Structure and Detailed Syllabus of the Four Year Undergraduate Programme (FYUGP)
of
MINOR COURSE (MI)
under NEP-2020

Department of Chemistry
JAGANNATH BAROOAH UNIVERSITY
Barpatra Ali, Jorhat-785001 (Assam)
Approved in the BOS, Chemistry held on 21.05.2026

SEMESTER-I

Paper Title	: GENERAL CHEMISTRY-I (Theory & Practical)
Category	: THEORY+ PRACTICAL
Paper Code	: CHMMI-011
Course No	: C- 01
Credits	: 04 (03+01)
No. of Classes	: 45
Total Marks	: 100 (End Semester: 45; In Semester: 45: Practical 15)

SEMESTER-II

Paper Title	: GENERAL CHEMISTRY-II (Theory & Practical)
Category	: THEORY+ PRACTICAL
Paper Code	: CHMMI-021
Course No	: C- 02
Credits	: 04 (03+01)
No. of Classes	: 45
Total Theory Marks	: 100 (End Semester: 45; In Semester: 45: Practical 15)

SEMESTER-III

Paper Title	: GENERAL CHEMISTRY-III (Theory & Practical)
Category	: THEORY & PRACTICAL
Paper Code	: CHMMI-031
Course No	: C- 03
Credits	: 04 (03+01)
No. of Classes	: 45
Total Marks	: (End Semester: 45; In Semester: 45: Practical 15)

SEMESTER-IV

Paper Title	: GENERAL CHEMISTRY-IV (Theory & Practical)
Category	: THEORY & PRACTICAL
Paper Code	: CHMMI-041
Course No	: C- 03
Credits	: 04 (03+01)
No. of Classes	: 45
Total Marks	: (End Semester: 45; In Semester: 45: Practical 15)

SEMESTER-V

Paper Title	: GENERAL CHEMISTRY-V (Theory & Practical)
Category	: THEORY & PRACTICAL
Paper Code	: CHMMI-051
Course No	: C- 03
Credits	: 04 (03+01)
No. of Classes	: 45
Total Marks	: (End Semester: 45; In Semester: 45: Practical 15)

SEMESTER-VI

Paper Title	: GENERAL CHEMISTRY-VI (Theory & Practical)
Category	: THEORY & PRACTICAL
Paper Code	: CHMMI-061
Course No	: C- 03
Credits	: 04 (03+01)
No. of Classes	: 45
Total Marks	: (End Semester: 45; In Semester: 45: Practical 15)

SEMESTER-VII

Paper Title	: GENERAL CHEMISTRY-VII (Theory & Practical)
Category	: THEORY & PRACTICAL
Paper Code	: CHMMI-071
Course No	: C- 03
Credits	: 04 (03+01)
No. of Classes	: 45
Total Marks	: (End Semester: 45; In Semester: 45: Practical 15)

SEMESTER-VIII

Paper Title	: GENERAL CHEMISTRY-VIII (Theory & Practical)
Category	: THEORY & PRACTICAL
Paper Code	: CHMMI-081
Course No	: C- 03
Credits	: 04 (03+01)
No. of Classes	: 45
Total Marks	: (End Semester: 45; In Semester: 45: Practical 15)

Semester	Course No.	Paper Title	Paper Code	Course Type	Credit Points	Marks Distribution			
						Theory	Practical	Internal Assessment	Total
I	C-01	General Chemistry –I	CHMMI-011	Theory & Practical	04	45	15	40	100
II	C-02	General Chemistry –II	CHMMI-021	Theory & Practical	04	45	15	40	100
III	C-03	General Chemistry –III	CHMMI-031	Theory & Practical	04	45	15	40	100
IV	C-04	General Chemistry –IV	CHMMI-041	Theory & Practical	04	45	15	40	100
V	C-05	General Chemistry –V	CHMMI-051	Theory & Practical	04	45	15	40	100
VI	C-06	General Chemistry –VI	CHMMI-061	Theory & Practical	04	45	15	40	100
VII	C-07	General Chemistry –VII	CHMMI-071	Theory & Practical	04	45	15	40	100
VIII	C-08	General Chemistry –VIII	CHMMI-081	Theory & Practical	04	45	15	40	100

