Core Course: Single major

COURSE DETAILS:

Course Title	**Inorganic Chemistry-I**
Semester	**Semester-1**
Course Code	**240/CHE/CC/101**
Course ID	**CC-A1**
Level of Course	**100-199**
Total Credits	**04 (Lecture: 03, Tutorial: 0, Practical: 01)**
Total Marks	**100**
Marks Distribution	**Theory External: 50** **Theory Internal: 25** **Practical External: 20** **Practical Internal: 05**

COURSE CURRICULUM DELIVERY WEEKLY DISTRIBUTION:

Total Hours per Week: 5	
Lectures (L) Hours per Week: 3	**Practical (P) Hours per Week: 2**

COURSE OBJECTIVES:

- Develop a fundamental understanding of periodic properties, chemical bonding theories and extraction methods of metals.
- Acquire skills in quantitative analysis through practical experiments in titrimetric analysis and acid-base titrations.
- Foster analytical thinking in understanding the relationship between electronic structure, chemical bonding, and physical properties of elements and compounds.
- Apply theoretical knowledge to practical scenarios such as metal extraction methods and chemical bonding predictions.
- Critically analyze experimental data and theoretical concepts to draw conclusions and solve problems in chemistry.

COURSE OUTCOMES:

- Students will be able to Explain and predict trends in atomic and ionic radii, ionization enthalpy, electron gain enthalpy, and electronegativity using various scales.
- Understand the principles of ionic bonding, metallic bonding, and weak forces.

- Apply valence bond theory and VSEPR theory to predict shapes and hybridization in simple inorganic molecules and ions.
- Analyze and compare different methods of metal extraction including Ellingham diagrams, electrolytic reduction, and hydrometallurgy.
- Perform and interpret results from titrimetric experiments including acid-base titrations and quantitative analysis of solutions.

DETAILED CONTENT OF COURSE:

Theory Syllabus: Total Contact Hours: 45

Unit	Topics	Contact Hours
I	**Periodic Properties** Quantum numbers, Aufbau and Pauli exclusion principles, Hund's rules of maximum multiplicity. Periodic classification of elements into s, p d & f block elements and electronic configuration, screening effect, effective nuclear charge and Slater's rules, discussion and trends of the following properties of representative elements (s & p block): atomic and ionic radii, ionization enthalpy, electron gain enthalpy and electronegativity (Pauling's/ Mulliken's/ Allred Rachow's scale).	**12**
II	**Chemical Bonding-I** Ionic Bonding: Lattice energy, Born-Haber cycle, solvation energy, and ionic radii; Metallic Bonding: Band theory, conductors, semiconductors, and insulators; Weak forces: Van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, instantaneous dipole-induced dipole interactions, hydrogen bonding.	**11**
III	**Chemical Bonding-II** Covalent Bonding: Valence bond theory (Heitler-London approach) and its limitation, directional characteristics of covalent bond, type of hybridization and shapes of simple inorganic molecules and ions (BeF_2, BF_3, CH_4, PF_5, SF_6, IF_7, SO_4^{-2}, ClO_4^{-1}, NO_3^{-1}) valence shell electron pair repulsion (VSEPR) theory to NH_3, H_3O^+, SF_4, ClF_3, H_2O, $SnCl_2$, ClO_3^{-1} and ICl_2^{-1}.	**11**
IV	**Extractions of Metals** General modes of occurrence of metals. Ellingham diagrams for the reduction of metal oxides using carbon and carbon monoxide as reducing agents. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.	**11**
V	**Practical**	**30**

	1. **Titrimetric Analysis:** (i) Calibration and use of apparatus (ii) Preparation of solutions of different Molarity/Normality. 2. **Acid-Base Titrations**: Principles of acid-base titrations to be discussed. (i) Estimation of oxalic acid using standardized NaOH solution (ii) Estimation of sodium carbonate using standardized HCl. (iii) Estimation of carbonate and hydroxide present together in a mixture. (iv) Estimation of carbonate and bicarbonate present together in a mixture.	

COURSE EVALUATION METHODS

Theory Exams: Total Marks: 75 (External: 50 + Internal: 25)

Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
External Assessment: 50 Marks (03 Hours)	• End Term Exam: 50 Marks

Practical Exam: Total Marks: 25 (External: 20 + Internal: 05)

Internal Assessment: 05 Marks	• Class Participation: 05 Marks
External Assessment: 20 Marks (03 Hours)	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Instruction for End-Term Theory Exam:

The Examiner is requested to set nine questions in total, selecting two questions from each section. Question-1 will be a compulsory question consisting short answer type questions covering all the units of the syllabus. All questions should carry equal marks. Log table and non-programmable calculator is allowed.

