

UNIVERSITY OF NORTH BENGAL



Raja Rammohunpur, Dist. Darjeeling, Pin: 734013

FYUGP syllabus

**B.Sc. 4-YEAR UNDER GRADUATE PROGRAM
(FYUGP) WITH CHEMISTRY AS MINOR
SUBJECT UNDER THE NEW CURRICULUM AND
CREDIT FRAMEWORK, 2024**

WITH EFFECT FROM THE 2024-2025 ACADEMIC SESSION

LAYOUT OF SYLLABUS FOR CHEMISTRY AS MINOR SUBJECT

<i>SEMESTER</i>	<i>COURSE TYPE</i>	<i>PAPER DESCRIPTION</i>
1	MINOR-1	PHYSICAL CHEMISTRY-I
2	MINOR-2	INORGANIC CHEMISTRY-I
3	MINOR-3	ORGANIC CHEMISTRY-I
4	MINOR-4	PHYSICAL CHEMISTRY-II
5	MINOR-5	INORGANIC CHEMISTRY-II
6	MINOR-6	ORGANIC CHEMISTRY-II
7	MINOR-7	GREEN CHEMISTRY
8	MINOR-8	BIOCHEMISTRY

Semester-I
COURSE TYPE: MINOR-1

PAPER CODE	PAPER DESCRIPTION
UCHEMIN11001	PHYSICAL CHEMISTRY-I
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
100	75

Semester-II
COURSE TYPE: MINOR-2

PAPER CODE	PAPER DESCRIPTION
UCHEMIN12002	INORGANIC CHEMISTRY-I
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
100	75

Semester-3
COURSE TYPE: MINOR-3

PAPER CODE	PAPER DESCRIPTION
UCHEMIN13003	ORGANIC CHEMISTRY-I
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
200	75

Semester-4
COURSE TYPE: MINOR-4

PAPER CODE	PAPER DESCRIPTION
UCHEMIN14004	PHYSICAL CHEMISTRY-II
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
200	75

Semester-5
COURSE TYPE: MINOR-5

PAPER CODE	PAPER DESCRIPTION
UCHEMIN15005	INORGANIC CHEMISTRY-II
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
300	75

Semester-6
COURSE TYPE: MINOR-6

PAPER CODE	PAPER DESCRIPTION
UCHEMIN16006	ORGANIC CHEMISTRY-II
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
300	75

Semester-7
COURSE TYPE: MINOR-7

PAPER CODE	PAPER DESCRIPTION
UCHEMIN17007	GREEN CHEMISTRY
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
400	75

Semester-8
COURSE TYPE: MINOR-8

PAPER CODE	PAPER DESCRIPTION
UCHEMIN18008	BIOCHEMISTRY
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
400	75

UNIVERSITY OF NORTH BENGAL

CHEMISTRY

Semester-I

MINOR-1

Paper Code: UCHEMAJ11001

Paper Description: PHYSICAL CHEMISTRY-I

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

PHYSICAL CHEMISTRY-I

UNIT I: 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, the relation between mean free path and coefficient of viscosity, calculation of σ from η .

The behavior of real gases: Deviations from ideal behavior, compressibility factor, Z , 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 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, and the law of corresponding states. **(15 Lectures)**

UNIT II: Liquid and Solid State

Liquid State: Physical properties of liquids; vapor pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.

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. Analysis of crystal structure of NaCl, and KCl. **(15 Lectures)**

UNIT III: Chemical Equilibrium and Ionic Equilibria

Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Le Chatelier's principle. Relationships between K_p , K_c and K_x for reactions involving ideal gases.

Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. pH scale,

common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts. Principles involved in separation of cations into groups and choice of group reagents. **(15 Lectures)**

Reference Books:

- ✚ Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
 - ✚ Ball, D. W. *Physical Chemistry*, Thomson Press, India, 2007.
 - ✚ Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa, 2004.
 - ✚ Mortimer, R.G. *Physical Chemistry*, 3rd Ed., Elsevier, 2009.
 - ✚ Engel, T. & Reid, P. *Physical Chemistry*, 3rd Ed., Pearson, 2013.
 - ✚ Levine, I.N. *Physical Chemistry*, 6th Ed., Tata McGraw Hill, 2010.
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PRACTICAL

PHYSICAL CHEMISTRY-I: (any three)

(30 HOURS)

1. Determination of the Density of a liquid.
2. (a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer. **or**
(b) Study of the variation of surface tension of a solution with concentration.
3. (a) Determination of the coefficient of viscosity of a liquid or dilute solution using an Ostwald's viscometer. **or**
(b) Study of the variation of viscosity of an aqueous solution with concentration of solute.
4. Preparation of buffer solutions and measurement of pH of the buffer solutions along with comparison with the theoretical values:
(a) Sodium acetate-acetic acid **or**
(b) Ammonium chloride-ammonium hydroxide

End Semester Examination (ESE):

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- Khosla, B.D.; Garg, V.C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co., New Delhi, 2011.
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CHEMISTRY

Semester-II

MINOR-2

Paper Code: UCHEMAJ1100XX

Paper Description: INORGANIC CHEMISTRY-I

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

INORGANIC CHEMISTRY-I

UNIT I: Atomic Structure

Bohr's theory, its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra.

Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2 , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, Shapes of s, p, and d atomic orbitals.

Pauli's Exclusion Principle, Hund's Rule, and Aufbau's Principle. Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations. **(15 Lectures)**

UNIT II: Periodicity of Elements

s, p, d, f block elements, the long form of the 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 the 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) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, and group electronegativity. **(15 Lectures)**

UNIT III: Chemical Bonding

Ionic Bonding: General characteristics of ionic bonding. Lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds.

Covalent Bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal, and octahedral arrangements.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing). Comparison of VB and MO approaches.

Dipole moment. Hydrogen Bonding.

(15 Lectures)

Reference Books:

- ✚ Cotton, F.A., Wilkinson, G & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
 - ✚ 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.
 - ✚ Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
 - ✚ Huheey, J.E., Keiter, E.A., Keiter, R.L & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India, 2006.
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PRACTICAL

INORGANIC CHEMISTRY-I:

(30 HOURS)

1. Qualitative analysis of **water-soluble** mixtures—**three ionic species** (two cations one anion or one cation and two anions) out of the following:

Cations: Pb^{2+} , Cu^{2+} , Fe^{3+} , Ni^{2+} , Zn^{2+} , Ba^{2+} , Na^+ , K^+ , NH_4^+

Anions: SO_4^{2-} , NO_3^- , Cl^-

Cations can be confirmed by Group Analysis or Special tests wherever feasible.

(Group Analysis is not mandatory)

End Semester Examination (ESE):

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- Marr & Rockett, *Practical Inorganic Chemistry*, Wiley & Sons, 1972.
 - Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2002
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CHEMISTRY

Semester-III

MINOR-3

Paper Code: UCHEMAJ1100XX

Paper Description: ORGANIC CHEMISTRY-I

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

ORGANIC CHEMISTRY-I

UNIT I: Basics of Organic Chemistry

Concept of (i) Aromatic and non-aromatic hydrocarbons; (ii) Organic acids and bases; (iii) Electrophiles and Nucleophiles and (iv) Hybridisation of organic compounds.

Electronic Displacements: Inductive, Electromeric, Resonance and Mesomeric effects, Hyperconjugation.

Homolytic and Heterolytic fission; Idea of Carbocations, Carbanions, and Free radicals (Types, shape, and the relative stability).

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions. **(15 Lectures)**

UNIT II: Chemistry of Non-aromatic Hydrocarbons

Alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Halogenation of alkanes.

Alkenes and Alkynes: Formation of alkenes and alkynes. Preliminary concept of E1, E2 elimination reaction, Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions (Markownikoff/Anti Markownikoff addition), hydroboration-oxidation, ozonolysis, catalytic reduction, hydroxylation.

Reactions of alkynes: Alkylation of terminal alkynes and reduction reactions. Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds. **(20 Lectures)**

UNIT III: Chemistry of Aromatic Hydrocarbons

Hydrogenation reaction of benzene, Directing effects of groups attached to benzene ring, Electrophilic aromatic substitution: Friedel-Craft's alkylation/acylation reaction, Halogenation, Nitration and Sulphonation reaction. **(10 Lectures)**

Reference Books:

- + Claiden, J.; Warren, S. & Greeves, N. *Organic Chemistry*, 2nd Ed., Oxford University Press, 2012.
 - + Carruthers, W. *Some Modern Methods of Organic Synthesis*, 4th Ed., Cambridge University Press, 2004.
 - + Loudon, M. *Organic Chemistry*, Oxford University Press, 2002.
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PRACTICAL

ORGANIC CHEMISTRY-I:

(30 HOURS)

1. Purification of organic compounds by crystallization using the following solvents:
(a) Water and (b) Alcohol
2. Determination of the melting points of organic compounds.
3. (a) Preliminary characterization of aliphatic and aromatic compounds by ignition.
(b) Detection of active unsaturation in organic compounds.
(c) Classification of Acidic and Alkaline compounds.