SEMESTER I

Paper Title : **GENERAL CHEMISTRY-I (THEORY)**
Paper Code : **CHMMJ-011**
Course No : **C- 01**
Credits : **03**
No. of Classes : **45**
Total Theory Marks : **45**

Course Objectives:

- To understand the important features of the quantum mechanical model of atom.
- To know the position and properties of elements, predict chemical reactions, understand trends in periodic properties among different elements.
- To introduce with a variety of structural aspects of organic molecules that are designed to lay the foundations for the study of the organic molecule.
- To impart basic knowledge of the gaseous state of matter; to understand the basic properties of liquids and their application.

Learner Outcome: Learner will gain an understanding of

- Quantum mechanical model of atom; concept of wave function, contour diagram, probability diagram etc.
- Properties of elements, atomic radii, ionic radii, size effect of ionic bond, solvation energy, covalent character of ionic bond, redox equations etc.
- Organic compounds, their classification, nomenclature; reaction of aliphatic hydrocarbons.
- Kinetic molecular model of a gas, behaviour of real gases etc.; various physical properties of liquids with special reference to surface tension and viscosity.

SECTION A: INORGANIC CHEMISTRY - I

UNIT-I: Atomic Structure: Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Contour boundary and probability diagrams and orbital.

(7 Lectures; Marks: 7)

UNIT-II: Periodicity of Elements: Effective nuclear charge, shielding or screening effect and their variation, Slater rules, atomic radii (van der Waals), Ionic and crystal radii, Covalent radii (octahedral and tetrahedral), Applications of ionization enthalpy, Electron gain enthalpy. Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge. Covalent character in ionic compounds, Polarising power and polarizability, Fajan's rules and consequences of polarization, Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

(8 Lectures; Marks: 8)

SECTION B: ORGANIC CHEMISTRY- I

UNIT-III: **Basics of Organic Chemistry:** Organic Compounds: Classification, and Nomenclature, Hybridization and shapes of molecules. Electronic effects: (Inductive, resonance and hyperconjugation) and steric effect and their applications (acid/base property). Homolytic and Heterolytic fission. Electrophiles and Nucleophiles; Nucleophlicity and basicity; Chemistry of reactive intermediates (carbocations, free radical, carbenes and nitrene).

(6 Lectures; Marks: 6)

UNIT-IV: Chemistry of Aliphatic Hydrocarbons: Formation of alkanes, Halogenation -relative reactivity and selectivity. Carbon-Carbon pi Bonds: Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), hydroxylation of alkenes with simple effect of stereo selectivity and specificity. 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

(9 Lectures; Marks: 9)

UNIT-V: Gaseous State: 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, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities. Behaviour of Real Gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. Van der Waals equation of state, its derivation and application in explaining real gas behaviour; virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

(15 Lectures; Marks: 15)

Paper Title : GENERAL CHEMISTRY-I (PRACTICAL)
Paper Code : CHMMJ-011
Course No : C- 01
Credits : 01
No. of Classes : 30
Total Marks : 15

EXPERIMENTAL WORK

(a) Preparation of normal and molar solution, for example KCl, Na2C2O4, HCl, H2SO4 etc. (Verification by conductometric measurement).

(b) Determination of water of crystallization of hydrated salt by ignition and weighing.

(c) Primary and secondary standard solution. Determination of strength of secondary standard solution by volumetric method (Titration of $KMnO_4$ Vs oxalic acid; Na2S2O4 Vs K2Cr2O7)

(d) Acid-Base titration

1. Estimation of carbonate and hydroxide present together in mixture.
2. Estimation of carbonate and bicarbonate present together in a mixture.