SUGGESTED BOOKS

1. "Concise Inorganic Chemistry" by J.D. Lee, Sudarshan Guha (Indian Adaptation)
2. "Inorganic Chemistry" by Puri, Sharma, and Kalia

3. "Principles of Inorganic Chemistry" by B.R. Puri, L.R. Sharma, and K.C. Kalia
4. "Extractive Metallurgy" by T. Rosenqvist, Terkel Rosenqvist (Indian Edition)
5. "Quantitative Chemical Analysis" by Daniel C. Harris
6. "Vogel's Textbook of Quantitative Chemical Analysis" by J. Mendham, R.C. Denney, J.D. Barnes, and M. Thomas
7. "Fundamentals of Analytical Chemistry" by Douglas A. Skoog, Donald M. West, F. James Holler, and Stanley R. Crouch
8. "Quantitative Inorganic Analysis" by A. I. Vogel



COURSE DETAILS:

Course Title	**Organic Chemistry-I**
Semester	**Semester-1**
Course Code	**240/CHE/CC/102**
Course ID	**CC-A2**
Level of Course	**100-199**
Total Credits	**04 (Lecture: 03, Tutorial: 0, Practical: 01)**
Total Marks	**100**
Marks Distribution	**Theory External: 50** **Theory Internal: 25** **Practical External: 20** **Practical Internal: 05**

COURSE CURRICULUM DELIVERY WEEKLY DISTRIBUTION:

Total Hours per Week: 5	
Lectures (L) Hours per Week: 3	**Practicals (P) Hours per Week: 2**

COURSE OBJECTIVES:

- Fundamental understanding of basic concepts in organic chemistry.
- Equip students with detailed knowledge of organic reaction mechanisms.
- Develop a comprehensive understanding of 2D and 3D structure of compounds including isomerism, conformational and configurations analysis,
- Enhance laboratory skills through practical experiments.

COURSE OUTCOMES:

- Students will be able to classify and name organic compounds, understand hybridization and electronic displacements, and apply these concepts to predict bond properties and reactivity.
- Capable of analysing and explaining organic reaction mechanisms, identifying reaction intermediates, and assessing the relative stability of these intermediates.
- Demonstrate proficiency in identifying and distinguishing between different types of isomerism, understanding chiral and achiral molecules, and applying CIP rules for configuration.
- Gain a thorough understanding of the properties, preparation methods, and reactivity patterns of alkanes, alkenes, and alkynes, including detailed mechanisms of key reactions.

- Students will develop practical skills in organic chemistry laboratory techniques, including purification, melting and boiling point determination, distillation, sublimation, and organic synthesis.

DETAILED CONTENT OF COURSE:

Theory Syllabus: Total Contact Hours: 45

Unit	Topics	Contact Hours
I	**Basic Concepts in Organic Chemistry** Classification, and Nomenclature of organic compounds, Hybridization: Shapes of molecules, influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their comparison & applications. Mechanism of Organic Reactions: Curly arrow rules, formal charges, Electrophiles and Nucleophiles, Homolytic and Heterolytic fission with suitable examples. Reaction intermediates: Carbocations, Carbanions, Free radicals, Carbenes, arynes and nitrenes (Types, shape, structure, Mechanistic study and relative stability) Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values.	**11**
II	**Stereochemistry and Conformational Analysis** Isomerism: Types of isomerism, Optical isomerism: elements of symmetry, Optical Activity, Specific Rotation, Molecular chirality/asymmetry, Enantiomers, chiral and achiral molecules with two stereogeniccentres, Diastereoisomers, Meso compounds, Racemic mixture and resolution. Relative and absolute configuration: CIP rules, D/L and R/S designations. Geometric isomerism: Configuration of geometric isomers. Cis-Trans and E & Z nomenclature, Conformational isomerism: Conformational analysis of ethane and n-butane; chair, boat, half chair and twist boat conformations of cyclohexane (interconversions and energy level diagram). Interconversions of Newman projection and Sawhorse formulae, Wedge Formula and Fischer representations (Erythrose, Threose and Tartaric acid), Difference between configuration and conformation.	**12**
III	**Hydrocarbons (Alkanes and Alkenes-1)** **Alkanes**: Physical (Boiling point, melting point, solubility) and chemical properties (Combustion, cracking, and reforming) of alkanes, general methods of preparation: Wurtz reaction, Kolbe reaction, Corey-House	**11**