End Semester Examination (ESE):

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- + Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education, 2009.
 - + Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G. & Tatchell, A.R. *Practical Organic Chemistry*, 5th Ed., Pearson, 2012.
 - + Vogel, A. *Vogel's Textbook of Practical Organic Chemistry*, 5th Ed., Pearson India, 2003.
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CHEMISTRY

Semester-IV

MINOR-4

Paper Code: UCHEMAJ1100XX

Paper Description: PHYSICAL CHEMISTRY-I

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

PHYSICAL CHEMISTRY-II

UNIT I: Thermodynamics

Basic Definitions and mathematical background. First Law, Enthalpy Functions, Relation between C_p and C_v , Joule-Thomson Experiment, Inversion of Temperature, Adiabatic Changes in State, Enthalpies of Chemical Changes, Important principles and definitions of thermochemistry. Hess's Law. The Second Law, Carnot Cycle and its efficiency.

Entropy, Variation of enthalpy of a reaction with temperature-Kirchhoff's equation.

Statement of Third Law of thermodynamics.

(15 Lectures)

UNIT II: Chemical Kinetics and Catalysis

Concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Specific reaction rate. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions. Pseudo-unimolecular reactions. Half-life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions.

Characteristics of catalysed reactions, Homogeneous and Heterogeneous catalysis (mechanism with examples), catalyst poisons and promoters, Acid-Base catalysis, Enzyme catalysis.

(20 Lectures)

UNIT III: Colloids

Definition with examples, Preparation of Colloidal systems, Purification of Sols, Classification of Colloid systems, Optical and electrical properties of Lyophobic Sols, Stability of Sols, Brownian motion, Gold Number.

(10 Lectures)

Reference Books:

- Atkins, P.W. & Paula, J. de *Atkin's Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
- Ball, D.W. *Physical Chemistry*, Thomson Press, India, 2007.
- Levine, I.N. *Physical Chemistry*, 6th Ed., Tata McGraw Hill, 2010.
- McQuarrie, D.A. & Simon, J.D. *Molecular Thermodynamics*, Viva Books Pvt. Ltd., New Delhi, 2004.

- ✚ Barrow, G.M. *Physical Chemistry*, 4th Ed. Narosa, 2004.
 - ✚ Castellan, G.W. *Physical Chemistry*, 4th Ed., Narosa, 2004.
 - ✚ Kotz, J.C.; Treichel, P.M. & Townsend, J.R. *General Chemistry*. Cengage Learning India Pvt. Ltd., New Delhi, 2009.
 - ✚ Mahan, B.H. *University Chemistry*, 3rd Ed. Narosa, 1998.
 - ✚ Petrucci, R.H. *General Chemistry*, 5th Ed. Macmillan Publishing Co., New York, 1985.
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PRACTICAL

PHYSICAL CHEMISTRY-II: (any three)

(30 HOURS)

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Calculation of enthalpy of ionization of ethanoic acid.
4. Study the kinetics of the following reactions:
5. Acid hydrolysis of methyl acetate with hydrochloric acid **or**
Saponification of ethyl acetate.

End Semester Examination (ESE):

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- ✚ Athawale, V.D. & Mathur, P. *Experimental Physical Chemistry*, New Age International, New Delhi, 2001.
 - ✚ Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co., New Delhi, 2011.
 - ✚ Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry*, 8th Ed.; McGraw-Hill, New York, 2003.
 - ✚ Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry*, 3rd Ed., W.H. Freeman & Co., New York, 2003.
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CHEMISTRY

Semester-V

MINOR-5

Paper Code: UCHEMAJ1100XX

Paper Description: INORGANIC CHEMISTRY-II

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

INORGANIC CHEMISTRY-II

UNIT I: Transition Elements, Lanthanoids and Actinoids

Transition Elements: General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states (Latimer diagrams).

Lanthanoids and Actinoids: Electronic configurations, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only). **(15 Lectures)**

UNIT II: Coordination Chemistry and Crystal Field Theory

Valence Bond Theory (VBT): Inner and outer orbital complexes of Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature.

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of Δ_o . Spectrochemical series. Comparison of CFSE for O_h and T_d complexes, Tetragonal distortion of octahedral geometry, Jahn-Teller distortion, Square planar coordination. **(18 Lectures)**

UNIT III: Acids-Bases and Redox reactions

Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept. Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB). Application of HSAB principle.

Redox equations, Standard Electrode Potential and its application to inorganic reactions.

Principles involved in volumetric analysis

(12 Lectures)

Reference Books:

- ✚ Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
- ✚ Wulfsberg, G. *Inorganic Chemistry*, Viva Books Pvt. Ltd.
- ✚ Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- ✚ Cotton, F.A., Wilkinson, G & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- ✚ 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.
 - ✚ Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
 - ✚ Huheey, J.E., Keiter, E.A., Keiter, R.L & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India, 2006.
 - ✚ Rodgers, G.E. *Inorganic & Solid State Chemistry*, Cengage Learning India Ltd., 2008.
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PRACTICAL

End Semester Examination (ESE):

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

PRACTICAL (INORGANIC CHEMISTRY-II):

(30 HOURS)

1. Acid-Base Titrations: (*any two*)

- (a) Estimation of carbonate and hydroxide present together in mixture.
- (b) Estimation of sodium carbonate and sodium bicarbonate present together in a mixture.
- (c) Estimation of free alkali present in different soaps/detergents

2. Oxidation-Reduction Titrimetry: (*any two*)

- (a) Estimation of oxalic acid by titrating it with KMnO_4 .
- (b) Estimation of Fe(II) and oxalic acid using standardized KMnO_4 solution.
- (c) Estimation of water of crystallization in Mohr's salt by titrating with KMnO_4 .

