Indrashil University

Department of Chemistry
School of Science

B.Sc. 2024-2028
Sem III-IV

Chemistry

Course Profile

Academic Year 2025-2026

B.Sc. Chemistry Semester III Course Structure

Course Code	Course Name	Course Type	L-T-P	Credits
CH2 101	Organic Chemistry-III: Chemistry of Carbonyls and Derivatives	Major Discipline Core (**MDC**)	2-0-0	2
CH2 102	Inorganic Chemistry-II: Chemical Bonding and Molecular Structure		2-0-0	2
CH2 103	Physical Chemistry-II: Thermodynamics and Phase Rules		2-0-0	2
CH2 104	Organic Chemistry-III Laboratory		0-0-4	2
CH2 105	Inorganic Chemistry - II Laboratory		0-0-4	2
CH2 106	Physical Chemistry – II Laboratory		0-0-4	2
		Minor Discipline Elective (**MDE**)		
CH2 107	Semiconductor Devices	Multi-Disciplinary (**MDS**)	2-0-0	2
CH2 108	Semiconductor Devices Laboratory		0-0-4	2
CH2 109	Soft Skills	Ability Enhancement Course (**AEC**)	2-0-0	2
CH2 110	Laboratory Operations and Safety Measures	Skill Enhancement Course (**SEC**)	2-0-0	2
CH2 111	Renewable Energy	Value Added Course (**VAC**)	2-0-0	2
Total			**14L+0T+ 16P = 30h**	**22**

B.Sc. Chemistry Semester IV Course Structure

Course Code	Course Name	Course Type	L-T-P	Credits
CH2 201	Organic Chemistry-IV: Chemistry of Enolates and Amines	Major Discipline Core (**MDC**)	2-0-0	2
CH2 202	Inorganic Chemistry-III: s and p-Block Elements		2-0-0	2
CH2 203	Physical Chemistry-III: Chemical and Ionic Equilibria		2-0-0	2
CH2 204	Organic Chemistry – IV Laboratory		0-0-4	2
CH2 205	Inorganic Chemistry - III Laboratory		0-0-4	2
CH2 206	Physical Chemistry – III Laboratory		0-0-4	2
CH2 207	Application of Semiconducting Materials	Minor Discipline Elective (**MDE**)	2-0-0	2
CH2 208	Semiconducting Materials Laboratory		0-0-4	2
		Multi-Disciplinary (**MDS**)		
CH2 209	Professional Communications	Ability Enhancement Course (**AEC**)	2-0-0	2
CH2 210	Software for Scientific Learning	Skill Enhancement Course (**SEC**)	2-0-0	2
CH2 211	Indian Culture and Civilization	Indian Knowledge System (**IKS**)	2-0-0	2
Total			**14L+0T+ 16P = 30**	**22**

B.Sc. Chemistry Semester III Detailed Syllabus with CLO

CH2 101: Organic Chemistry -III: Chemistry of Carbonyls and Derivatives (L-T-P-C: 2-0-0-2)

Program: B. Sc. Chemistry	**Semester:** III
Course code: CH2 101	**Course Name:** Organic Chemistry -III: Chemistry of Carbonyls and Derivatives

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
2 per week	-	2	30	Lecture	CCE, ESE	50	40

Course Description: This course deals with understanding the chemistry of carbonyl compounds and Carboxylic Acids, and their Derivatives. It covers preparation, physical and chemical properties, and reactivity of carbonyl compounds and carboxylic acid derivatives. This course also explains the reaction mechanism of related name reactions. We will learn the structure elucidation of polynuclear hydrocarbons.

Course Learning Outcomes: At the end of this course, students will be able to:

CLO1: Remember the related name reaction of alcohols and carbonyl compounds

CLO2: Understand the mechanism name reactions related to carbonyl compounds

CLO3: Apply the knowledge of key reactions such as nucleophilic addition (for aldehydes/ketones), and nucleophilic acyl substitution (for carboxylic acid derivatives)

CLO4: Compare the reactivity and interconversion of carboxylic acids, esters, acid chlorides, anhydrides, and amides.

Syllabus

Units	Content	Hours
Unit I: Chemistry of Carbonyl Compounds	**Chemistry of Carbonyl Compounds:** Structure, reactivity, preparation and properties; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Benzoin condensation, Knoevenagel condensation, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-β-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$) **Addition reactions of α, β-unsaturated carbonyl compounds:** Michael addition **Active methylene compounds:** Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.	**12**
Unit II: Carboxylic Acids and their Derivatives	**Carboxylic Acids:** Nomenclature and general properties of Carboxylic Acids**,** preparation and reactions of monocarboxylic acids, effect of substituents on acidic strength. Typical reactions of dicarboxylic acids, hydroxy acids, and unsaturated acids. **Carboxylic Acids Derivatives:** Preparation and reactions of acid chlorides, anhydrides, esters, and amides; Comparative study of nucleophilic substitution at acyl group - Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation, and Curtius rearrangement.	**12**

Unit III: Cycloalkane**s**	**Cycloalkanes:** nomenclature, Preparation and properties of cycloalkanes and their derivatives - Baeyer's strain theory and limitation, Conformations of Cycloalkanes and their reactivity	**06**

Reading References:

1. R. T. Morrison; R. N. Boyd; S. K. Bhattacharjee. *Organic Chemistry.* Pearson Education India, New Delhi. 2010, 7th Ed.
2. I. L. Finar. *Organic Chemistry (Volume 1).* Dorling Kindersley (India) Pvt. Ltd., Pearson Education, New Delhi. 1963, 4th Ed.
3. I. L. Finar. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products).* Dorling Kindersley (India) Pvt. Ltd., Pearson Education, New Delhi. 2002, 5th Ed.
4. R. M. Acheson. *Introduction to the Chemistry of Heterocyclic Compounds.* John Wiley & Sons, New York. 2008, 3rd Ed.
5. T. W. Graham Solomons; C. B. Fryhle; S. A. Snyder. *Organic Chemistry.* John Wiley & Sons, Inc., Hoboken. 2017, 12th Ed.
6. P. S. Kalsi. *Textbook of Organic Chemistry.* New Age International Publishers, New Delhi. 2000, 1st Ed.
7. J. Clayden; N. Greeves; S. Warren; P. Wothers. *Organic Chemistry.* Oxford University Press, Oxford. 2014, 2nd Ed.
8. J. Singh; S. M. Ali; J. Singh. *Natural Product Chemistry.* Pragati Prakashan, Meerut. 2010, 1st Ed.

