJ-20)
Credits - 03

Learning objective:

- Interpretation of Mass Spectra, Infrared Spectra, Nuclear Magnetic Resonance Specta.
- Learn how to use spectra to elucidate structures of organic compounds.
- Learn how to solve chemical and structural problems in a systematic manner.

Application of Spectroscopy

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Ultraviolet and Visible Spectroscopy** Various electronic transitions (185-800 nm), Beer – Lambert law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Fieser-Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds.	10h
2	**Infrared Spectroscopy** Instrumentation and sample handling. Characteristic vibrational frequencies of alkanes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrations frequencies, overtones, combination bands and Fermi resonance, FT, IR, IR of gaseous, solids and polymeric materials.	10h
3	**Nuclear Magnetic Resonance Spectroscopy** General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercaptan), chemical exchange, effect of deuteration, solvent effects. Fourier transform technique.	10h
4	**Carbon 13 NMR Spectroscopy** General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and Carbonyl carbon), coupling constants. Two-dimension NMR spectroscopy – COSY, NOESY, DEPT, INEPT.	08h
5	**Mass Spectrometry** Introduction, ion production – EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement, Nitrogen rule. High resolution mass spectrometer. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination	07h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1. Physical methods for chemistry, R.S. Drago, Saunders Company
2. Structural methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin and S. Cradock, ELBS.
3. Infrared and Raman Spectra: Inorganic and Co-ordination Compounds, K. Nakamoto, Wiley.
4. Progress in Inorganic Chemistry vol. 8, Ed. F.A. Cotton, vol. 15, Ed S.J. Lippard, Wiley.
5. Transition Metal Chemistry eA.R.L. Carlin voi. S, Dekker
6. Inorganic Elecironic Speciroscopy, A.P.B. Lever, Elsevier.

Semester-VIII

PAPER: Advanced Major Paper-1 (AMJ-1)

Credits - 03

Learning objective:

- The basics of medicinal chemistry, biophysical properties
- Biological activity parameters
- Drug metabolism
- Biophysical and chemical properties of enzymes, hormones, vitamins
- Concept of rational drug design

Medicinal Chemistry

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Bio-physicochemical properties** Acidity/Basicity, Solubility, Ionization, Hydrophobic properties, Hydrophilic properties, Lipinski Rule, Drug-like properties, Understanding of the biological activity parameters such as Ki, Kd, LD50, EC50, IC50, CC50, ADMET properties	10h
2	**Structural properties** Isosterism, Bioisosterism, Nonclassical isosteres, Understanding of the 3D-structure along with bond length, bond angle and dihedral angle, Concept of Configuration and Conformation with examples, Concept of stereochemistry in terms of biological response with examples, Stereoselective receptors or enzymes such as muscarinic receptor, Stereo chemically pure drug and racemates, Examples such as catecholamines, etc.	10h
3	**Drug target understanding** Metabolism, Drug metabolism, Anti-metabolite, Enzyme inhibitor, Agonist, Antagonist, Examples.	05h
4	**Medicinal Chemistry of Therapeutic Agent** Structure, Chemistry, Mode of action and adverse effect of the representative therapeutic agents such as Anti-infective agent, Antimalarials, Antibacterial, Antiviral, Anticancer, CNS acting drugs, Adrenergic Agents, Cholinergic Drugs, Diuretics, Cardiovascular, local anesthetic agent, Analgesic Agents, Histamine and Antihistamine agents	10h
5	**Steroids, Prostaglandins, Enzyme, Hormone and Vitamins** Biophysical-chemical properties, Steroid Hormone Receptors, Chemical Contraceptive agents, COX-2 inhibitors, Prostaglandins for Ophthalmic use, pharmaceutically important enzyme products such as Pancreatin, Trypsin, Insulin. Classification of vitamins with examples. **Concept of rational drug design** Structure activity relationship, Drug-receptor understanding, Molecular modeling, Structure based drug design. QSAR.	10h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

- Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical ...by Charles Owens Wilson, John H. Block, Ole Gisvold, John Marlowe Beale
- Foye's Principles of Medicinal Chemistry by David A. Williams, Thomas L. Lemke, William O. Foye (2008), Kluwer publication.
- Remington: The Science and Practice of Pharmacy Vol 1, Ed. 19 by Joseph Price Remington, Alfonso R. Gennaro. (1995), MACK Publishing.
- Burgers Medicinal Chemistry by Manfred E. Wolff, Alfred Burger
- Burgers Medicinal Chemistry and Drug Discovery by Abraham D. J., Lewis F. L., Burger A., vol.5, 6^{th} Edn., 2003, Hoboken N.J.Wiley,
- The Organic Chemistry of Drug Design and Drug Action by Silverman R. B., 2^{nd} Edn., Academic Press. 2012.
- Exploring QSAR: Fundamental and applications in Chemistry and Biology by Hansch C. and Leo, A American Chemical Society (1995)
- Patrick, G. Medicinal Chemistry, Oxford.University Press (2000).

Semester-VIII
PAPER Title: Advanced Major Paper -2 (AMJ-2)
Credits - 03

Learning objective:

- The mechanism of polymer material formation.
- Molecular weight and structure property relationship
- Polymerization procedure and Zigler-Natta catalysis.
- Characterization of polymers

Polymer Chemistry

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Introduction** Polymer, monomer, examples of polymers, biopolymers, classification, polymerization process, degree of polymerization, condensation, addition polymers, kinetics of addition polymerization process.	10h
2	**Polymeric Structure and Property Relationship** Structure of polymers - Linear, branched, cross linked, and network polymers, molecular weight (number average, weight average, viscosity average) and distribution of molecular weight, polydispersity index, crystallinity in polymer, melting temperature and glass transition temperature, Volumetric properties - molar volume, density, Van der Waals volume - Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship.	15h
3	**Polymerization Chemistry** Industrial methods of polymerization such as a bulk, solution, emulsion, suspension. Stereochemistry of polymers and stereo-specific polymerization, Catalysts-their utility in polymers and stereo-specific polymerizations, Catalysts their utility in polymer manufacture, Zieglar-Natta, Metallocene and others.	10h
4	**Characterization of Polymers** Molecular Weight Determination by Light Scattering, Osmometry, End-Group Analysis, Viscosity, Gel Permeation Chromatography; Application, of FTIR, UV-visible, NMR, and Mass Spectroscopy for Identification of polymers.	10h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

- D.W. Van Krevelen and P.J. Hoftyzen, "Properties Of Polymer, 3rd Edition Elsevier Scientific, Publishing Company Amsterdam - Oxford - Newyork. 1990.
- J.E. Mark Ed.AIP, Physical Properties Of Polymers Hand Book, Williston, Vt, 1996.
- Reaction Engineering of Step Growth Polymerization, S K Gupta and Anil Kumar, Plenum Press, 1987 4. Odian; George, Principles of Polymerization, McGraw-Hill Book Co., New York (1970).
- W. Billmeyer, Text book of polymer science, 3rd Edn., 2007, Wiley.
- J.R.Fried, Polymer Science and Technology, (2005), PHI publication.
- Billmeyer Jr.; Fred W., Textbook of Polymer Science, Wiley- Interscience Publishers, New York (1962).

Semester-VIII
PAPER Title: Advanced Major Paper -3 (AMJ-3)
Credits - 03

. **Learning objective:**

- Crystalline solids – parameters, symmetry.
- Silica based materials in applications.
- Technological importance of ionic liquids, preparation of materials– using sol-gel technique.
- Nano-structured materials, self-assembled structure.
- Composites and its applications.
- Understanding basic parameters of crystalline solids, symmetry and crystal structures.
- Mesoporous/microporous silica-based materials, functionalized hybrid materials and its applications.