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics
  - Practical Notebook/Viva

Course Outcomes (COs) & Bloom's Mapping:

After the completion of this course, the learner will be able to:

CO 1: Apply the quantum mechanical model of the atom by applying the Schrödinger wave equation, de Broglie relation, and uncertainty principles to interpret orbital shapes, radial/angular distribution curves, and electron probability densities.
CO 2: Understand periodic trends and use Fajan's rules to predict the degree of covalent or ionic character in chemical bonds based on dipole moments.
CO 3: Explain the structural features, IUPAC nomenclature, and electronic effects of organic molecules to determine the stability of reactive intermediates and relative acid-base strengths.
CO 4: Apply mechanistic pathways (such as E1/E2 elimination) to predict the major stereoselective or regioselective products in the synthesis and reactions of aliphatic hydrocarbons.
CO 5: Understand molecular properties of gases by utilizing the kinetic molecular model and **analyse** deviations of real gases from ideal behaviour by deriving and utilizing the van der Waals and virial equations of state to correlate critical constants with intermolecular forces.
CO 6: Execute the quantitative using two-indicator acid-base titrations, and **analyse** the volumetric data to calculate the individual mass concentrations of each component in the solution.

Knowledge Dimensions	**Remember L1**	**Understand L2**	**Apply L3**	**Analyze L4**	**Evaluate L5**	**Create L6**
Factual						
Conceptual		**CO2, CO3, CO5**	**CO1, CO4**	**CO5**		
Procedural		**CO6**		**CO6**		
Metacognitive						

Suggested Books:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 10th Ed., Oxford University Press (2014).

Reference Books:

- Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970.
- Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962.
- Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
- Kapoor, K. L. *A Textbook of Physical Chemistry*, Vol. 1

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SEMESTER-II

Paper Title : GENERAL CHEMISTRY-II (THEORY)
Paper Code : CHMMJ-021
Course No : C- 02
Credits : 03
No. of Classes : 45
Total Theory Marks : 45

Course Objectives:

- To understand the different types of bonds formed by atoms and their chemical approaches of bonding and shape of molecules.
- To impart basic knowledge on transition metals and their applications.
- To impart knowledge on stereochemistry and importance of alkyl and aryl halides.
- To introduce with a variety of laws of thermodynamics, thermo-chemistry and their applications.

Learner Outcome: Learner will gain an understanding of

- Molecular geometries, physical and chemical properties of the molecules; Current bonding models for simple inorganic and organic molecules in order to predict structures and important bonding parameters.
- Catalytic, magnetic and redox properties of transition elements.
- Stereochemistry; 2D, 3D structures of molecules and their interconversion; E/Z, R/S nomenclature, Conformational analysis of alkanes.
- Chemistry of alkyl halides aryl halides; their preparation and reactions.
- Different thermodynamic functions; First, second & third law of thermodynamics.

SECTION A: INORGANIC CHEMISTRY - II

UNIT-I: Chemical Bonding: Ionic Bonding: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé and Kapustinskii expression and its application (no derivation). Madelung constant, Born-Haber cycle and its application, Solvation energy. Covalent Bonding: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths. Metallic Bonding: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

(10 Lectures; Marks: 10)

Unit II: Intermolecular Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions.

Repulsive forces, Hydrogen bonding. Effects of chemical force, melting and boiling points, solubility energetics of dissolution processes.

(5 Lectures; Marks: 5)

SECTION B: ORGANIC CHEMISTRY- II

UNIT-III: **Stereochemistry-I:** Fischer, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: E/Z notations with C.I.P rules. Optical Isomerism in compounds with or without chiral centers (allenes, spirans and biphenyls): Optical Activity, Specific Rotation, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture, resolution and enantiomeric excess. Relative and absolute configuration.

Conformational Analysis: Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes (ethane and n-butane): Relative stability: Energy diagrams of cyclohexane; Relative stability of cyclohexanes.

(15 Lectures; Marks: 15)

SECTION C: PHYSICAL CHEMISTRY– II

UNIT-IV: Chemical Thermodynamics-I: Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. **First law:** 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, Joule-Thomson effect.