CH2 102: Inorganic Chemistry-II: Chemical Bonding and Molecular Structure (L-T-P-C: 2-0-0-2)

Program: B. Sc. Chemistry	**Semester:** III
Course Code: CH2 102	**Course name:** Inorganic Chemistry-II: Chemical Bonding and Molecular Structure

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
2 per week	-	2	30	Lecture	CCE, ESE	50	40

Course Objective:

- Understanding different chemical bonding in a molecule.
- Explanation of polarity, deformation of ions, and the consequences of deformation.
- This course also delivers the idea about VSEPR theory and weak chemical forces, including H-bonding.

Course Learning Outcomes: At the end of this course, students will be able to

CLO1: Define different bonding patterns in a molecule.

CLO2: Predict the geometry of any molecule using VSEPR theory.

CLO3: Apply the concept of Fazan's rule, Born-Haber Cycle, Born-Lande equation.

CLO4: Analyze different weak intermolecular forces.

Syllabus

Units	Content	Hours
Unit I: Covalent interaction, VSEPR rule	Lewis structure, Resonance and resonance energy, Formal charge, 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, bond strength bond order and bond energy relations, effects of hydrogen bond, application, structure of ice, $CuSO_4.5H_2O$, Hybridization of orbitals, Valence Bond theory and its limitations, types of hybridization and shapes of inorganic molecules and ions, VSEPR theory to NH_3, H_3O^+, SF_4, ClF_3, ICl_2^-, and H_2O. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2.	**10**
Unit II: Ionic interaction	**Ionic Bond**: General characteristics of ionic compounds, melting point, boiling point, hardness, solubility, conductance, radius ratio rule, coordination number, limitation of radius-ratio rule, lattice energy, Born-Haber Cycle, Born-Lande equation for lattice energy, comparison between lattice energy and hydration energy, Born-Haber cycle, metallic bond, Ionic character in covalent compounds: Concept of dipole moment, comparison of DM of different molecules, Bond moment. Percentage ionic character from dipole moment and electronegativity difference. Metallic Bond.	**10**
Unit III: Non-bonding interaction	Van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, and Instantaneous dipole-induced dipole interactions. Factors determining Van der Waal's force, Repulsive forces, Hydrogen bonding: types, applications, Effects of chemical forces.	**10**

Reading References:

1. J. D. Lee. *Concise Inorganic Chemistry.* Blackwell Science, Oxford. 2008, 5th Ed.
2. R. P. Sarkar. *General and Inorganic Chemistry, Vol. I & II.* New Central Book Agency, Kolkata. 2012, 1st Ed.
3. F. A. Cotton; G. Wilkinson; Paul L. Gaus. *Basic Inorganic Chemistry.* Wiley, New York. 2007, 3rd Ed.
4. Dr. R. L. Madan. *Chemistry for Degree Students.* S. Chand and Company Ltd., New Delhi. 2010, 2nd Ed.

CH2 103: Physical Chemistry-II: Chemical Thermodynamics (L-T-P-C: 2-0-0-2)

Program: B. Sc. Chemistry	**Semester:** III
Course Code: CH2 103	**Course Name:** Physical Chemistry II: Thermodynamics and Phase Rules

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
2 per week	-	2	30	Lecture	CCE, ESE	50	40

Course Objectives:

- Develop a foundational understanding of thermodynamic systems, variables, and the laws governing energy, heat, and work transformations.
- Apply concepts of entropy, enthalpy, and free energy to evaluate the spontaneity and feasibility of chemical and physical processes, including phase transitions.
- Interpret and construct phase diagrams of single- and multi-component systems, using the phase rule and thermodynamic principles to predict equilibrium states.

Course Learning Outcomes: At the end of this course, students will be able to

CLO1: Recognize and use the thermodynamic parameters correctly.

CLO2: Understand the first, second, third, and zeroth laws of thermodynamics.

CLO3: Apply the knowledge of chemical thermodynamics to interpret the chemical reactions.

CLO4: Correlate thermodynamics to solve practical problems in physical and chemical systems.

Syllabus

Units	Content	Hours
Unit I: Laws of Thermodynamics	Intensive and extensive variables; state and path functions; isolated, closed, and open systems; zeroth law of thermodynamics. Cycles and processes (isobaric, isothermal, isochoric, and adiabatic, reversible, irreversible). **First law:** Concept of heat, work, internal energy, and statement of first law; enthalpy, *H*, the relation between heat capacities, calculations of *Q*, *W*, *U,* and *H* for reversible, irreversible, and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. **Second Law:** Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes. **Third Law:** Statement of the third law, concept of residual entropy, calculation of absolute entropy of molecules.	**10**
Unit II: Thermochemistry	**Thermochemistry:** Heats of reactions: standard states; enthalpy of formation of molecules, ions. Enthalpy of combustion and its applications: calculation of bond energy, bond dissociation energy, and resonance energy from thermochemical data, the effect of temperature (Kirchhoff's equations), and pressure on the enthalpy of reactions. Adiabatic flame temperature, explosion temperature.	**10**
Unit III: Free Energy and Phase Rules	**Free Energy Functions: Understand E, H, A, G.** Gibbs and Helmholtz free energy; Free energy change and spontaneity. Apply Maxwell relations and thermodynamic significance. Use the free energy concept to analyze chemical and physical processes and phase transitions. Phase rule: Introduction to Phases and Phase Transitions, Phase Diagrams: One-Component Systems, Thermodynamics of Phase Transitions, Phase Diagrams: Binary Systems, Advanced Concepts & Applications.	**10**

Reading References:

1. G. W. Castellan. *Physical Chemistry.* Narosa Publishing House, New Delhi. 2004, 3rd Ed.
2. P. C. Rakshit. *Physical Chemistry.* Levant Books, Kolkata. 2020, 7th Ed.
3. R. L. Madan. *Chemistry for Degree Students.* S. Chand Publications, New Delhi. 2022, 1st Ed.
4. Gurdeep Raj. *Advanced Physical Chemistry.* Krishna Prakashan Media, Meerut. 2018, 4th Ed.

CH2 104: Organic Chemistry-III Laboratory (L-T-P-C: 0-0-4-2)

Program: B. Sc. Chemistry	**Semester:** III
Course Code: CH2 104	**Course Name:** Organic Chemistry-III Laboratory

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
--	4 per week	2	60	Lab	CCE, ESE	50	40

Course Objectives:

- Course focuses on synthesis, transformation, and analysis of organic compounds
- Key reaction types: condensation, rearrangement, substitution, oxidation, reduction
- To perform classical name reactions: Aldol condensation, Hofmann & Curtius rearrangements, Mannich & Gabriel synthesis and Electrophilic aromatic substitutions
- Focus on: Understanding reaction mechanisms, developing experimental techniques
- Practical techniques used: Reflux, crystallisation, distillation, Thin-layer chromatography (TLC), Melting point determination for purity evaluation

Course Learning Outcomes: At the end of this course, students will be able to

CLO1: Recall the names, reagents, conditions, and types of involved in the synthesis of organic compounds.