	reaction and decarboxylation of carboxylic acids, Reactivity and Mechanisms: Free radical substitutions, halogenation: relative reactivity and selectivity. **Alkenes**: Structure and isomerism, physical (Boiling point, melting point, solubility) and chemical properties (Stability, reactivity).	
IV	**Hydrocarbons (Alkenes-1I and Alkynes)** **Alkenes**: Formation, Mechanism of elimination reactions (E1, E2, E1cb), Saytzeff and Hoffmann elimination, Reactions of alkenes: Electrophilic additions their mechanisms (Markownikov/ Anti Markownikov addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). **Alkynes**: General methods of preparation, reactions of alkynes: acidity, electrophilic and nucleophilic additions, hydration to form carbonyl compounds, alkylation of terminal alkynes.	**11**
V	**Practical** 1. Calibration of a 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 prepared organic compounds (Kjeldahl method and electrically heated melting point apparatus). 4. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method). 5. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds. 6. Simple Distillation of Organic Mixtures. 7. Fractional Distillation of Alcohols 8. To study the process of sublimation of camphor and phthalic acid. 9. Organic Preparation: a. Bromination of acetanilide/aniline/phenol, b. Nitration of nitrobenzene/toluene	**30**

COURSE EVALUATION METHODS

Theory Exams: Total Marks: 75 (External: 50 + Internal: 25)

Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks

	• Mid Term Exam: 15 Marks
External Assessment: 50 Marks (03 Hours)	• End Term Exam: 50 Marks

Practical Exam: Total Marks: 25 (External: 20 + Internal: 05)

Internal Assessment: 05 Marks	• Class Participation: 05 Marks
External Assessment: 20 Marks (03 Hours)	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Instruction for End Term Theory Exam:

The Examiner is requested to set nine questions in total, selecting two questions from each section. Question-1 will be a compulsory question consisting short answer type questions covering all the units of the syllabus. All questions should carry equal marks. Log table and non-programmable calculator is allowed.

SUGGESTED BOOKS

1. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. J. E. McMurry, Fundamentals of Organic Chemistry, 7thEdition, Cengage Learning India, 2013.
3. R. N. Boyd, R. T. Morrison and S. K. Bhattcharjee, Organic Chemistry, 7thEdition, Pearson, 2014.
4. P. S. Kalsi, Stereochemistry Conformation and Mechanism, New Age International, 2005.
5. J. Singh, L.D.S. Yadav, Organic Chemistry (Volume I), 14th Edition, Pragati Prakashan, 2019.
6. E. L. Eliel & S. H. Wilen, Stereochemistry of Organic Compounds, Wiley: London, 1994.
7. S. M. Mukerji, S. P. Singh, K.P.Kapoor and R. Das, Organic Chemistry (Volume I), 2nd Edition, New Age International Publishers, 2010.
8. S. M. Mukerji, S. P. Singh, K.P. Kapoor and R. Das, Organic Chemistry (Volume II), 2nd Edition, New Age International Publishers, 2012.
9. B.S. Furniss ; A. J. Hannaford ; P.W.G. Smith ; A. R. Tatchell, Practical Organic Chemistry, 5th Edition., Pearson, 2012.
10. F.G. Mann & B.C. Saunders, Practical Organic Chemistry, Pearson, 2009.
11. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R.(2012),Vogel's textbook of Practical Organic Chemistry, Pearson.

Course Title	**Physical Chemistry-I**
Semester	**Semester-I**
Course Code	**260/CHE/CC/103**
Course ID	**CC-A3**
Level of Course	**100-199**
Total Credits	**04 (Lecture: 03, Tutorial: 0, Practical: 01)**
Total Marks	**100**
Marks Distribution	**Theory External: 50** **Theory Internal: 25** **Practical External: 20** **Practical Internal: 05**

COURSE CURRICULUM DELIVERY WEEKLY DISTRIBUTION:

Total Hours per Week: 4	
Lectures (L) Hours per Week: 3	**Practical (P) Hours per Week: 2**

COURSE OBJECTIVES

- To develop a fundamental understanding of the rates of chemical reactions, including rate laws, order, and half-life of reactions.
- To introduce the foundational theories of reaction rates and their role in explaining reaction mechanisms.
- To develop mathematical skills for determining the order and rate constants of chemical reactions.
- To provide comprehensive knowledge of electrolytic conductance and the theories governing ionic conduction.
- To develop experimental and analytical skills in conductivity measurements, including the application of Kohlrausch's Law and determination of degree of dissociation.

COURSE OUTCOMES

- Apply concepts of reaction rates to derive rate laws, determine order of reactions, and evaluate half-life for different reaction systems.
- Explain and critically analyze theories of reaction rates in the context of reaction mechanisms.
- Solve numerical problems to determine order and rate constants using appropriate mathematical methods.
- Analyze electrolytic conductance and explain ionic mobility using theories such as Arrhenius theory and Ostwald's dilution law.

- Perform conductivity measurements and apply Kohlrausch's Law to determine degree of dissociation and related parameters (e.g., pK_a).