Reference Books:

- ✚ Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
 - ✚ Marr & Rockett, *Practical Inorganic Chemistry*, Wiley & Sons, 1972.
 - ✚ Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2002.
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CHEMISTRY

Semester-VI

MINOR-6

Paper Code: UCHEMAJ1100XX

Paper Description: ORGANIC CHEMISTRY-II

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

ORGANIC CHEMISTRY-II

UNIT I: Halogenated Hydrocarbons

Alkyl halides: Methods of preparation, nucleophilic substitution reactions—SN1, SN2 and SNi mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts. Nucleophilic aromatic substitution; SNAr, 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 of organic compounds.

(15 Lectures)

UNIT II: Alcohols, Phenols and Carboxylic acids

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.

Carboxylic acids: 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.

(15 Lectures)

UNIT III: Carbonyl Compounds

Structure, preparation and reactivity of carbonyl compounds (Nucleophilic additions, Nucleophilic addition-elimination reactions, ammonia derivatives with mechanism). Umpolung of reactivity.

Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann rearrangement and Benzil-Benzilic acid rearrangement, Haloform reaction and Baeyer Villiger oxidation, Swarn oxidation.

Oxidations and reductions (Clemmensen, Wolff-Kishner, MPV, Selective reduction using metal hydrides (LiAlH₄, NaBH₄).

Addition reactions of unsaturated carbonyl compounds: Michael addition. Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate. **(15 Lectures)**

Reference Books:

- ✚ McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed., Cengage Learning India Edition, 2013.
 - ✚ Carruthers, W. *Some Modern Methods of Organic Synthesis*, 4th Ed., Cambridge University Press, 2004.
 - ✚ Loudon, M. *Organic Chemistry*, Oxford University Press, 2002.
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PRACTICAL

ORGANIC CHEMISTRY-II:

(30 HOURS)

1. Detection of special elements (N, S, Cl, Br, I) in organic compounds.
2. Identification of functional groups (Alcoholic-OH, Phenolic-OH, carbonyl group, carboxylic acid group).
3. Systematic Analysis of Non-nitrogenous Organic Compounds possessing mono functional Groups.

End Semester Examination (ESE):

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- ✚ Mann, F. G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education, 2009.
 - ✚ Vogel, A. *Vogel's Textbook of Practical Organic Chemistry*, 5th Ed., Pearson India, 2003.
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CHEMISTRY

Semester-VII

MINOR-7

Paper Code: UCHEMAJ1100XX

Paper Description: GREEN CHEMISTRY

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

GREEN CHEMISTRY

Green Chemistry – an overview, Principles of Green Chemistry.

Green chemistry metrics: atom economy, percent yield, reaction mass efficiency, environmental factor,

Green synthetic methods: organic synthesis in aqueous media, Ionic liquids, Supercritical liquids, microwave assisted organic reactions, Solvent free organic reactions, Solid phase organic synthesis, Merrifield synthesis.

Metal catalyzed organic reactions, characteristics of transition metals which make them suitable as catalysts, Homogeneous and heterogeneous catalysis. Catalyst and molecular activation, Catalytic reaction and the 16 electron rule, Catalysts for fine chemical synthesis, transition metal ion catalysts for organic transformations involving catalytic reductions, oxidations, carbon–carbon bond formation, hydrolysis, and their applications in epoxidation of alkenes, isomerization of unsaturated molecules, Alkene Metathesis, Oligomerisation and polymerization (Zeigler Natta polymerization), olefin oxidation (Wacker Process), Hydroformylation (oxoreaction), Fischer-Tropsch Reaction, Monsanto Acetic Acid Process, and Reppe Carbonylation.