CLO2: Understand the mechanisms of organic reactions and describe their synthetic importance and functional group transformations.

CLO3: Perform organic synthesis experiments using appropriate laboratory equipment and prepare compounds

CLO4: Interpret reaction outcomes, compare reaction pathways, identify products, evaluate Purity, and analyse selectivity and mechanism differences in multi-step organic reactions.

Syllabus

Sr. No.	Name of the Experiment	Hours
1.	To prepare Chalcones by Aldol Condensation of Acetone and Benzaldehyde	**7**
2.	To perform Hofmann Degradation of Benzamide to Aniline	**7**
3.	To prepare Phenylhydrazine from Benzoyl Azide via Curtius Rearrangement	**7**
4.	To synthesize Gabriel phthalimide through a practically suitable example	**7**
5.	To perform Mannich condensation reaction with benzaldehyde, aniline and acetophenone	**8**
6.	To prepare the m-Nitroaniline via Selective Reduction of m-Dinitrobenzene	**8**
7.	To oxidize the following compounds: benzaldehyde, benzyl alcohol acetophenone to benzoic acid (by iodoform reaction)	**8**
8.	To prepare Carbazole (Dibenzopyrrole)	**8**

Reading References

1. B. S. Furniss. *Vogel's Textbook of Practical Organic Chemistry.* Pearson Education, New Delhi. 2011, 5th Ed.
2. A. I. Vogel; A. R. Tatchell; B. S. Furniss; A. J. Hannaford; P. W. G. Smith. *Textbook of Practical Organic Chemistry.* Prentice-Hall, London. 1996, 5th Ed.
3. A. K. Nad; B. Mahapatra. *An Advanced Course in Practical Chemistry.* New Central Book Agency, Kolkata. 2022, 3rd Ed.
4. V. K. Ahluwalia; Sunita Dhingra. *Practical Organic Chemistry.* New Central Book Agency, Kolkata. 2017, 1st Ed.
5. N. K. Vishnoi. *Advanced Practical Organic Chemistry.* Vikas Publishing House, New Delhi. 2009, 3rd Ed.

CH2 105: Inorganic Chemistry - II Laboratory (L-T-P-C: 0-0-4-2)

Program: B. Sc. Chemistry	**Semester:** III
Course code: CH2 105	**Course name:** Inorganic Chemistry-II Laboratory

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
--	4 per week	2	60	Lab	CCE, ESE	50	40

Course Objective:

- learning and analyzing the various group I and II halides.
- Preparation and estimation of coordination complexes of transition metals like Cu and Ni.
- This course also deals with the determination of water of hydration in a given sample.

Course Learning Outcomes: At the end of this course, students will be able to

CLO1: Identify the basic radicals for group I and group II metals.

CLO2: Understand the preparation and characterization of coordination complexes.

CLO3: Demonstrate the formation of Cu and Ni complexes and calculate the yield

CLO4: Analyze the water of hydration/ crystallization in coordination compounds.

Syllabus

Sr. No.	Name of the Experiment	Hours
1.	To analyze and identify of group-I halides (potassium iodide, lithium chloride, and sodium chloride by flame test	**10**
2.	To analyze and identify the group-II halides (calcium chloride, strontium chloride, barium chloride	**10**
3.	To prepare and characterize tetramine-copper (II) sulfate Complex and calculation of the yield from the stoichiometric equation.	**10**
4.	To prepare and characterize hexamine nickel (II) chloride and calculate the yield from the stoichiometric equation	**10**
5.	To determine the formula of an unknown hydrated sample	**10**
6.	To Separate the given inorganic mixture using the filtration process	**10**

Reading References:

1. G. H. Jeffery; J. Bassett; J. Mendham; R. C. Denney. *Vogel's Textbook of Quantitative Chemical Analysis.* Orient Longman, New Delhi. 1989, 5th Ed.
2. G. Svehla. *Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis.* Orient Longman, New Delhi. 1982, 5th Ed.
3. Mala Nath. *Inorganic Chemistry: A Laboratory Manual.* Narosa Publishing House, New Delhi. 2016, 1st Ed.

CH2 106: Physical Chemistry-II Laboratory (L-T-P-C: 0-0-4-2)

Program: B. Sc. Chemistry	**Semester:** III
Course code: CH2 106	**Course name:** Physical Chemistry-II Laboratory

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
--	4 per week	2	60	Lab	CCE, ESE	50	40

Course Objectives:

- Understand and apply the laws of thermodynamics
- Quantify thermodynamic parameters such as enthalpy changes, heat of reaction, dilution, neutralization, hydration, and solution
- Develop experimental skills in chemical thermodynamics by designing, executing, and analyzing thermodynamic and phase behavior experiments, including verification of Hess's Law and Phase Rule.

Course Learning Outcomes: At the end of this course, students will be able to

CLO1: Identify the first law of thermodynamics.

CLO2: Recognize the second law of thermodynamics.

CLO3: Estimate property changes of mixing

CLO4: Evaluate Hess's law

Syllabus

Sr. No.	Name of the Experiment	Hours
1.	To demonstrate the first law of thermodynamics using simple household systems	**6**
2.	To determine heat loss by the reactants in an exothermic reaction by calculating the heat gained by the products of that reaction.	**6**
3.	To Experimentally demonstrate the second law of thermodynamics with glow sticks	**6**
4.	To determine the integral heats of dilution of H_2SO_4 starting with 10M acid and going down to 5M acid in the order 9M, 8M, 7M, 6M.	**8**
5.	To determine the heat loss by the reactants in an exothermic reaction by calculating the heat gained by the products of that reaction.	**8**
6.	To determine the enthalpy of neutralization of hydrochloric acid with sodium hydroxide using a coffee mug calorimeter	**6**
7.	To investigate the solubility of benzoic acid in water and determination of the change in enthalpy.	**6**
8.	To determine the enthalpy of hydration of copper sulphate	**6**
9.	To experimentally demonstrate the ΔH values of two reactions using the technique of a constant-pressure calorimeter	**8**

Reading References:

1. B. D. Khosla; V. C. Garg. *Senior Practical Physical Chemistry.* R. Chand & Co., New Delhi. 2018, 18th Ed.
2. B. Viswanathan; P. S. Raghavan. *Practical Physical Chemistry.* Viva Books Private Limited, Navi Mumbai. 2017, 1st Ed.
3. A. K. Nad; B. Mahapatra; A. Ghoshal. *An Advanced Course in Practical Chemistry (Paperback).* New Central Book Agency Pvt. Ltd., Kolkata. 2012, 3rd Ed.
4. J. N. Gurtu; Amit Gurtu. *Advanced Physical Chemistry Experiments.* Pragati Prakashan, Meerut. 2008, 1st Ed.