DETAILED CONTENT OF COURSE:

Theory Syllabus: Total Contact Hours: 45

Unit	Topics	Contact Hours
I	**Chemical Kinetics-I** Rate of reaction, rate equation, factors influencing the rate of a reaction – concentration, temperature, pressure, solvent, light, catalyst. Order of a reaction, integrated rate expression for zero order, first order, second and third order reaction. Difference between molecularity and order of reaction. Half-life period of reaction. Methods of determination of order of reaction (Graphical, half-life period, Vant Hoff method, integrated rate expression method).	11
II	**Chemical Kinetics-II** Effect of temperature on the rate of reaction – Arrhenius equation, Theories of reaction rate Simple collision theory for unimolecular and bimolecular collision. Transition state theory of Bimolecular reactions. Steady state approximation. Comparison between collision theory and Arrhenius theory. Comparative study of Activated complex theory and collision theory. Theory for unimolecular reactions (Lindemann Hypothesis).	12
III	**Electrochemistry-I** Electrolytic conduction, factors affecting electrolytic conduction, specific, conductance, molar conductance, equivalent conductance and relation among them, their variation with concentration Arrhenius theory of ionization, Ostwald's Dilution Law, Debye- Huckel Onsager's equation for strong electrolytes. Transport number, definition and determination by Hittorf's method.	11
IV	**Electrochemistry-II** Kohlrausch's Law, calculation of molar ionic conductance and effect of viscosity, temperature & pressure on it, Application of Kohlrausch's Law in calculation of conductance of weak electrolytes at infinite dilution, Applications of conductivity measurements: determination of degree of dissociation, determination of Ka of acids, determination of solubility product of sparingly soluble salts, conductometric titrations, Definition of pH and pKa. Buffer solution. Buffer action. Henderson – Hazel equation. Buffer mechanism of buffer action.	11

V	**Practical** 1. Determination of surface tension of a liquid using the drop number method. 2. Determination of surface tension of a liquid using the drop weight method. 3. Determination of surface tension of different mixtures and solutions. 4. Study of the effect of temperature on the surface tension of a liquid. 5. Determination of the viscosity of a liquid using Ostwald's viscometer. 6. Determination of the viscosity of a liquid using a falling sphere viscometer. 7. Study of the effect of temperature on the viscosity of a liquid. 8. Study of the effect of concentration on the viscosity of a solution. 9. Determination of the viscosity of polymer solutions.	**30**

COURSE EVALUATION METHODS

Theory Exams:

Total Marks: 75 (External: 50 + Internal: 25)

Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks

Practical Exam:

Total Marks: 25 (External: 20 + Internal: 05)

Internal Assessment: 05 Marks	• Class Participation: 05 Marks
External Assessment: 20 Marks (03 Hours)	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Instructions for End Term Theory Exam:

The Examiner is requested to set nine questions in total, selecting two questions from each section. Question-1 will be a compulsory question consisting short answer type questions covering all the units of the syllabus. All questions should carry equal marks. Log table and non-programmable calculator is allowed.

SUGGESTED BOOKS

Theory

1. Atkins, P., & de Paula, J. (2018). *Physical chemistry* (11th ed.). Oxford University Press.
2. Levine, I. N. (2014). *Physical chemistry* (6th ed.). McGraw-Hill Education.
3. Laidler, K. J. (1987). *Chemical kinetics* (3rd ed.). Harper & Row.
4. Frost, A. A., & Pearson, R. G. (1961). *Kinetics and mechanism* (2nd ed.). Wiley.
5. Puri, B. R., Sharma, L. R., & Pathania, M. S. (2017). *Principles of physical chemistry* (47th ed.). Vishal Publishing Co.
6. Glasstone, S. (1946). *An introduction to electrochemistry*. D. Van Nostrand Company.
7. Bard, A. J., & Faulkner, L. R. (2001). *Electrochemical methods: Fundamentals and applications* (2nd ed.). Wiley.
8. Bahl, B. S., Tuli, G. D., & Bahl, A. (2016). *Essentials of physical chemistry*. S. Chand Publishing.

Practical

1. Kumari, R., & Anand, A. (2018). *Physical chemistry laboratory manual: An interdisciplinary approach*. I.K. International Publishing House.
2. Vogel, A. I., Jeffery, G. H., Bassett, J., Mendham, J., & Denney, R. C. (1989). *Vogel's textbook of quantitative chemical analysis* (5th ed.). Longman.
3. Yadav, J. B. (2013). *Advanced practical physical chemistry*. Krishna Prakashan Media.
4. Rao, C. N. R., & Agarwala, U. C. (1988). *Experiments in physical chemistry*. Wiley Eastern.
5. Gupta, S. V. (2014). *Viscometry for liquids: Calibration of viscometers*. Springer.
6. Bartell, F. E. (1944). *Laboratory manual of colloid and surface chemistry* (2nd ed.). Edwards Brothers.