(7 Lectures; Marks: 7)

UNIT- V: Liquid State: Molecular forces and general properties of liquids. **Surface Tension:** surface tension, surface energy, effect of temperature on surface tension, shapes of liquid drops and soap bubbles, capillary action, determination of surface tension by capillary rise method drop number methods using stalagmometer. Effect of temperature on surface tension. Parachor, Additive and constitutive properties: atomic and structural parachor. Elucidation of structure of benzene and benzoquinone. **Viscosity:** Definition, viscosity coefficient, fluidity, determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature, size, weight, shape of molecules and intermolecular forces.

(8 Lectures; Marks: 8)

Paper Title : GENERAL CHEMISTRY-II (PRACTICAL)
Paper Code : CHMMJ-021
Course No : C- 02
Credits : 01
No. of Classes : 30
Total Theory Marks : 15

EXPERIMENTAL WORK

1. Surface tension measurements: Determine the surface tension by (i) drop number (ii) drop weight method.
2. Viscosity measurement using Ostwald's viscometer

MODES OF IN-SEMESTER ASSESSMENT: 40 Marks

- Two Internal Examination - **20 Marks**
- Others (any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics
  - Practical Notebook/Viva

Course Outcomes (COs) & Bloom's Mapping

After the completion of this course, the learner will be able to:

CO 1: Apply bonding theories (VSEPR, VBT, MOT) to predict molecular geometry, explain s-p mixing, construct molecular orbital diagrams for homo/heteronuclear diatomic and simple polyatomic species, and evaluate properties like bond order and magnetism.
CO 2: Understand the factors governing crystalline solids and solution chemistry by utilizing the Born-Haber cycle, lattice energy expressions, and comparing the effects of different intermolecular forces on physical properties.
CO 3: Examine structural and optical isomerism by converting between spatial projection formulae, assigning absolute configurations.
CO 4: Understand the relative stability and structural constraints of cyclic and acyclic hydrocarbons by utilizing conformational analysis energy profiles.
CO 5: Calculate the thermodynamic parameters for ideal and van der Waals gases undergoing reversible, irreversible, or free expansion under isothermal and adiabatic conditions based on the First Law of Thermodynamics.
CO 6: Explain the macromolecular behaviour of liquids by interpreting the physical significance of surface tension, viscosity, and parachor, and **determine** the surface tension and coefficient of viscosity of unknown liquid systems by executing experimental protocols.

Knowledge Dimensions	**Remember L1**	**Understand L2**	**Apply L3**	**Analyze L4**	**Evaluate L5**	**Create L6**
Factual		**CO2**				
Conceptual		**CO4, CO6**	**CO1, CO5**	**CO3**		
Procedural			**CO6**			
Metacognitive						

Suggested Books:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Kapoor K. L. *A Textbook of Physical Chemistry* Sixth Ed., Vol. 2, Macmillan, India

Reference Books:

- Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970
- Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.
- Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London, 1994.
- Kalsi, P. S. *Stereochemistry Conformation and Mechanism*, New Age International, 2005.
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.:New Delhi (2004).
- Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill (2010).

SEMESTER-III

Paper Title : **GENERAL CHEMISTRY-III (THEORY)**
Category : **THEORY & PRACTICAL**
Paper Code : **CHMMI-031**
Course No : **C- 03**
Credits : **03**
No. of Classes : **45**
Total Theory Marks : **45**
In-semester Marks : **40**

Course Objectives:

- To understand acid-base concept, indicators.
- To understand principles of quantitative analysis.
- To gain insight in preparations and reactions of alcohols, phenols, ethers and epoxides.
- To understand interactions of ions in solutions.

Course Outcome: Students will gain an understanding of

- Different theories of acid – base concept, relative strength of acids, HSAB principle and its application and indicators.
- Principles of qualitative analysis namely Volumetric Analysis and Gravimetric Analysis.
- Preparation and reactions of Alcohols, Phenols, Ethers and Epoxides
- Ionization of electrolytes, dissociation constants, pH scale, common ion effect; buffer solutions, solubility, solubility product and its application hydrolysis and hydrolysis constants.