CH2 107: Semiconductor Devices (L-T-P-C: 2-0-0-2)

Program: B. Sc. Chemistry	**Semester:** III
Course code: CH2 107	**Course name:** Semiconductor Devices

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
2 per week	1 per week	2	30	Lecture	CCE, ESE	50	40

Course Objectives: The students will learn

- The basics of materials and fundamentals of different semiconducting devices.
- The materials properties due to their lattice vibrations, the basics of Brillouin zone, phonons, etc.
- The characteristics of various electronic devices such as diodes, transistor, etc which help to design a semiconducting instrument.

Course Learning Outcomes: At the end of this course students will be able to

CLO1: Remember the basic concept of different semiconducting devices.

CLO2: Understand the concept of phonons, diodes and transistors, and related fields.

CLO3: Examine the behavior of physical properties of solid materials.

CLO4: Analyze the concepts of diodes and transistors and apply them to real-life problems.

Syllabus

Units	Content	Hours
Unit I: Lattice Vibrations	Elastic and atomic force constant, Brillouin zone, Dispersion relation, Dynamics of a chain of atoms, chain of two types of atoms, optical and acoustic modes, Phonons, Momentum of phonon, interaction of light with ionic crystals, inelastic collision of photon by phonon, Einstein's and Debye's theories of specific heat of solids, lattice heat capacity, density of modes, Debye approximation, examples	**12**
Unit II: Semiconductor Diodes	Drift of Carriers in Electric and Magnetic Fields, Principal and Application of Light Emitting Diode, Photodiode, Varactor Diode, Zener Diode, Tunnel Diode Illustrative examples and related problems.	**8**
Unit III: Transistors	Characteristics of npn and pnp transistor, active and saturation region, common emitter, common base and common collector configuration, input and output characteristics, basics of field effect transistor (FET) and junction field effect transistor (JFET), Bi-polar junction transistor (BJT)	**10**

Reading References:

1. R. K. Puri; V. K. Babbar. *Solid State Physics.* S. Chand & Co. Ltd., New Delhi. 2010, 1st Ed.
2. V. K. Mehta. *Principles of Electronics.* S. Chand & Co. Ltd., New Delhi. 2014, 7th Ed.
3. Arthur Beiser. *Concepts of Modern Physics.* Tata McGraw-Hill, New Delhi. 2002, 6th Ed.
4. Charles Kittel. *Introduction to Solid State Physics.* John Wiley & Sons, New York. 2018, 8th Ed.
5. S. M. Sze; Kwok K. Ng. *Physics of Semiconductor Devices.* Wiley, New York. 1996, 2nd Ed.
6. P. Bhattacharya. *Semiconductor Opto-Electronic Devices.* Prentice Hall, New Delhi. 1996, 2nd Ed.
7. M. K. Achuthan; K. N. Bhat. *Fundamentals of Semiconductor Devices.* McGraw Hill Education, New Delhi. 2007, 1st Ed.
8. J. Allison. *Electronic Engineering Materials and Devices.* McGraw Hill Education, New Delhi. 1990, 1st Ed.

CH2 108: Semiconductor Devices Laboratory (L-T-P-C: 0-0-4-2)

Program: B. Sc. Chemistry	**Semester:** III
Course code: CH2 108	**Course name:** Semiconductor Devices Laboratory

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
--	4 per week	2	60	Lab	CCE, ESE	50	40

Course Objectives: The student will learn

- The basic principle involved in various electronic instruments.
- To observe and understand the characteristics of these instruments.
- To design their own circuit using different types of ICs which can help them for real life applications.
- To differentiate the semiconductors with the help of their Hall coefficient which can lead them to pick a perfect material for the right application.

Course Learning Outcomes: At the end of this course students will be able to
CLO1: Record different types of data for different instruments.
CLO2: Estimate the I-V characteristics of semiconductor devices such as diode, transistors.
CLO3: Examine whether the provided semiconductor device is working or not by demonstrating the proper circuits.
CLO4: Design different types of electrical circuits such as in logic gates.
CLO5: Determine different parameters for various experiments.

Syllabus

Sr. No.	Name of the Experiment	Hours
1	To Study the frequency response of a single PNP Transistor using common emitter transistor amplifier.	**8**
2	To Design the electrical circuit of different logic gates with the help of various types of ICs and verify the truth table for the same.	**8**
3	To perform: (a) Determination of the Hall voltage developed across the given material and (b) Calculate the Hall coefficient of the same material.	**12**
4	To Analyze the half-wave and full-wave rectifier output circuits using a capacitor in shunt as a filter.	**8**
5	To determine the figure of merit of a given Galvanometer.	**8**
6	To Study and verify the Stefan's Law of radiation (The law states that the amount of energy radiated through unit time from the surface of a black body is directly proportional to the fourth power of its absolute temperature).	**8**
7	To determine the given high resistance by the Substitution method.	**8**

Reading reference:

1. Harnam Singh; P. S. Hemne. *B.Sc. Practical Physics.* S. Chand & Co., New Delhi. 2000, 1st Ed.
2. C. L. Arora. *B.Sc. Practical Physics.* S. Chand & Co., New Delhi. 2010, Revised Ed.
3. P. R. Sasi Kumar. *Practical Physics.* PHI Learning Pvt. Ltd., New Delhi. 2011, 1st Ed.
4. Dinesh V. Kala. *Physics Practical Manual for UG & PG.* Dinesh Publication, New Delhi. 2020, 1st Ed.

CH2 109: Soft Skills (L-T-P-C: 2-0-0-2)

Program: B. Sc. Chemistry	**Semester:** III
Course code: CH2 109	**Course name:** Soft Skills

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
2 per week	--	2	30	Lecture	CCE, ESE	50	40

Course Objectives:

- Understand and assess personal strengths and weaknesses through self-analysis.
- Develop a growth-oriented mindset by learning goal-setting and prioritization techniques.
- Foster creative and lateral thinking for academic and real-life problem solving.
- Acquire essential corporate etiquette and professional behavior.
- Enhance communication, interpersonal, and time management skills necessary for professional success.