Syllabus

2nd Semester

B.Sc. with major in Chemistry

Bachelor of Science with Major in Chemistry
Core Course
(To be effective from Session 2026-27)

COURSE DETAILS:

Course Title	**Inorganic Chemistry-II**	
Semester	**Semester-2**	
Course Code	260/CHE/CC/201	
Course ID	**CC-A4**	
Level of Course	**100-199**	
Total Credits	**04 (Lecture: 03, Tutorial: 0, Practical: 01)**	
Total Marks	**100**	
Marks Distribution	**Theory External: 50**	**Theory Internal: 25**
	Practical External: 20	**Practical Internal: 05**

COURSE CURRICULUM DELIVERY WEEKLY DISTRIBUTION:

Total Hours per Week: 5	
Lectures (L) Hours per Week: 3	**Practical (P) Hours per Week: 2**

COURSE OBJECTIVES:

- Develop a comprehensive understanding of advanced topics in chemical bonding .
- To study different properties of s block elements and noble gases.
- To explore the chemistry of boron and carbon families, including their structures, properties, and reactivity.
- To understand the electronic configuration, periodic properties, and oxides/oxyacids of nitrogen family elements.
- To study the oxoacids and properties of oxygen and halogen families.
- Foster critical thinking skills to evaluate and apply chemical principles in various contexts such as inorganic synthesis, analysis, and materials science.
- Communicate scientific concepts effectively through written reports and oral presentations based on experimental findings and theoretical knowledge.

COURSE OUTCOMES:

- Students will be able to apply molecular orbital theory to predict bond order, bond length, and bond energy in homonuclear and heteronuclear diatomic molecules.
- Analyze multiple bonding (σ and π bond approach), covalent character in ionic compounds, and the consequences of polarization using Fajan's rules.
- Understand the inert pair effect, diagonal relationship, and complex formation tendencies of s-

block elements. Describe the structure, bonding, and synthesis of fluorides, oxides, and oxyfluorides of noble gases

- Explain the chemistry of the boron family, including diborane's electron-deficient bonding, borazine's structure, and Lewis acidity of boron trihalides.
- Describe the catenation, allotropes of carbon (diamond, graphite, fullerenes), and the structure of silicates and silicones.
- Compare the structure and acidic strength of oxides and oxyacids of nitrogen and phosphorus and explain allotropes of phosphorus.
- Explain the structure and properties of oxoacids, hydrogen peroxides and interhalogen compounds.

DETAILED CONTENT OF COURSE:

Theory Syllabus: Total Contact Hours: 45

Unit	Topics	Contact Hours
I	**Chemical Bonding-III** Molecular orbital theory of homonuclear and heteronuclear diatomic molecules (N_2, O_2, C_2, CO, and NO), bond order, bond length and bond energy. Multiple bonding (σ and π bond approach) and bond lengths, Covalent character in ionic compounds, polarizing power and polarizability, Fajan's rules and consequences of polarization.	10
II	**Chemistry of s-block elements and Noble gases** Comparative study, Diagonal relationship and anomalous behaviour of the first member of each group. Solvation and Complex formation tendency of s-block elements, crown ethers and cryptates. Silent features of hydrides. Occurrence, inertness and use of noble gases, structure, bonding, synthesis and properties of fluorides, oxides and oxyfluorides of Xe.	11
III	**Chemistry of Boron family** Brief comparative study of group 13 to 17, Boron family (13th group): Electronic configuration, periodic properties, inert pair effect and diagonal relationship. Diborane: Preparation, properties and structure (as an example of electron-deficient compound and multicenter bonding), Borazine chemical properties and structure, relative strength of trihalide of Boron as Lewis acids, the structure of aluminium (III) chloride. **Chemistry of Carbon family** Electronic configuration and periodic properties, Catenation and allotropes of carbon (diamond, graphite and fullerenes), Carbides, structural aspects of fluorocarbons, silicates and silicones, preparation, properties and uses.	12