Surfactant for CO₂: (precision cleaning or dry cleaning of garments), Environmentally safe marine antifoulant, Right fit pigments: Synthetic azo pigments in place of toxic organic and inorganic pigments. Preparation of poly lactic acid from corn. **(45 Lectures)**

Reference Books:

- ✚ Anatas, P.T & Warner J.K, *Green Chemistry-Theory and Practical*, Oxford University Press, 1998.
 - ✚ Ahluwalia, V.K. & Kidwai, M. R. *New Trends in Green Chemistry*, Annamalaya Publishers, 2005.
 - ✚ Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker, 2001.
 - ✚ Cann, M.C. & Connely, M.E. *Real-World Cases in Green Chemistry*, ACS, Washington, 2000.
 - ✚ Lancaster, M. *Green Chemistry: An Introductory text*, RSC Publishing, 2nd Ed.
 - ✚ Ryan, M.A. & Tinneland M. *Introduction to Green Chemistry*, ACS, Washington, 2002.
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PRACTICAL

GREEN CHEMISTRY: (any two)

(30 HOURS)

1. Solid-state synthesis of Benzillic acid.
2. Extraction of d-limonene from citrus fruits.
3. Solvent-free microwave-assisted one-pot synthesis of phthalocyanine complex of copper (II).
4. Bromination of acetanilide by green method.


End Semester Examination (ESE):

At the end of the semester, a practical examination will be conducted as per the following guidelines.

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

-  Anastas, P.T. & Warner, J.K. *Green Chemistry-Theory and Practical*, Oxford University Press, 1998.
-

CHEMISTRY

Semester-VIII

MINOR-8

Paper Code: UCHEMAJ1100XX

Paper Description: BIOCHEMISTRY

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

BIOCHEMISTRY

Carbohydrates: Open chain and cyclic structure: Glucose and Fructose, Mutarotation. Ascending and descending in monosaccharides. Structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose).

Amino Acids, Peptides and Proteins: Preparation of Amino Acids: Strecker synthesis, Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis. Reactions: complexation of amino acids with Cu(II) ions, ninhydrin test. An overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.

Lipids: Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, iodine number. Rancidity.

Enzymes: Characteristics of enzymes. Salient features of the active site of enzymes. Mechanism of enzyme action (taking trypsin as an example), coenzymes and cofactors and their role in biological reactions, enzyme inhibitors and their importance.

Concept of Energy in Biosystems: ATP: The universal currency of cellular energy, Agents for transfer of electrons in biological redox systems: NAD^+ , FAD. Glycolysis, Krebs cycle.

Metalloproteins: Oxygen transporting and electron transporting. Heme proteins: Hemoglobin, Myoglobin, Hemerythrin, Hemocyanin, Cytochrome P450, Cytochrome c oxidase. Non-heme proteins: Copper in cytochrome c oxidase and in respiratory chain, blue copper proteins.

Metalloenzymes: Zinc enzymes-carboxypeptidase and carbonic anhydrase. Iron enzyme-catalyses, peroxidase and cytochrome P-450. Copper enzyme-superoxide dismutase.

Role of alkali and alkaline earth metals in biological systems. Biological functions and toxicity caused by metal ions. Biological fixation of nitrogen. Chlorophyll-the photosynthetic catalyst, Bio-availability of metal ions. **(45 Lectures)**

Reference Books:

- ✚ Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
 - ✚ Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, 6th Ed. W.H. Freeman and Co. 2006.
 - ✚ Nelson, D.L., Cox, M.M. & Lehninger, A.L. *Principles of Biochemistry*, IV Edition, W.H. Freeman and Co. 2009.
 - ✚ Murray, R.K., Granner, D.K., Mayes, P.A. & Rodwell, V.W. *Harper's Illustrated Biochemistry*, XXVIII Edition, Lange Medical Books/ McGraw-Hill, 2009.
 - ✚ Lippard, J. & Berg, G.M. *Principles of Bio-Inorganic Chemistry*, Panima Publishing, 1994.
-

PRACTICAL

BIOCHEMISTRY: (any two)

(30 HOURS)

1. Analysis of Carbohydrates: Aldoses and ketoses, reducing and non-reducing sugars.
2. Estimation of Glycine by Sorenson's Formalin method.
3. Study of the titration curve of Glycine.
4. Estimation of Protein by Lowry's method.
5. Detection of the optimum temperature for action of salivary amylase on starch.
6. Determination of the saponification value of an oil or fat.
7. Determine the Iodine number of an oil or fat.
8. Isolation and characterization of DNA from onion/peas/cauliflower.