Course Learning Outcomes: At the end of this course students will be able to

CLO1: Remember the basics of communication skills and self-analysis.

CLO2: Understand the goal-setting and creative thinking.

CLO3: Observe the effective communications and presentation.

CLO4: Analyze the corporate etiquette.

Syllabus

Units	Content	Hours
Unit I: Self-Analysis and Attitude	• SWOT Analysis • Who am I? • Factors influencing Self Perception • Self Esteem • Understanding positive and negative attitudes	**10**
Unit II: Goal Setting and Interpersonal Development	• Types of Goals: Immediate, Short term, Long term • Strategies to Achieve Goals • Time Management and Prioritization • Building Motivation and Overcoming Procrastination • Active Listening and Empathetic Communication • Trust Building and Networking Skills • Emotional Intelligence in Goal Pursuit	**10**
Unit III: Creativity and Corporate Etiquette	• Creative Thinking: Out-of-the-box and Lateral Thinking • Innovative Problem-Solving Techniques • Professional Email and Telephone Etiquette • Virtual Meeting Etiquette and Online Presence • Workplace Etiquette and Interpersonal Behavior • Corporate Dining and Dress Etiquette • Presentation and Public Interaction Manners • Handling Criticism and Building Professional Relationships	**10**

Reading references:

1. Jeff Butterfield. *Soft Skills for Everyone.* Cengage Publications, Boston. 2020, 2nd Ed.
2. Barun K. Mitra. *Personality Development and Soft Skills.* Oxford University Press India, New Delhi. 2016, 2nd Ed.
3. Edward de Bono. *Lateral Thinking: Creativity Step by Step.* Harper Perennial, New York. 2015, Reissue Ed.

CH2 110: Laboratory Operations and Safety Measures (L-T-P-C: 2-0-0-2)

Program: B. Sc. Chemistry	**Semester:** III
Course code: CH2 110	**Course name:** Laboratory Operations and Safety Measures

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
2 per week	--	2	30	Lecture	CCE, ESE	50	40

Course Description: This course deals with understanding of various chemical operations in the laboratory. This course also explains the handling of chemicals and materials with proper guide and regulations. This course also delivers essential safety measures required in chemical laboratories.

Course Learning Outcomes: At the end of this course students will be able to
CLO1: Understand the safe working practices in a chemistry laboratory.
CLO2: Handle safely different glass apparatus.
CLO3: Analyze the chemicals and equipment safety in the laboratory.
CLO4: Apply protocols and methods for instruments in the laboratory.

Syllabus

Units	Content	Hours
Unit: I Safety Measures	Includes design of a lab Do's and Don'ts chart, chemical classification and labeling, MSDS preparation, and safety symbol identification. Covers recognition of incompatible chemicals, handling and storage of compressed gas cylinders, and shelf reagent storage guidelines. Involves study of exposure limits, hazard classification, safe disposal protocols, and review of institutional safety policies, audits, and inspections.	**10**
Unit: II Laboratory Instruments	Covers the handling and use of common laboratory apparatus—glass, plastic, and metal—including cleaning, drying, and calibration of volumetric equipment. Involves the identification and assembly of lab setups, the use of heating devices (burners, hot plates, mantles, muffle furnaces), and stirring tools (magnetic stirrers, shakers, heating/cooling baths). Includes types of filter papers, use of analytical balances, melting point apparatus, distillation/reflux assemblies, safety in handling flammable solvents, and preparation of laboratory reagents.	**10**
Unit: III Chemical Handling	Students must handle chemicals safely by reading labels and MSDS for hazard info, wearing a lab coat, gloves, and goggles, and working in ventilated areas or fume hoods. Label all containers clearly, never pipette by mouth, and always add acid to water, not the reverse. Avoid direct contact, wash hands after use, and never return unused chemicals to original containers. Dispose of waste properly and know the locations of safety equipment. Report any spills or accidents immediately to the supervisor.	**10**

Reading references:

1. D. A. Skoog; D. M. West; F. J. Holler. *Fundamentals of Analytical Chemistry.* Saunders College Publishing, USA. 1991, 2nd Ed.
2. J. Mendham; R. C. Denney; J. D. Barnes; M. J. K. Thomas. *Vogel's Textbook of Quantitative Chemical Analysis.* Pearson Education, New Delhi. 2002, 6th Ed.
3. B. S. Furniss; A. J. Hannaford; P. W. G. Smith; A. R. Tatchell. *Vogel's Textbook of Practical Organic Chemistry.* Longman Scientific and Technical, Longman Group Ltd., UK. 1989, 5th Ed.

CH2 111: Renewable Energy (L-T-P-C: 2-0-0-2)

Program: B. Sc. Chemistry	**Semester:** IV
Course code: CH2 111	**Course name:** Renewable Energy

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
2 per week	--	2	30	Lecture	CCE, ESE	50	40

Course Description:

- This course focuses on the understanding of energy resources, including Global status, Types of energy resources, Challenges associated with energy resources.
- This course focuses both conventional and non-conventional energy sources.
- This course focuses on fundamentals and applications of solar energy systems.

Course Learning Outcomes: At the end of this course students will be able to
CLO1: Understand the basic of alternative sources of energy
CLO2: Understand the energy harvesting and its applications using wind and hydro, biomass, piezoelectric material etc.
CLO3: Conceptual understanding and importance of solar cell
CLO4: Understand the electromagnetic energy harvesting and its applications

Syllabus

Unit	Content	Hours
Unit I: Energy Resources and Global Status	Energy Sources, World Energy Status, Availability of conventional and non-conventional energy resources, Comparison of various conventional energy systems, Advantages and disadvantages of conventional energy sources, Alternate sources of energy, Fossil fuels, nuclear energy and their limitations.	**10**
Unit II: Non-Conventional Energy Sources	Need of renewable energy, Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Tidal Energy, Ocean Thermal Energy Conversion, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. Grid interconnection topologies, Hydropower resources, environmental impact of hydro power sources. Advantages and limitations of non-conventional energy sources.	**10**
Unit III: Solar Energy Systems	Solar energy and its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar greenhouses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic systems.	**10**

Reading References:

1. B. H. Khan. *Non-Conventional Energy Sources.* McGraw Hill Education, New Delhi. 2017, 2nd Ed.
2. G. D. Rai. *Non-Conventional Energy Sources.* Khanna Publishers, New Delhi. 2011, 5th Ed.
3. M. P. Agarwal. *Solar Energy.* S. Chand & Co. Ltd., New Delhi. 2005, 1st Ed.
4. Suhas P. Sukhatme. *Solar Energy: Principles of Thermal Collection and Storage.* Tata McGraw-Hill Publishing Co. Ltd., New Delhi. 2008, 3rd Ed.
5. Godfrey Boyle. *Renewable Energy: Power for a Sustainable Future.* Oxford University Press, Oxford. 2012, 3rd Ed.
6. Godfrey Boyle. *Renewable Energy: Power for a Sustainable Future.* Oxford University Press, Oxford, in association with The Open University. 2004, 2nd Ed.
7. J. Balfour; M. Shaw; S. Jarosek. *Photovoltaics.* Lawrence J. Goodrich Publications, USA. 2001, 1st Ed.
8. Dr. P. Jayakumar. *Solar Energy: Resource Assessment Handbook.* Ministry of New and Renewable Energy (MNRE), Government of India. 2009, 1st Ed.