SECTION A: INORGANIC CHEMISTRY - III

UNIT-I: Acid-Base Concepts: Arrhenius Definition, Lewis Definition, Bronsted-Lowry Definition, Lux Flood Definition, Solvent System Definition, Solvated Proton, Relative Strength of Acids, Leveling Solvents, Types of Acid-Base Reactions, Pearson's Hard and Soft Acids and Bases (HSAB) Concept, Application of HSAB Principle, Theory of Acid–Base Indicators, Selection of Indicators and their Limitations.

(10 Lectures; 10 Marks)

UNIT-II: Principles of Volumetric Analysis and Gravimetric Analysis: Principle involved in volumetric (Redox & Complexometry) and Gravimetric analysis. Application in analytical chemistry: Estimation of Ni(II) by DMG, Al (III) as oxinate in a given solution, Estimation of Mg (II) and Zn (II) by complexometric titrations using EDTA.

(05 Lectures; 5 Marks)

SECTION B: ORGANIC CHEMISTRY- III

Unit-III: Alcohols, Phenols, Ethers and Epoxides:

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, 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 epoxides with alcohols, ammonia derivatives and $LiAlH_4$.

(9 Lectures; Marks: 9)

UNIT-IV: Organic Synthesis using Active methylene & organometallic compounds:
Active Methylene Compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.
Organometallic compounds of Mg and Li: Use in synthesis of organic compounds.

(6 Lectures: Marks: 6)

SECTION C: PHYSICAL CHEMISTRY – III

Unit-V: 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 monoprotic acid (exact treatment). Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; Henderson equation; Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

(15 Lectures; Marks: 15)

Paper Title	**: CHEMISTRY LAB-III (Practical)**
Paper Code	**: CHMMI-031 PR**
Course No	**: C- 03**
Credits	**: 01**
No. of Classes	**: 30**
Total Marks	**: 15**

EXPERIMENTAL WORK

1. Purification of organic compound and determination of melting point: Purification of organic compounds by crystallization using the following solvents: Water, Alcohol, Alcohol-Water.
2. Separation of mixtures of amino acids by Paper chromatography

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (any one) - **20 Marks**
  - Home Assignment
  - Practical Notebook/Viva

Text Books:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Pathania, P. S.; *Physical Chemistry. 48th Edition* (2021).

SEMESTER-IV

Paper Title : **GENERAL CHEMISTRY-IV (THEORY)**
Category : **THEORY & PRACTICAL**
Paper Code : **CHMMI-041**
Course No : **C- 05**
Credits : **03**
No. of Classes : **45**
Total Theory Marks : **45**
In-semester Marks : **40**

Course Objectives:

- To understand oxidation and reduction processes and the
- To understand principles underlying qualitative analysis,
- To get knowledge on preparation and reactions of carbonyl compounds.
- To get knowledge on structure and arrangement of constituent particles in solid state of matter.

Course Outcome: Students will gain an understanding of

- Oxidation and reduction reactions and balancing of redox reactions by oxidation Number Method and Ion-electron Method
- Basic Principles Involved in Analysis of acid and basic radicals, different types of equilibrium, solubility products, common ion effect
- Structure, reactivity, preparation and reactions of carbonyl compounds
- Arrangement of constituent particles in solids, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements

SECTION A: INORGANIC CHEMISTRY - IV

UNIT-I: Oxidation-Reduction: Oxidation and Reduction Reactions, Oxidation Number Concept, Balancing Redox Equations by Oxidation Number Method and Ion-electron Method, Equivalent Weight of Oxidizing and Reducing agents, Standard Electrode Potential and its Application to Inorganic Reactions.

(06 Lectures; 6 Marks)

UNIT-II: Theoretical Principles in Qualitative Analysis (H_2S Scheme): Basic Principles Involved in Analysis of Cations and Anions, Different types of equilibrium, solubility products, common ion effect (with example). Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II and removal methods.