Materials Chemistry

FM-60 **Time 3hrs**

Unit	Content	Hours
1	**Basics of crystalline solids** Crystalline solids, crystal systems, Bravais lattices, coordination number, packing factors – cubic, hexagonal, diamond structures, lattice planes, Miller indices, interplanar distances, directions, types of bonding , lattice energy, Madelung constants, Born Haber cycle, cohesive energy, Symmetry elements, operations , translational symmetries - point groups, space groups, equivalent positions, close packed structures, voids, crystal structures, Pauling rules, defects in crystals, polymorphism, twinning.	10h
2	**Silica based materials:** Introduction to Zeolites, metallosilicates, silicalites and related microporous materials, Mesoporous silica, metal oxides and related functionalized mesoporous materials: Covalent organic frameworks, Organic-Inorganic hybrid materials, periodic mesoporous organo silica, metal organic frameworks: H_2 /CO_2 gas storage and catalytic applications	10h
3	**Inorganic solids/ionic liquids of technological importance:** Preparation of inorganic solids: Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydro-thermal method, Ion-exchange and Intercalation methods. Introduction to Solid electrolytes, inorganic liquid crystals. Ionic liquids, forces responsible for ionic liquids, synthesis and application of imidazolium and phosphonium based ionic liquids. Host-guest chemistry (elementary ideas).	15h
4	**Composite materials:** Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.	10h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr.)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1.Atkins P, Overton T., Rourke J. Weller M. and Armstrong F Shriver and Atkins.

2 Inorganic Chemistry Oxford University Press, Fifth Edition, 2012.

3. Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural chemistry. John Wiley,1974.

4. Poole, C.P. & Owens, F.J. Introduction to Nanotechnology John Wiley 2003.

5. Rodger, G.E. Inorganic and Solid-State Chemistry, Cengage Learning, 2002.

Semester-VIII

PAPER Title: Chemistry Practical – MJ 8 + AMJ-1 LAB
Credits - 04

Content

1.Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures. Preparation of buffer solutions of different pH (i. Sodium acetate-acetic acid, ii. Ammonium chloride-ammonium hydroxide

2. Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Fe (III) and Al (III)

3.Chromatographic separation of the active ingredients of plants, flowers and juices by TLC.

4. IR/DSC analysis of known polymer sample (for students' demonstration only)

5. Determination of flash point & fire point of given fuel sample.

6. Determination of viscosity index, cloud point, pour point of given fuel sample.

7. Determination of calorific value of given fuel sample/coal sample using bomb calorimeter.

8. Proximate analysis of given coal sample.

9. Determination of the iodine number of oil. 10. Determination of the saponification number of oil.

- Purification Techniques of Solvents by Fractional Distillation and Vacuum Distillation.
- Thin Layer Chromatography Technique and Purification of commercially available drugs/Synthesized Compounds by Column Chromatography.
- Preparation of Acid/Basic Salts of Drugs and Evaluation of their Physicochemical Properties. (Benzilic Acid & Sodium Benzoate).
- Synthesis & Purification of following Compounds using:

(i) Precipitation or Recrystallization.
(ii) Synthesis of Benzimidazole.
(iii) Synthesis of Anthranilic Acid.
(iv) Synthesis of Sulphanilamide.
(v) Synthesis of benzoic acid from benzyl alcohol.
(vi) Synthesis of 1,4 – dihydropyridine.

- Computational modeling of drug design/use softwares may be demonstrated to students.
- Free radical solution polymerization of any one: Styrene, methylmethacrylate, methyl acrylate, methacrylic acid (using free radical initiators). (Purification of monomer should be taught)
- Preparation of phenol-formaldehyde resins
- Emulsion polymerization of polymethylmethacrylate.
- Use of viscometer for molecular weight determination – (any known polymer, example: polyvinyl pyrrolidone in water/polyacrylamide in $NaNO_2$ solution) by viscometry. (Students should be explained regarding principles and use of ubblohde/ostwald viscometer).
- Estimation of amount of HCHO in a given solution by sodium bisulphite method.
- Use of FTIR/TGA/DSC – for polymer characterization (may be demonstrated to students)

Determination of exchange capacity of cation exchange resins and anion exchange resins.

- Analysis of spectra of UV-Vis, FTIR, NMR and Mass of simple organic compounds. (students may encourage to prepare simple organic compounds following given protocol

(azodyes, acetanilides, benzoic acid, etc.) (or may use commercially available organic componds) and can be trained to identify/analyze important peaks/functionality, determine mass of the molecules (mass-spectra). They can submit a report regarding their analysis to course teacher.