B.Sc. Chemistry Semester IV
Detailed syllabus
CH2 201: Organic Chemistry -III: Chemistry of Enolates and Amines (L-T-P-C: 2-0-0-2)

Program: B. Sc. Chemistry	**Semester:** IV
Course code: CH2 201	**Course Name:** Organic Chemistry -IV Chemistry of Enolates and Amines

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
2 per week	--	2	30	Lecture	CCE, ESE	50	40

Course Objectives:

- Understand enols, enolates, and amines in terms of structure and reactivity
- Learn keto–enol tautomerism and enolate formation (kinetic vs. thermodynamic)
- Explore mechanisms of aldol, Claisen, and Michael reactions
- Apply enolate chemistry in C–C bond formation and synthetic design
- Study amines: structure, nomenclature, basicity, and synthesis

Course Learning Outcomes: At the end of this course students will be able to
CLO1: Understand keto–enol tautomerism and enolate ion formation mechanisms.
CLO2: Analyze factors influencing regioselectivity in enolate chemistry.
CLO3: Apply enolate reactivity in designing aldol and Claisen-type syntheses.
CLO4: Interpret stereoselectivity and conjugate addition in Michael reactions.
CLO5: Classify and predict the behavior of primary to quaternary amines.
CLO6: Demonstrate knowledge of amine synthesis and their key reactions

Syllabus

Units	Content	Hours
Unit I: Enolate Chemistry	Acidity of α-Hydrogens, Keto–Enol Tautomerism; Enolate Ions and Enolate equivalents; Enolate Formation from aldehydes, ketones and esters; E- vs Z-enolates; enolates as ambident nucleophiles (can attack via α-carbon or oxygen); Thermodynamic vs Kinetic Enolates; Factors Affecting Enolate Reactivity; Resonance stabilization of enolates; Epimerization and deuteration of Enolates; General reactivity toward electrophiles; Control using base and temperature; Introducing the nitrogen analogs of enolates	**10**
Unit II: Applications of Enolate Chemistry	Synthetic applications of enolates in carbon–carbon bond-forming reactions; aldol reactions; how to control aldol reactions of esters, aldehydes and ketones; Claisen condensations and its variants; Alkylation of Enolates; use of enolates in Michael reactions	**10**
Unit III: Structure and Reactivity of Amines	Nomenclature and structure classification of amines; basicity and reactivity of amines; factors influencing basicity; aryl vs alkyl amines; synthesis of amines (reductive amination; gabriel synthesis; hofmann bromamide rearrangement); reactions of amines (acylation, alkylation, diazotization; aryldiazonium salts and sandmeyer reactions; electrophilic aromatic substitution in aromatic amines like aniline (activation, ortho/para directing effects)	**10**

Reading References:

1. I. L. Finar. *Organic Chemistry, Volume I & II.* Dorling Kindersley (India) Pvt. Ltd., Pearson Education, New Delhi. 2002, 5th Ed.
2. R. K. Bansal. *Heterocyclic Chemistry.* New Age International Publishers, New Delhi. 2010, 5th Ed.
3. R. M. Acheson. *An Introduction to the Chemistry of Heterocyclic Compounds.* John Wiley & Sons, New York. 2008, 3rd Ed.
4. William Templeton. *An Introduction to the Chemistry of Terpenoids and Steroids.* Oxford University Press, Oxford. 1966, 1st Ed.
5. Kenneth Walter Bentley. *The Alkaloids.* Interscience Publishers (Wiley), New York. 1957, 1st Ed.

CH2 202: Inorganic Chemistry-III: s and p-Block Elements (L-T-P-C: 2-0-0-2)

Program: B. Sc. Chemistry	**Semester:** IV
Course code: CH2 202	**Course name:** Inorganic Chemistry-III s and p-Block Elements

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
2 per week	--	2	30	Lecture	CCE, ESE	50	40

Course Objective:

- The concept of periodicity related to old and modern periodic table.
- This course delivers the details study of Slater's rule and calculates the effective nuclear charge of individual ion.
- This course also focuses the concept of different radii, lattice energy, hydrides, crown ether, cause and effect of inert pair effect.

Course Learning Outcomes: At the end of this course students will be able to
CLO1: Define general electronic configuration of s, p, d and f-block elements.
CLO2: Elaborate discussion of different types of radii.
CLO3: Calculate the effective nuclear charge by using Slater's rule.
CLO4: Summarize the physical and chemical properties of gr-I & II metals, inert pair effect.

Syllabus

Units	Content	Hours
Unit I: Periodicity of Elements	General electronic configuration of s, p, d, f-block elements, periodicity, Concept of old and modern periodic table, the long form of the periodic table. Detailed discussion of the following properties of the elements, with reference to s & p-block. (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in the periodic table, effects (b) Atomic radii (van der Waals) (c) Ionic and crystal radii. (d) Covalent radii (octahedral and tetrahedral), metallic. (e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (f) Electron gain enthalpy, trends of electron gain enthalpy, abnormality, factors that affect the value of E.A. (g) Electronegativity, factors, trends, Pauling's/ Mulliken's and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, and group electronegativity	**12**
Unit II: Physical and chemical properties of gr-I & II metals	Characteristic flame color, complexation of alkali ions (crown ether), Inert pair effect: cause & effect, Relative stability of different oxidation states, diagonal relationship, and anomalous behavior of the first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Lattice energy Basic beryllium acetate and nitrate. Study of the following compounds with emphasis on structure, bonding, preparation, properties, and uses. Boric acid and borates, boron nitrides, carboranes and graphitic compounds, Oxides, and oxoacids of nitrogen, phosphorus, and chlorine.	**12**
Unit III: Hydrides	Hydrides and their classification: ionic, covalent, and interstitial. Bonding, preparation and structure of different hydrides. Borohydrides, Banana bond, concept of 2c-3e bond	**06**

Reading references:

1. R. L. Madan. *Chemistry for Degree Students.* S. Chand Publications, New Delhi. 2016, 1st Ed.
2. R. P. Sarkar. *General and Inorganic Chemistry.* New Central Book Agency, Kolkata. 2011, 3rd Ed.
3. J. D. Lee. *Concise Inorganic Chemistry.* Oxford University Press, Oxford. 2008, 5th Ed.
4. F. A. Cotton; G. Wilkinson; Paul L. Gaus. *Basic Inorganic Chemistry.* Wiley, New York. 2007, 3rd Ed.
5. N. N. Greenwood; A. Earnshaw. *Chemistry of the Elements.* Pergamon Press, Oxford. 1989, 1st Ed.