End Semester Examination (ESE)

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- ✚ *Manual of Biochemistry Workshop*, Department of Chemistry, University of Delhi, 2012.
 - ✚ Arthur, I. V. *Quantitative Organic Analysis*, Pearson.
-

End Semester Examination (ESE)

Question pattern of 60 marks paper:

Serial No.	Questions to be answered	Out of	Marks for each Question	Total Marks
1	5	8	2	5 x 2 = 10
2	6	9	5	6 x 5 = 30
3	2	3	10	2 x 10 = 20

UNIVERSITY OF NORTH BENGAL



Raja Rammohunpur, Dist. Darjeeling

Pin: 734 013, West Bengal, India

FYUGP syllabus

B.Sc. 4-YEAR UNDER GRADUATE
PROGRAM (FYUGP) WITH CHEMISTRY
AS **MAJOR** SUBJECT UNDER THE NEW
CURRICULUM AND CREDIT
FRAMEWORK, **2024**

WITH EFFECT FROM THE ACADEMIC SESSION

2024-2025

LAYOUT OF SYLLABUS FOR CHEMISTRY AS MAJOR SUBJECT

<i>SEMESTER</i>	<i>COURSE TYPE</i>	<i>PAPER DESCRIPTION</i>
1	MAJOR-1	ORGANIC CHEMISTRY-I
	MAJOR-2	INORGANIC CHEMISTRY-I
2	MAJOR-3	PHYSICAL CHEMISTRY-I
	MAJOR-4	ORGANIC CHEMISTRY-II
3	MAJOR-5	INORGANIC CHEMISTRY-II
	MAJOR-6	PHYSICAL CHEMISTRY-II
3	SEC	PHARMACEUTICAL CHEMISTRY
4	MAJOR-7	ORGANIC CHEMISTRY-III
	MAJOR-8	INORGANIC CHEMISTRY-III
5	MAJOR-9	PHYSICAL CHEMISTRY-III
	MAJOR-10	ORGANIC CHEMISTRY-IV
	MAJOR-11	INORGANIC CHEMISTRY-IV
	MAJOR-12	PHYSICAL CHEMISTRY-IV
6	MAJOR-13	ORGANIC CHEMISTRY-V
	MAJOR-14	INORGANIC CHEMISTRY-V
	MAJOR-15	PHYSICAL CHEMISTRY-V
	MAJOR-16	SPECTROSCOPY
7	MAJOR-17	RESEARCH METHODOLOGY
	MAJOR-18 (HONS. WITHOUT RESEARCH)	GREEN CHEMISTRY
	MAJOR-18 (HONS. WITH RESEARCH)	PROJECT/ DISSERTATION/ LITERATURE SURVEY
	MAJOR-19	PHYSICAL CHEMISTRY-VI
8	MAJOR-20	ORGANIC CHEMISTRY-VI
	MAJOR-21	INORGANIC CHEMISTRY-VI
	MAJOR-22 (HONS. WITHOUT RESEARCH)	BIOCHEMISTRY
	MAJOR-22 (HONS. WITH RESEARCH)	PROJECT WORK
	MAJOR-23 (HONS. WITHOUT RESEARCH)	POLYMER CHEMISTRY & ANALYTICAL CHEMISTRY

	MAJOR-23 (HONS. WITH RESEARCH)	PROJECT WORK
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Semester-I

COURSE TYPE: MAJOR-1

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ11001	ORGANIC CHEMISTRY-I
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
100	75

COURSE TYPE: MAJOR-2

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ11001	INORGANIC CHEMISTRY-I
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
100	75

UNIVERSITY OF NORTH BENGAL
CHEMISTRY

Semester-I

MAJOR-1

Paper Code: UCHEMAJ11001

Paper Description: ORGANIC CHEMISTRY-I

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

ORGANIC CHEMISTRY-I

UNIT I: Basics of Organic Chemistry

Hybridization of Organic compounds.

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation; Organic acids and bases: their relative strength.

Homolytic and Heterolytic fission; Electrophiles and Nucleophiles; Types, shape and the relative stability of Carbocations, Carbanions, Free radicals, Carbenes and Nitrenes.

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions (definition with examples). **(12 Lectures)**

UNIT II: Chemistry of Hydrocarbons

Carbon-Carbon sigma bonds: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation-relative reactivity and selectivity.

Carbon-Carbon pi-bonds: Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions, Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions, their mechanisms (Markownikov/Anti-Markownikov addition), hydroboration-oxidation, ozonolysis, catalytic reduction, *syn*- and *anti*-hydroxylation (oxidation), addition reactions in conjugated dienes; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethylbenzene.

Reactions of alkynes: Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes and Reduction reactions. **(21 Lectures)**

UNIT III: Aromatic Hydrocarbons

Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions, polynuclear hydrocarbons and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/ acylation with their mechanism. Directing effects of the groups. **(12 Lectures)**

Reference Books:

- ✚ Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
 - ✚ Finar, I. L. *Organic Chemistry (Volume1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
 - ✚ McMurry, J. E. *Fundamentals of Organic Chemistry*, 7thEd. Cengage Learning India Edition, 2013.
 - ✚ Claiden, J.; Warren, S. & Greeves, N. *Organic Chemistry*, 2nd Ed., Oxford University Press, 2012.
 - ✚ Carruthers, W. *Some Modern Methods of Organic Synthesis*, 4th Ed., Cambridge University Press, 2004.
 - ✚ Loudon, M. *Organic Chemistry*, Oxford University Press, 2002.
 - ✚ Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, 6th Ed., Harlow, 1961.
-