IV	**Chemistry of Nitrogen family** Electronic configuration and periodic properties, allotropes of phosphorus (white, red and black P), Oxides: Structure of oxides of nitrogen and phosphorus, Oxyacids: Structure and relative acidic strength of oxy acids of nitrogen and phosphorus. **Chemistry of oxygen family and halogens** Oxygen family (16th group): Oxy acids of sulphur — structure and acidic strength. Hydrogen Peroxide properties and uses. Halogen family (17th group): Interhalogen compounds (their properties and structures), Hydra and oxy acids of chlorine — structure and comparison of acid strength, cationic nature of Iodine.	12
V	**Practical** **Redox Titrations**: (i) To determine the percentage purity of the given sample of Mohr's salt, 22 gm of which are dissolved per liter of the given solution. Provided N/20 Potassium permanganate solution. (ii) To determine the percentage of the Ferrous ions in a given sample of Mohr's salt, 20 gm of which are dissolved per litre of the given solution. Provided N/20 Potassium permanganate solution. (iii) To determine the number of molecules of water of crystallization in the given sample of Oxalic Acid. Provided N/20 Potassium permanganate solution. (iv) To determine the percentage of Fe (II) ions in the given sample of Mohr's salt by titrating it with $K_2Cr_2O_7$ using (diphenylamine/ *N*-phenyl anthranilic acid) as indicator. (v) To determine the value of x in the given sample of Mohr's salt, 19.5 gm of which have been dissolved per litre of the water, by titrating it with N/20 $K_2Cr_2O_7$ 2. Paper Chromatography of following metal ions (i) Cu (II) and Cd (II) metal ions (ii) Ni (II) and Co (II) metal ions	30

COURSE EVALUATION METHODS

Theory Exams:

Total Marks: 75 (External: 50 + Internal: 25)

Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks

External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks

Practical Exam:

Total Marks: 25 (External: 20 + Internal: 05)

Internal Assessment: 05 Marks	• Class Participation: 05 Marks
External Assessment: 20 Marks (03 Hours)	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Instructions for End Term Theory Exam:

The Examiner is requested to set nine questions in total, selecting two questions from each section. Question-1 will be a compulsory question consisting short answer type questions covering all the units of the syllabus. All questions should carry equal marks.

SUGGESTED BOOKS:

- Kumar, A.; (2021), **Chemistry of the Main Group Elements**, Aaryush Education.
- Patania, V.B.; (2007), **Periodic Classification of Elements**, Campus Books International.
- Johnson, W.R.; (2007), **Atomic Structure Theory**, Springer.
- Kumar, A.; Rathore, V.S.; Chauhan, S.; (2024), **Atomic Structure & Bonding**, S. Dinesh & Co.
- Greenwood, N.N.; Earnshaw, A.; (1997), **Chemistry of the Elements**, Elsevier.
- Sharma, R.K.; (2007), **Chemistry of Chemical Bonding**, Discovery Publishing House.
- Kumar, J.; Sethi, S.; Shewate, V.T.; Mohan, V.; (2025), **Inorganic Chemistry: Structure, Bonding and Applications**, A.G. Publishing house.
- Huheey, J.E.; Keiter, E.A.; Keiter, R.L.; Medhi, O.K.; (2022) **Inorganic Chemistry: Principles of Structure and Reactivity**, Pearson Education.

240/CHE/CC202

COURSE DETAILS

Course Title	**Organic Chemistry-II**	
Semester	**Semester-2**	
Course Code	**CC-A5**	
Course ID		
Total Credits	**04 (Lecture: 03, Tutorial: 0, Practical: 01)**	
Total Marks	**100**	
Marks Distribution	**Theory External: 50** **Practical External: 20**	**Theory Internal: 25** **Practical Internal: 05**

COURSE CURRICULUM DELIVERY WEEKLY DISTRIBUTION:

Total Hours per Week: 5	
Lectures (L) Hours per Week: 3	**Practicals (P) Hours per Week: 2**

COURSE OBJECTIVES:

- Develop a deep understanding of the fundamental concepts in organic chemistry.
- Gain proficiency in explaining reaction mechanisms.
- Acquire practical knowledge of synthetic methods for various organic compounds including preparation techniques and reactions.
- Understand the factors influencing reactivity and selectivity in organic reactions.
- Apply acquired knowledge to solve problems related to synthesis, reactivity, and mechanisms of organic compounds in a variety of contexts.

COURSE OUTCOMES:

- Students will be able to define aromaticity, Huckel's rule, and apply them to predict aromatic character in various compounds.
- Explain the concept of electrophilic aromatic substitution and predict reaction outcomes.
- Analyze and differentiate between mechanisms of nucleophilic substitution reactions and various rearrangement reactions.
- Perform and explain synthetic transformations using appropriate methods.
- Evaluate and predict the reactivity and selectivity of organic compounds based on structural features and electronic effects.
- Apply knowledge of organic chemistry principles to propose synthetic routes, predict reaction outcomes, and solve problems related to organic synthesis and reactivity.