CH2 203: Physical Chemistry-III: Chemical and Ionic Equilibria (L-T-P-C: 2-0-0-2)

Program: B. Sc. Chemistry	**Semester:** IV
Course code: CH2 203	**Course name:** Physical Chemistry-III Chemical and Ionic Equilibria

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
2 per week	--	2	30	Lecture	CCE, ESE	50	40

Course Objectives:

- Understand ionic equilibrium concepts, including ionization, buffers, and solubility product.
- Analyze chemical equilibrium using thermodynamic principles and equilibrium constants.
- Apply equilibrium concepts to industrial processes like the Haber and Contact processes.

Course Learning Outcomes: At the end of this course students will be able to

CLO1: Understand and apply the principles of ionic equilibrium: Learners will be able to explain the behavior of strong and weak electrolytes, calculate pH, and predict outcomes of acid-base reactions and buffer systems using equilibrium constants.

CLO2: Analyze solubility and hydrolysis phenomena in ionic systems: Students will calculate solubility products, hydrolysis constants, and interpret the effect of common ions on solubility and buffer behavior in various chemical environments.

CLO3: Apply thermodynamic concepts to chemical equilibrium: Learners will derive and use relationships involving Gibbs free energy, reaction quotient, and equilibrium constants to evaluate the spontaneity and direction of chemical reactions.

CLO4: Evaluate and optimize real-world chemical processes using equilibrium principles Students will assess the impact of temperature, pressure, and catalysts on industrial processes such as the Haber and Contact processes through Le Chatelier's Principle and thermodynamic analysis.

Syllabus

Units	Content	Hours
Unit I: Ionic equilibrium	**Ionic equilibrium:** Strong, moderate, and weak electrolytes, degree of ionization, factors affecting the degree of ionization, ionization constant, and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment). Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis, Buffer solutions; Henderson equation and its applications; buffer capacity, buffer range, buffer action. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Theory of acid-base indicators; selection of indicators and their limitations.	**12**
Unit II: Chemical equilibrium	**Chemical equilibrium:** Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. A coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure, and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p, K_C, and K_X. Le Chatelier's principle.	**12**

Unit III: Industrial applications	**Ammonia synthesis (Haber process)** – optimization via pressure/temperature, **Sulfuric acid production (Contact process)** – role of catalyst, temperature, and gas-phase equilibria	**6**

Reading References:

1. R. L. Madan. *Chemistry for Degree Students.* S. Chand Publications, New Delhi. 2016, 1st Ed.
2. B. R. Puri; L. R. Sharma. *Principles of Physical Chemistry.* Vishal Publishing Co., Jalandhar. 2020, 49th Ed.
3. G. W. Castellan. *Physical Chemistry.* Narosa Publishing House, New Delhi. 2004, 3rd Ed.
4. Gurdeep Raj. *Advanced Physical Chemistry.* Krishna Prakashan Media, Meerut. 2018, 4th Ed.

CH2 204: Organic Chemistry-III Laboratory (L-T-P-C: 0-0-4-2)

Program: B. Sc. Chemistry	**Semester:** IV
Course code: CH2 204	**Course name:** Organic Chemistry-III Laboratory

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
--	4 per week	2	60	Lab	CCE, ESE	50	40

Course Objectives:

- Gain hands-on experience with enolate and amine chemistry
- Perform key reactions: tautomerism, aldol/Claisen condensations, Michael additions, enamine alkylation
- Synthesize aromatic and aliphatic amines
- Understand reaction mechanisms

Course Learning Outcomes: At the end of this course, students will be able to
CLO1: Perform key organic reactions involving enolates and amines using standard lab techniques.
CLO2: Analyze mechanisms of aldol, Claisen, and electrophilic substitution reactions.
CLO3: Classify and identify amines through qualitative tests.
CLO4: Monitor and interpret reactions using chromatographic and analytical methods.

Syllabus

Sr. No.	Name of the Experiment	Hours
1	To demonstrate keto–enol tautomerism using acetylacetone	**6**
2	To prepare a silyl enol ether from a ketone using TMSCl and base.	**6**
3	To synthesize α,β-unsaturated ketone from a base-catalyzed aldol condensation between acetone and benzaldehyde	**6**
4	To perform the Self-claisen condensation: Synthesis of ethyl acetoacetate	**6**
5	To perform Michael addition: 1,4-conjugate addition of enolate to methyl vinyl ketone or cyclo	**6**
6	To perform the Diazotization reaction: Preparation of methyl orange from sulfanilic acid	**6**
7	To perform the Acylation of aniline to form acetanilide	**6**
8	To perform the Synthesis of primary amine via Gabriel phthalimide synthesis	**6**
9	To perform: Electrophilic substitution in aniline: Bromination of aniline to 2,4,6- 2,4,6-tribromoaniline	**6**
10	To perform: Enamine alkylation (stork-type reaction)	**6**

Reading References:

1. B. S. Furniss. *Vogel's Textbook of Practical Organic Chemistry.* Pearson Education, New Delhi. 2011, 5th Ed.
2. A. I. Vogel; A. R. Tatchell; B. S. Furniss; A. J. Hannaford; P. W. G. Smith. *Textbook of Practical Organic Chemistry.* Prentice-Hall, London. 1996, 5th Ed.
3. A. K. Nad; B. Mahapatra. *An Advanced Course in Practical Chemistry.* New Central Book Agency, Kolkata. 2022, 3rd Ed.
4. V. K. Ahluwalia; Sunita Dhingra. *Practical Organic Chemistry.* New Central Book Agency, Kolkata. 2017, 1st Ed.
5. N. K. Vishnoi. *Advanced Practical Organic Chemistry.* Vikas Publishing House, New Delhi. 2009, 3rd Ed.