PRACTICAL

ORGANIC CHEMISTRY-I

(30 HOURS)

1. Checking the calibration of the thermometer.
2. Purification of organic compounds by crystallization using the following solvents:
(a) Water; (b) Alcohol; (c) Alcohol-Water
3. Determination of the melting points of organic compounds.
4. Effect of impurities on the melting point-mixed melting point of two unknown Organic compounds.
5. (a) Preliminary characterization of aliphatic and aromatic compounds by ignition.
(b) Detection of active unsaturation in organic compound.
(c) Classification of acidic and alkaline compounds.

End Semester Examination (ESE)

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- ✚ Mann, F. G. & Saunders, B. C. *Practical Organic Chemistry*, Pearson Education, 2009.
 - ✚ Furniss, B. S.; Hannaford, A. J.; Smith, P. W. G. & Tatchell, A. R. *Practical Organic Chemistry*, 5th Ed., Pearson, 2012.
 - ✚ Vogel, A. *Vogel's Textbook of Practical Organic Chemistry*, 5th Ed., Pearson India, 2003.
-

Semester-I

MAJOR-2

Paper Code: UCHEMAJ11002

Paper Description: INORGANIC CHEMISTRY-I

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

INORGANIC CHEMISTRY-I

UNIT I: 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 ψ^2 . 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.

Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number. **(14 Lectures)**

UNIT II: 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:

- Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table
- Atomic radii (van der Waals)
- Ionic and crystal radii
- Covalent radii (octahedral and tetrahedral)
- Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy
- Electron gain enthalpy, trends of 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, hybridization, group electronegativity **(16 Lectures)**

UNIT III: 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 and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

(ii) *Covalent bond*: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals, Bent's rule. Molecular orbital theory. Molecular orbital diagrams of diatomic molecules N_2 , O_2 , C_2 , B_2 ,

F₂, CO, NO, and their ions (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.

Fajan's rule of Ionic distortion and its application.

(15 Lectures)

Reference Books:

- ✚ Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
 - ✚ 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.
 - ✚ Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.
 - ✚ Huheey, J.E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry*, 4th Ed., Harper Collins College Publishers, 1993.
 - ✚ Shriver and Atkins' *Inorganic Chemistry*, 5th Ed., Oxford University Press, 2009.
 - ✚ Cotton, F.A.; Wilkinson, G.; Murillo, C.A. & Bachmann, M. *Advanced Inorganic Chemistry*, 6th Ed., Wiley-Interscience, New York, 1999.
-

PRACTICAL

INORGANIC CHEMISTRY-I:

(30 HOURS)

1. Qualitative analysis of **water-soluble** mixtures-**four ionic species** (two cations and two anions), out of the following:
Cations: Pb²⁺, Cu²⁺, Fe³⁺, Al³⁺, Ni²⁺, Zn²⁺, Ba²⁺, Sr²⁺, Ca²⁺, Na⁺, K⁺, NH₄⁺
Anions: S²⁻, SO₄²⁻, NO₂⁻, NO₃⁻, Cl⁻, Br⁻, I⁻
Group analysis can be carried out but Cations can also be confirmed by special tests wherever feasible. (**Group analysis is not mandatory**)

End Semester Examination (ESE)

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- Mendham, J., A. I. *Vogel's Quantitative Chemical Analysis*, 6th Ed., Pearson, 2009.
 - Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
-

Semester-II

COURSE TYPE: MAJOR-3

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ12003	PHYSICAL CHEMISTRY-I
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
100	75

COURSE TYPE: MAJOR-4

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ12004	ORGANIC CHEMISTRY-II
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
100	75

Semester-II

MAJOR-3

Paper Code: UCHEMAJ11003

Paper Description: PHYSICAL CHEMISTRY-I

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

PHYSICAL CHEMISTRY-I

UNIT I: Gaseous state

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation, Concept of temperature and Gas Laws from KTG. Collision Number, 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 of speeds in one, two and three dimensions 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 heat capacity from equipartition principle.