(09 Lectures; 9 Marks)

SECTION B: ORGANIC CHEMISTRY- IV

Unit-III: Carbonyl Compounds - Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism;

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, $NaBH_4$, MPV, PDC and PGC); Addition reactions of unsaturated carbonyl compounds: Michael addition.

(8 Lectures; Marks: 8)

Unit-IV: 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 and Curtius rearrangement.

(7 Lectures; Marks: 7)

SECTION C: PHYSICAL CHEMISTRY – IV

Unit-V: 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 and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals.

(15 Lectures; Marks: 15)

Paper Title	**: CHEMISTRY LAB-IV (Practical)**
Paper Code	**: CHMMI-041 PR**
Course No	**: C- 04**
Credits	**: 01**
No. of Classes	**: 30**
Total Marks	**: 15**

EXPERIMENTAL WORK

1. Qualitative semimicro analysis of mixtures containing 4 radicals. The following radicals are suggested:

CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, CH_3COO^-, F^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (any one) - **20 Marks**
  - Home Assignment
  - Practical Notebook/Viva

Text Books:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.

- Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Pathania, P. S.; *Physical Chemistry. 48th Edition* (2021).
- Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970
- Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- Kapoor K. L. *A Textbook of Physical Chemistry* Sixth Ed., Vol. 2, Macmillan, India

SEMESTER-V

Paper Title : GENERAL CHEMISTRY-V (THEORY)
Category : THEORY & PRACTICAL
Paper Code : CHMMI-051
Course No : C- 05
Credits : 03
No. of Classes : 45
Total Theory Marks : 45
In-semester Marks : 40

UNIT-I: Coordination Chemistry-I: Coordinate bonding: double and complex salts. Werner's theory of coordination complexes, Classification of ligands, Ambidentate ligands, chelates, Coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, Geometrical and optical isomerism in square planar and octahedral complexes.

Valence Bond Theory (inner and outer orbital complexes) and its limitations, Electroneutrality principle and back bonding, Elementary Crystal Field Theory: splitting of d^n configurations in octahedral, square planar and tetrahedral fields, crystal field stabilization energy (CFSE) in weak and strong fields; pairing energy. Spectrochemical series. Jahn- Teller distortion. Chelate effect, polynuclear complexes, Labile and inert complexes

(15 Lectures; Marks: 15)

Unit-II: **Nitrogen Containing Functional Groups**: Preparation and important reactions of nitro compounds, nitriles and isonitriles. Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hofmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3°amines with Hinsberg reagent and nitrous acid.
Diazonium Salts: Preparation and their synthetic applications.

(8 Lectures; Marks: 8)

Unit-III: Heterocyclic Compounds: Classification, 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), Thiophene, Pyridine (Hantzsch synthesis), Structure and reactivity of quinoline and isoquinoline.

(7 Lectures; Marks: 7)

UNIT IV: Chemical Kinetics: Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, kinetics of complex reactions (integrated rate expressions up to first order only): (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.

(15 Lectures; Marks: 15)

Paper Title : CHEMISTRY LAB-V (Practical)
Paper Code : CHMMI-051 PR
Course No : C- 05
Credits : 01
No. of Classes : 30
Total Marks : 15

EXPERIMENTAL WORK

1. Detection of extra elements in organic compounds (N, O, S; up to two extra elements).
2. Benzolyation of amines and phenols by Schotten-Baumann reaction.
3. Benzil-benzilic rearrangement

MODES OF IN-SEMESTER ASSESSMENT: 40 Marks

- Two Internal Examination **20 Marks**
- Others **20 Marks**
  - Home Assignment
  - Practical Notebook/Viva

Text Books:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Pathania, P. S.; *Physical Chemistry. 48th Edition* (2021).