DETAILED CONTENT OF COURSE:

Theory Syllabus: Total Contact Hours: 45

Unit	Topics	Contact Hours
I	**Aromatic Hydrocarbons** Concept of Aromaticity, Huckel's rule, aromatic character of arenes, anti-aromatic and non-aromatic compounds, cyclic carbocations and carbanions with suitable examples and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation, Friedel Crafts alkylation/ acylation with their mechanism. Directing effects of groups in electrophilic substitution.	11
II	**Chemistry of Halogenated Hydrocarbons** **Alkyl halides**: Methods of preparation and properties, nucleophilic substitution reactions-SN^1, SN^2 and SN^i mechanisms with stereochemical aspects, effect of solvent and energy profile diagrams, nucleophilic substitution *vs.* elimination. **Aryl halides**: Preparation (including preparation from diazonium salts) and properties, nucleophilic aromatic substitution; SNAr, Benzyne mechanism. Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.	11
III	**Alcohol, Phenol, Ether and Epoxides** **Alcohols:** preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Hydrogen bonding, Acidic nature, Bouveault-Blanc Reduction, Oxidation of diols by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement. **Phenols:** Preparation and properties; Acidity and affecting factors, Ring substitution reactions, Reimer-Tiemann and Kolbe's-Schmidt Reactions, Fries and Claisen rearrangements and their mechanism. **Ethers and Epoxides**: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia and $LiAlH_4$.	11
IV	**Carbonyl Compounds** Structure, reactivity, preparation and properties; 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, $LiAlH_4$, $NaBH_4$, MPV, PDC). Addition reactions of α, β-unsaturated carbonyl compounds: Michael addition **Enolates** Keto-enol tautomerism of active methylene compounds, Acidity of α-hydrogens, Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.	12

V	**Practical**	**30**
	1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements). 2. Systematic qualitative analysis of organic compounds possessing monofunctional groups (Alcohols, Phenols, Carbonyl, -COOH). (Including Derivative Preparation). 3. Organic Preparations: • Acetylation of one of the following amines (aniline, o-, m-, p-toluidines and o-, m-, p-anisidine) and one of the following phenols (β -naphthol, vanillin, salicylic acid) • Benzolyation of one of the following amines (aniline, o-, m-, p-toluidines and o-, m-, p-anisidine) and one of the following phenols (β-naphthol, resorcinol, *p*-cresol) by Schotten-Baumann reaction. • Oxidation of ethanol/ isopropanol (Iodoform reaction). • *p*-Bromoacetanilide from acetanilide • Oxime and Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone. • Dibenzalacetone from acetone and benzaldehyde. • 2,4-DNP derivative of Benzophenone/Acetophenone. The above derivatives should be prepared using 0.5-1 g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.	

COURSE EVALUATION METHODS

Theory Exams: Total Marks: 75 (External: 50 + Internal: 25)

Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks

Practical Exam: Total Marks: 25 (External: 20 + Internal: 05)

Internal Assessment: 05 Marks	• Class Participation: 05 Marks
External Assessment: 20 Marks (02 Hours)	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Instruction for End Term Theory Exam:

The Examiner is requested to set nine questions in total, selecting two questions from each section.

Question-1 will be a compulsory question consisting short answer type questions covering all the units of the syllabus. All questions should carry equal marks. Log table and non-programmable calculator is allowed.

SUGGESTED BOOKS

1. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
3. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005), Intermediate for Organic Synthesis, I.K.International.
5. Solomons, T. W. G.; Fryhle, C. B. ; Snyder, S. A. (2016),Organic Chemistry, 12th Edition, Wiley.
6. Chandra, R.; Singh, S.; Singh, A. (2019), Organic reactions and their nomenclature, Arcler Press.
7. Mann, F. G.; Saunders, B. C. (2009), Practical Organic Chemistry, Pearson Education.
8. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012),Vogel's Textbook of Practical Organic Chemistry, Pearson.
9. Ahluwalia, V.K.; Aggarwal, R.(2004), Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press.

Bachelor of Science with Major Chemistry
Core Course
To be Effective from Session 2026-27

Course Title	**Physical Chemistry-II**
Semester	**Semester-II**
Course Code	260/CHE/CC/203
Course ID	**CC-A6**
Level of Course	
Total Credits	**04 (Lecture: 03, Tutorial: 0, Practical: 01)**
Total Marks	**100**
Marks Distribution	**Theory External: 50** **Theory Internal: 25** **Practical External: 20** **Practical Internal: 05**

COURSE CURRICULUM DELIVERY WEEKLY DISTRIBUTION:

Total Hours per Week: 4	
Lectures (L) Hours per Week: 3	**Practical (P) Hours per Week: 2**

COURSE OBJECTIVES:

- To develop a fundamental understanding of the behavior of gases, including gas laws, kinetic theory, and deviations from ideal behavior.
- To explain molecular motion and statistical distribution in gases and relate them to macroscopic properties such as viscosity and collision phenomena.
- To introduce the structural and physical properties of liquids and liquid crystals along with their measurement techniques.
- To impart knowledge of solid-state chemistry, crystallography, and methods for determination of crystal structures.
- To develop analytical and experimental skills using pH-metric and conductometric techniques for quantitative chemical analysis.