Behavior of real gases: Deviations from ideal gas behavior, compressibility factor, Z , 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, mention of other equations of state (Berthelot, Dietirici), 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. **(22 Lectures)**

UNIT II: Liquid state

Physical properties of liquids, vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases, Liquid crystal (Preliminary Idea), Classification, phases, Properties and Applications. **(5 Lectures)**

UNIT III: 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. Glasses and liquid crystals. **(18 Lectures)**

Reference Books:

- ✚ Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry*, 10th Ed. Oxford University Press, 2014.
 - ✚ Ball, D. W. *Physical Chemistry*, Thomson Press, India, 2007.
 - ✚ Castellan, G. W. *Physical Chemistry*, 4th Ed. Narosa, 2004.
 - ✚ Mortimer, R. G. *Physical Chemistry*, 3rd Ed. Elsevier, NOIDA, UP, 2009.
 - ✚ Engel, T. & Reid, P. *Physical Chemistry*, 3rd Ed. Pearson, 2013.
-

PRACTICAL

PHYSICAL CHEMISTRY-I: (any two)

(30 HOURS)

1. **Surface tension measurements:**
 - a. Determination of the surface tension of a liquid/ ethanol solution by Drop number method.
 - b. Determination of composition of an unknown solution by Drop Number Method using solutions of known composition (solutions of ethanol may be used).
2. **Viscosity measurement using Ostwald's viscometer:**
 - a. Determination of viscosity of aqueous solutions of polymer / ethanol / sugar at room temperature.
 - b. Determination of composition of an unknown solution by Ostwald Viscometer using solutions of known composition (solutions of ethanol, Sucrose may be used).
3. **Indexing of a given powder diffraction pattern of a cubic crystalline system.**

End Semester Examination (ESE)

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- Khosla, B. D., Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co. New Delhi, 2011.
 - Garland, C. W., Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry*, 8thEd. McGraw-Hill, New York, 2003.
 - Halpern, A. M. & Mc Bane, G. C. *Experimental Physical Chemistry*, 3rd Ed. W.H. Freeman & Co. New York, 2003.
-

Semester-II

MAJOR-4

Paper Code: UCHEMAJ11004

Paper Description: ORGANIC CHEMISTRY-II

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 206)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

ORGANIC CHEMISTRY-II

UNIT I: Stereochemistry

Tetrahedral carbon, chirality, 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. *Re/Si* face, topicity: Homotopic, Heterotopic, Enantiotopic, Diastereotopic group. Optical activity, specific rotation, Chirality. Asymmetry/Disymmetry, Enantiomers, Molecules with two or more chiral centres, Distereoisomers, Meso compounds, Racemic modification and resolution. Relative and absolute configuration: D/L and *R/S* designations, *threo-erythro* form, Atropisomerism. (12 Lectures)

UNIT II: Cycloalkanes and Conformational Analysis

Conformation and physical properties, conformation of ethane, propane, and butane (including substituted variety). Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of cycloalkanes (cyclobutane, cyclopentane, cyclohexane, and mono and di-substituted cyclohexanes): Relative stability: Energy diagrams: Chair, Boat and Twist boat forms of cyclohexane and decalin. (12 Lectures)

UNIT III: Dynamic Stereochemistry

Introduction (Stereo-selective and stereo-specific reaction), dynamic stereochemistry of acyclic and cyclic molecules, nucleophilic substitution, elimination reactions and addition reactions. (6 Lectures)

UNIT IV: Chemistry of Halogenated Hydrocarbons

Alkyl halides: Naming and structure of alkyl halides, methods of preparation, allylic bromination of alkenes, nucleophilic substitution reactions—*SN1*, *SN2*, and *SNi* mechanisms with stereochemical aspects and effect of solvent; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts, nucleophilic aromatic substitution; *SNAr*, cine Substitution.

Relative reactivity of alkyl, allyl/benzyl, vinyl, and aryl halides towards nucleophilic substitution reactions. (15 Lectures)

Reference Books:

- ✚ Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- ✚ Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- ✚ 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.
- ✚ Clayden J, Greeves N & Warren S, *Organic Chemistry*, 2nd Ed. Oxford University Press Inc, New York, 2001.
- ✚ Carruthers, W. *Some Modern Methods of Organic Synthesis*, 4th Ed., Cambridge University Press, 2004

PRACTICAL

ORGANIC CHEMISTRY-II: (any three)

(30 HOURS)

1. Detection of special elements in solid or liquid organic compounds.
2. Perform an Iodoform reaction with ethanol/Isopropanol/acetone/any suitable compound.
3. Preparation of Aryl halide involving diazonium salt.
4. Bromination of acetanilide by conventional method.
5. Bromination of acetanilide by green method (Bromate-bromide method).
6. Preparation of 1,3,5-tribromo benzene.

End Semester Examination (ESE)

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- Furniss, B.S. Hannaford, A.J. Smith, P.W.G. Tatchell, A.R. *Practical Organic Chemistry*, 5th Ed. Pearson, 2012.
 - Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education, 2009.
-

End Semester Examination (ESE)

Question pattern of 60 marks paper (Theory)

Serial No.	Questions to be answered	Out of	Marks for each Question	Total Marks
1	5	8	2	$5 \times 2 = 10$
2	6	9	5	$6 \times 5 = 30$
3	2	3	10	$2 \times 10 = 20$