Reference Books:

- Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970
- Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- Kapoor K. L. *A Textbook of Physical Chemistry* Sixth Ed., Vol. 2, Macmillan, India

SEMESTER-VI

Paper Title : GENERAL CHEMISTRY-VI (THEORY)
Category : THEORY & PRACTICAL
Paper Code : CHMMI-061
Course No : C- 05
Credits : 03
No. of Classes : 45
Total Theory Marks : 45

UNIT-I: Bioinorganic Chemistry: Elements of life: essential and beneficial elements, major, trace and ultratrace elements, the role of metal ions (specially Na, K, Mg, Ca, Fe, Cu, and Zn) in biological system. Metal ion transport across biological membrane Na/ K-ion pump. Metal ions in biological systems: Heme proteins-hemoglobin, myoglobin, Non-Heme Iron Proteins: Iron storage and transfer-ferritin, transferrin; electron transfer (Iron-sulfur protein)-rubredoxin, ferredoxin; O_2 transport-hemerythrin, Copper proteins and Enzymes-Hemocyanin, superoxide dismutase, ceruloplasmin, cytochrome coxidase; Zinc and Cobalt enzymes-carbonic anhydrase, carboxypeptidase, Vitamin B_{12} and and Nitrogen fixation Metals in medicines and therapy. Pt and Au complexes as drugs (examples only), metal dependent diseases (examples only), Toxic metal ions and their effects (Hg, Pb, Cd and As), chelation therapy (examples only),

(15 Lectures; Marks: 15)

Unit-II: Biomolecules:
Carbohydrates: Occurrence, classification and their biological importance. Monosaccharides: absolute configuration of glucose and fructose, epimers and anomers, mutarotation, Haworth projections and conformational structures; Interconversions of aldoses and ketoses.
Amino Acids, peptides and Proteins: Amino acids, Peptides and their classification. α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis; Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Elementary idea of structure of protein.
Lipids: Common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

(15 Lectures; Marks: 15)

UNIT II: Conductance: Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Huckel-Onsager equation, Wien effect, Debye-Falkenhagen effect, transference numbers and their relation to ionic mobilities. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water, (iii) conductometric titrations.

(8 Lectures; Marks: 8)

UNIT III: Electrochemistry: Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials. Electrochemical cells, reversible and

irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone electrodes.

(7 Lectures; Marks: 7)

Paper Title : CHEMISTRY LAB-VI (Practical)
Paper Code : CHMMI-061 PR
Course No : C- 06
Credits : 01
No. of Classes : 30
Total Marks : 15

EXPERIMENTAL WORK (ANY ONE)

1. Estimation of Fe (II) and oxalic acid using standardized $KMnO_4$ solution.
2. Estimation of oxalic acid and sodium oxalate in a given mixture.
3. Preparation of urea formaldehyde.
4. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.

MODES OF IN-SEMESTER ASSESSMENT: 40 Marks

- Two Internal Examination - 20 Marks
- Others - 20 Marks
  - Home Assignment
  - Practical Notebook/Viva

Text Books:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
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Reference Books:

- Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970
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- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- Kapoor K. L. *A Textbook of Physical Chemistry* Sixth Ed., Vol. 2, Macmillan, India

SEMESTER VII

Paper Title : GENERAL CHEMISTRY-VII (THEORY)
Category : THEORY & PRACTICAL
Paper Code : CHMMI-071
Course No : C- 07
Credits : 03
No. of Classes : 45
Total Theory Marks : 45

Course Objectives

- Understand the principles and metrics of Green Chemistry.
- Analyze environmental impacts and sustainability of chemical processes.
- Apply green solvents, catalysts, and eco-friendly synthetic methods.
- Evaluate industrial applications of green chemistry and waste minimization strategies.

Learning Outcomes

- Explain green chemistry principles and calculate green metrics.
- Select suitable green solvents and catalytic systems for reactions.
- Describe modern green synthetic methodologies and applications.
- Assess industrial processes for sustainability and environmental safety.

Unit I: Principles of Green Chemistry

- Twelve principles of green chemistry, atom economy, E-factor, reaction mass efficiency.
- Life cycle assessment, toxicology, environmental impact.

(10 Lectures, 10 Marks)

Unit II: Green Solvents and Catalysis

- Alternative solvents: Ionic liquids, supercritical fluids, water as a solvent, solvent-free reactions.
- Green catalysis: Heterogeneous catalysis, biocatalysis, photocatalysis, phase transfer catalysis.