COURSE OUTCOMES

- Apply gas laws, kinetic theory, and equations of state to analyze and predict the behavior of ideal and real gaseous systems.
- Analyze molecular motion and statistical distribution in gases and correlate them with macroscopic properties such as viscosity, diffusion, and collision phenomena.
- Evaluate the physical properties of liquids and explain the structure, classification, and applications of liquid crystals using appropriate measurement techniques.
- Interpret crystal structures and explain solid-state properties using crystallographic principles and X-ray diffraction methods.
- Perform quantitative chemical analysis using pH-metric and conductometric techniques to determine dissociation constants (pKa) and composition of mixtures.

DETAILED CONTENT OF COURSE:

Theory Syllabus: Total Contact Hours: 45

Unit	Topics	Contact Hours
I	**Gaseous State-I** Elementary treatment of gas laws, Real and ideal gases, Boyle's temperature, gas constant R and its numerical values critical constants and their determination, Kinetic gas equation and its derivation, cause of deviation of gases from ideal behaviour, Vander waal's equation and its deviation under different PV isotherms of real gases, isotherms of carbon dioxide, continuity of states, Relationship between critical constants and vander waal's constants, law of corresponding states, Reduced equation of state, Law of corresponding states, liquification of gases (based on Joule- Thomson effect), Degree of freedom of motion and principle of equipartition of energy.	11
II	**Gaseous State-II:** Kinetic Molecular theory of gases, Maxwell's distribution law of velocities and energies, Root mean square velocity, average velocity and most probable velocity and their relationship, Mean free path and its derivation, Collision diameter, Collision number and collision frequency, viscosity of gases. Relationship between mean free path and coefficient of viscosity, calculation of molecular diameter from coefficient of viscosity.	12
III	**Liquid State and liquid Crystals:** Structure of liquids, Properties of liquids-surface tension, refractive index, viscosity, vapour pressure and optical rotation and their measurement. Liquid crystals: Difference between solids, liquids and liquid crystals, types of liquid crystals, Applications of liquid crystals.	11
IV	**Solid State:** Crystalline and amorphous solids, Type of unit cells, Laws of crystallography law of constancy of interfacial angels, law of rational indices, law of symmetry, Symmetry of elements in crystals, Seven crystal system, Bravais Lattice Bragg's equation and its derivation, X-ray diffraction of crystals. Determination of crystal structure of NaCl, KCl, CsCl.	11

V	**Practical** 1. pH metric titration of strong acid vs. strong base. 2. pH metric titration of weak acid vs. weak base. 3. pH metric titration of weak acid vs. strong base. 4. pH metric titration of a mixture of acids vs. base. 5. Determination of pKa of weak acids using pH metric titration. 6. Conductometric titration of strong acid vs. strong base. 7. Conductometric titration of weak acid vs. weak base. 8. Conductometric titration of weak acid vs. strong base. 9. Conductometric titration of mixture of acids vs. base. 10. Conductometric titration of a salt solution with silver nitrate.	**30**

COURSE EVALUATION METHODS

Theory Exams:

Total Marks: 75 (External: 50 + Internal: 25)

Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks

Practical Exam:

Total Marks: 25 (External: 20 + Internal: 05)

Internal Assessment: 05 Marks	• Class Participation: 05 Marks
External Assessment: 20 Marks (03 Hours)	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Instructions for End Term Theory Exam:

The Examiner is requested to set nine questions in total, selecting two questions from each section. Question-1 will be a compulsory question consisting short answer type questions covering all the units of the syllabus. All questions should carry equal marks. Log table and non-programmable calculator is allowed.

Recommended Textbooks:

Theory:

1. Atkins, P., & de Paula, J. (2018). *Physical chemistry* (11th ed.). Oxford University Press.
2. Pauling, L. (1988). *General chemistry* (3rd ed.). Dover Publications.
3. Puri, B. R., Sharma, L. R., & Pathania, M. S. (2017). *Principles of physical chemistry* (47th ed.). Vishal Publishing Co.
4. Levine, I. N. (2014). *Physical chemistry* (6th ed.). McGraw-Hill Education.
5. Bahl, B. S., Tuli, G. D., & Bahl, A. (2016). *Essentials of physical chemistry* (S. Chand ed.). S. Chand Publishing.
6. Rajaram, J., & Kuriacose, J. C. (2014). *Modern physical chemistry*. S. Chand Publishing.

Practical:

1. Yadav, J. B. (2013). *Advanced practical physical chemistry*. Krishna Prakashan Media.
2. Rao, C. N. R., & Agarwala, U. C. (1988). *Experiments in physical chemistry*. Wiley Eastern.
3. Jeffery, G. H., Bassett, J., Mendham, J., & Denney, R. C. (1989). *Vogel's textbook of quantitative chemical analysis* (5th ed.). Longman.