Experiments – 60 Marks
Viva-Voice – 20 Marks
Notebook – 20 Marks

Semester-VIII
PAPER Title: Minor Paper-2D (MN-2D)
Credits - 03

Learning objective:

- Physical and chemical properties of protein used in modern biotechnology
- Chemical principles of enzymatic effects
- Kinetic parameters of enzymatic reactions

Bio-Organic Chemistry

FM−60 Marks **Time 3hrs**

Unit	Content	Hours
1	**Enzymes:** Introduction and historical perspective Chemical and Biological Catalysis. Nomenclature, classification and extraction of Enzymes, Enzyme inhibition – Reversible and irreversible.	10h
2	**Mechanism of enzyme action:** Examples of some typical enzyme mechanism (a) Transition State theory (b) Acid-base Catalysis (c) Covalent Catalysis	10h
3	**Bio-technological application of enzymes:** Use of enzymes in feed and drink industries	08h
4	**Clinical uses of enzymes:** Mutations and genetic diseases. Enzyme therapy and recombinant DNA technology.	10h
5	**Co-enzymes:** Structure and biological function of co-enzyme A, co-factors as derived from vitamins, vitamin-B_{12}.	07h

Sessional Internal Assessment (SIA) Full Marks – 15 Marks
A – Internal written Examination – 10 Marks (1 Hr)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1. Bio-Organic and Inorganic Chemistry by P.S. Kalsi

Semester-VIII

PAPER Title: Chemistry Practical - MN-2D LAB

Credits - 01

FM-25 Marks **Pass Marks - 10**

Content

- Preparation of Benzanilide from aniline.
- Preparation of p-nitro acetanilide from acetanilide.
- Preparation of benzoic acid from benzaldehyde.
- Preparation of m-dinitro benzene form nitro benzene.
- Preparation of methyl orange.
- Determination of food adulterants in the given food items.

Experiments – 15 Marks
Viva-Voice – 05 Marks
Notebook – 05 Marks

MJ & AMJ (PRACTICAL)

SEM	SUBJECTS-CREDITS	INTERNAL MARKS	SEM. END MARKS	FULL MARKS	PASS MARKS
I	MJ 1 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 1 (Practical) – 1	–	25	25	10
II	MJ 2 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 3 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 2 (Practical) – 2	–	50	50	20
III	MJ 4 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 5 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 3 (Practical) – 2	–	50	50	20
IV	MJ 6 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 7 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 8 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 4 (Practical) – 3	–	75	75	30
V	MJ 9 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 10 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 11 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 5 (Practical) – 3	–	75	75	30
VI	MJ 12 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 13 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 14 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 15 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 6 (Practical) – 4	–	100	100	40
VII	MJ 16 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 17 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 18 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 19 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 7 (Practical) – 4	–	100	100	40
VIII	MJ 20 (Theory) – 3	10 + 5 = 15	60	75	30
	MJ 8 (Practical) – 1	–	25	25	10
	AMJ 1 (Theory) – 3	**10 + 5 = 15**	**60**	**75**	**30**
	AMJ 10 (Theory) – 3	**10 + 5 = 15**	**60**	**75**	**30**
	AMJ 11 (Theory) – 3	**10 + 5 = 15**	**60**	**75**	**30**
	AMJ 1 (Practical) – 3	–	**75**	**75**	**30**

MN 1 & MN 2 (PRACTICAL)

SEM	SUBJECTS-CREDITS	INTERNAL MARKS	SEM. END MARKS	FULL MARKS	PASS MARKS
I	MN 1A (Theory) – 3	10 + 5 = 15	60	75	30
	MN 1A (Practical) – 1	–	25	25	10
II	MN 2A (Theory) – 3	10 + 5 = 15	60	75	30
	MN 2A (Practical) – 1	–	25	25	10
III	MN 1B (Theory) – 3	10 + 5 = 15	60	75	30
	MN 1B (Practical) – 1	–	25	25	10
IV	MN 2B (Theory) – 3	10 + 5 = 15	60	75	30
	MN 2B (Practical) – 1	–	25	25	10
V	MN 1C (Theory) – 3	10 + 5 = 15	60	75	30
	MN 1C (Practical) – 1	–	25	25	10
VI	MN 2C (Theory) – 3	10 + 5 = 15	60	75	30
	MN 2C (Practical) – 1	–	25	25	10
VII	MN 1D (Theory) – 3	10 + 5 = 15	60	75	30
	MN 1D (Practical) – 1	–	25	25	10
VIII	MN 2D (Theory) – 3	10 + 5 = 15	60	75	30
	MN 2D (Practical) – 1	–	25	25	10