(15 Lectures, 15 Marks)

Unit III: Green Synthesis and Industrial Applications

- Green synthetic methodologies: Microwave-assisted, ultrasound-assisted, sonochemistry, solid-state reactions.
- Green chemical processes in industry: Pharmaceuticals, polymers, fine chemicals.
- Biomass utilization, renewable energy, waste minimization.

(20 Lectures, 20 Marks)

Paper Title : GENERAL CHEMISTRY-VII (Practical)
Category : THEORY & PRACTICAL
Paper Code : CHMMI-071
Course No : C- 07
Credits : 01
No. of Classes : 30

Total Theory Marks : 15

EXPERIMENTAL WORK (ANY ONE)

1. Preparation of biodiesel from vegetable/ waste cooking oil.
2. Calculation of atom economy of organic reaction.
3. Preparation of Manganese (III) acetylacetonate, $Mn(acac)_3$
4. Synthesis of dihydropyrimidone.
5. Synthesis of 1,1-bis(2-naphthol)

MODES OF IN-SEMESTER ASSESSMENT: 40 Marks

- Two Internal Examination - 20 Marks
- Others - 20 Marks
    - Home Assignment
    - Practical Notebook/Viva

Text Books: P.T. Anastas & J.K. Warner (Green Chemistry: Theory and Practice), R. Luque, J. Campelo and J.M. Clark (Handbook of Green Chemistry).
Recommended Books: M. Lancaster (Green Chemistry: An Introductory Text), J. Clark and D. Macquarrie (Handbook of Green Chemistry and Technology).

SEMESTER VIII

Paper Title : GENERAL CHEMISTRY-VIII (THEORY)
Category : THEORY & PRACTICAL
Paper Code : CHMMI-081
Course No : C- 08
Credits : 03
No. of Classes : 45
Total Theory Marks : 45

Unit I: Introduction to Materials

- Classification of materials (metals, ceramics, polymers, composites), bonding in materials.
- Crystalline and amorphous solids, defects in solids, crystal structures (BCC, FCC, HCP).

(10 Lectures, 10 Marks)

Unit II: Advanced Materials

- Nanomaterials: Synthesis (top-down, bottom-up), characterization, properties, applications.
- Smart materials: Shape memory alloys, pH-sensitive materials, self-healing materials.
- Biomaterials: Biocompatibility, types, applications in medicine.

(15 Lectures, 15 Marks)

Unit III: Polymer Materials

- Historical background, basic nature, classification, raw materials, gas cracker, naphtha cracker, Molecular forces and chemical bonding in polymers, Texture of Polymers.
- Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.
  Physical, thermal, Flow & Mechanical Properties of polymers. Conducting polymers-Introduction, conduction mechanism, polyaniline (PANI), polyacetylene, polyparaphenylene and polypyrrole, applications of conducting polymers.

(20 Lectures, 20 Marks)

Paper Title : GENERAL CHEMISTRY-VIII (THEORY)
Category : PRACTICAL
Paper Code : CHMMI-081
Course No : C- 08
Credits : 01
No. of Classes : 30
Total Theory Marks : 15

EXPERIMENTAL WORK (ANY ONE)

1. Preparation of urea formaldehyde resin
2. Preparation of phenol formaldehyde resin

3. Determination of molecular weight of a polymer by viscosity method.
4. Synthesis and characterization of Schiff-base ligands and their metal complexes.

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others - **20 Marks**
    - Home Assignment
    - Practical Notebook/Viva

Text Books: W.D. Callister (Materials Science and Engineering: An Introduction), C.N.R. Rao and B. Raveau (Transition Metal Oxides), A.R. West (Solid State Chemistry and its Applications).

Recommended Books: M. Faraday (Experimental Researches in Chemistry and Physics), J. Zarzycki (Glasses and the Vitreous State), L.V. Azaroff (Introduction to Solids);Inorganic Chemistry, Shriver & Atkins, 5th Edition Oxford; Introduction to Polymer by R. J. Young and P. A. Lovell