GUIDELINES FOR QUESTION SETTER

i. Question Paper shall show Full Marks (FM), Pass Marks (PM) & Maximum Time allowed (in Hrs.) at the top of the Question Paper.

ii. In order to avoid wrote memory and to evaluate in-depth study, knowledge, understanding and application domain of student the pattern of questions as given below must be set.

iii. There will be two categories of Questions Namely **Group A & Group B.** Group A will be of very short answer type (consisting objective type excluding multiple choice questions) of 1 mark & short answer type of 5 marks and questions in this group will be all compulsory. Group B will contain long answer type questions.

iv. **For <u>Semester Internal Examination (SIE 10 marks, 1Hr Exam):</u>**

There will be **two** group of questions. **Question No.1 will be very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.

v. **For <u>Semester Internal Examination (SIE 20 marks, 1Hr Exam):</u>**

There will be two group of questions. **Group A is compulsory** which will contain two questions. **Question No. 1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.

FORMAT OF SAMPLE QUESTION PAPER FOR SEM. INTERNAL EXAM

Question format for **10 Marks:**

Subject/Code

F.M. – 10 **Time – 1Hr.** **Exam Year**

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. ……
   ii. ……
   iii. ……
   iv. ……
   v. ……

Group B

2. …… [5]
3. …… [5]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **20 Marks:**

Subject/Code

F.M. – 20 **Time – 1Hr.** **Exam Year**

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. ……
   ii. ……
   iii. ……
   iv. ……
   v. ……
2. …… [5]

Group B

3. …… [10]
4. …… [10]

Note: There may be subdivisions in each question asked in Theory Examination.

Note: These formats may be modified or designed uniformly for a common type of courses.

FOR SEMESTER END EXAM

vi. **For <u>End Semester Examination (ESE 50 marks, 2Hrs Exam):</u>**

There will be **two** group of questions. **Question No. 1 will be very short answer type compulsory question in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.

vii. **For <u>End Semester Examination (ESE 60 marks, 3Hrs Exam):</u>**

There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No. 1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.

viii. **For <u>End Semester Examination (ESE 75 marks, 3Hrs Exam):</u>**

There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.

ix. **For <u>End Semester Examination (ESE 100 marks, 3Hrs Exam):</u>**

There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of twenty marks each, out of which any four are to answer.

Note: There may be subdivisions in each question asked in Theory Examinations.

FORMAT OF SAMPLE QUESTION PAPER FOR END SEM. EXAM

Question format for **50 Marks:**

Subject/Code

F.M. – 50 **Time – 2Hrs.** **Exam Year**

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1 = 5]
   i. ……
   ii. ……
   iii. ……
   iv. ……
   v. ……

Group B

2. …… [15]
3. …… [15]
4. …… [15]
5. …… [15]
6. …… [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **60 Marks:**

Subject/Code

F.M. – 60 **Time – 3Hrs.** **Exam Year**

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1 = 5]
   i. ……
   ii. ……
   iii. ……
   iv. ……
   v. ……
2. …… [5]
3. …… [5]

Group B

4. …… [15]
5. …… [15]
6. …… [15]
7. …… [15]
8. …… [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **75 Marks:**

Subject/Code

F.M. – 75 **Time – 3Hrs.** **Exam Year**

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1 = 5]
   i. ……
   ii. ……
   iii. ……
   iv. ……
   v. ……
2. …… [5]
3. …… [5]

Group B

4. …… [15]
5. …… [15]
6. …… [15]
7. …… [15]
8. …… [15]
9. …… [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **100 Marks:**

Subject/Code

F.M. – 100 **Time – 3Hrs.** **Exam Year**

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [10x1 = 10]
   i. …… vi. ……
   ii. …… vii. ……
   iii. …… viii. ……
   iv. …… ix. ……
   v. …… x. ……
2. …… [5]
3. …… [5]

Group B

4. …… [20]
5. …… [20]
6. …… [20]
7. …… [20]
8. …… [20]
9. …… [20]

Note: There may be subdivisions in each question asked in Theory Examination.