CH2 205: Inorganic Chemistry III Laboratory (L-T-P-C: 0-0-4-2)

Program: B. Sc. Chemistry	**Semester:** IV
Course code: CH2 205	**Course name:** Inorganic Chemistry III Laboratory

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
--	4 per week	2	60	Lab	CCE, ESE	50	40

Course Objective: This practical course covers

- learning and analyzing the water of crystallization of various salts of Gr-I & II.
- Determine the percentage of purity of Gr-I salt.
- This course deals separation of metal ions gravimetrically.
- This course also deals with the exchange capacity of cation exchange resin and the separation of different amino acids by chromatographic techniques.

Course Learning Outcomes: At the end of this course, students will be able to

CLO1: Analyzing water of crystallization and calculating the percentage of purity

CLO2: Separate different ions gravimetrically.

CLO3: Determine the exchange capacity of ion exchange resins.

CLO4: Identify different amino acids by chromatographic techniques.

Syllabus

Sr. No.	Name of the Experiment	Hours
1	To determine and calculate the water of crystallization of a given salt. $BaCl_2$ $2H_2O$, $Mg.SO_4$ $7H_2O$, $CuSO_4$. $5H_2O$	**8**
2	To determine the Percentage of Purity of a given salt (Na_2CO_3, $NaHCO_3$)	**8**
3	To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extract the Ni^{2+}-DMG complex in chloroform, and determine its concentration by spectrophotometry	**8**
4	To determine the exchange capacity of cation exchange resins and anion exchange resins.	**12**
5	To separate the amino acids from organic acids by ion exchange chromatography.	**12**
6	To separate different metal ions from their binary mixture by TLC	**12**

Reading references:

1. G. H. Jeffery; J. Bassett; J. Mendham; R. C. Denney. *Vogel's Textbook of Quantitative Chemical Analysis.* Orient Longman, New Delhi. 1989, 5th Ed.
2. G. Svehla. *Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis.* Orient Longman, New Delhi. 1982, 5th Ed.
3. Mala Nath. *Inorganic Chemistry: A Laboratory Manual.* Alpha Science International Ltd., Oxford. 2016, 1st Ed.

CH2 206: Physical Chemistry-III Laboratory (L-T-P-C: 0-0-4-2)

Program: B. Sc. Chemistry	**Semester:** IV
Course code: CH2 206	**Course name:** Physical Chemistry-III Laboratory

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
--	4 per week	2	60	Lab	CCE, ESE	50	40

Course Objectives:

- Understand buffer preparation and pH control.
- Perform pH-metric titrations and calculate dissociation constants.
- Explore chemical equilibrium shifts and thermodynamic principles.
- Determine solubility products and pKa values experimentally

Course Learning Outcomes: At the end of this course, students will be able to
CLO1: Perform and analyze experiments involving acid-base equilibria, buffer systems, and solubility equilibria.
CLO2: Calculate equilibrium constants using experimental data and interpret the effects of changing system variables.
CLO3: Demonstrate safe laboratory practices and accurate data handling in equilibrium-based experiments.
CLO4: Validate the Le Chatelier's principle

Syllabus

Sr. No.	Name of the Experiment	Hours
1	To prepare buffer solutions of different pH a. Sodium acetate-acetic acid b. Ammonium chloride-ammonium hydroxide	**4**
2	To perform the pH-metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.	**6**
3	To determine the dissociation constant of a weak acid.	**6**
4	To study the shift in equilibrium in the reaction of ferric and thiocyanate ions.	**8**
5	To validate the Le Chatelier's Principle using simple laboratory methods	**8**
6	To investigate the effect of Temperature on Equilibrium Constant (Van't Hoff Equation)	**8**
7	To determine the Unfavorable Reaction through a Coupled Favorable Reaction	**8**
8	To determine the pKa of a Polyprotic Acid (e.g., Phosphoric Acid) via pH Titration	**6**
9	To determine the solubility product for the sparingly soluble salts.	**6**

Reading References:

1. B. D. Khosla; V. C. Garg; Adarsh Gulati. *Senior Practical Physical Chemistry.* R. Chand & Co., New Delhi. 2018, 1st Ed.
2. B. Viswanathan; P. S. Raghavan. *Practical Physical Chemistry.* Viva Books Private Limited, Navi Mumbai. 2017, 1st Ed.
3. A. K. Nad; B. Mahapatra; A. Ghoshal. *An Advanced Course in Practical Chemistry (Paperback).* New Central Book Agency Pvt. Ltd., Kolkata. 2022, 3rd Ed.
4. B. Viswanathan; P. S. Raghavan. *Practical Physical Chemistry.* Viva Books, New Delhi. 2012, 1st Ed.

5. J. N. Gurtu; Amit Gurtu. *Advanced Physical Chemistry Experiments.* Pragati Prakashan, Meerut. 2011, 1st Ed.

CH2 207: Application of Semiconducting Materials (L-T-P-C: 2-0-0-2)

Program: B. Sc. Chemistry	**Semester:** IV
Course code: CH2 207	**Course name:** Application of Semiconducting Materials

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
2 per week	--	2	30	Lecture	CCE, ESE	50	20

Course Objectives: The students will learn

- The fundamentals of photodiode, LED, diode laser and also can
- The working of these semiconducting devices.
- The fundamentals and principle of some of the memory devices with real life application.
- The use of these devices in different types of sensors and actuators.

Course Learning Outcomes: At the end of this course students will be able to
CLO1: Remember the basic concept of different semiconducting devices.
CLO2: Understand the concept of different types of radiations and memory devices.
CLO3: Understand the characteristics of different devices such as memory device, optical device, coupled device and etc.
CLO4: Analyze the concept of different transitions and optical devices for real life application.

Syllabus

Units	Content	Hours
Unit I: Photonic Device	Diode photodetectors, solar cell, Light Emitting Diode (LED), diode laser (condition for population inversion, in active region), optical gain and threshold current for lasing, relation between optical gain and threshold current, Fabry-Perrot cavity length for lasing and the separation.	**15**
Unit II: Memory Devices	Static and Dynamic Random-Access memories (SRAM and DRAM), Complementary Metal Oxide Semiconductor (CMOS), P-Channel MOS (PMOS) and N-Channel MOS (NMOS), Nonvolatile – NMOS, Magnetic, Optical and Ferroelectric Memories, Charge Coupled Devices (CCD), Application in Sensor and Actuator Devices	**15**

Reading References

1. R. K. Puri; V. K. Babbar. *Solid State Physics.* S. Chand & Co. Ltd., New Delhi. 2010, 1st Ed.
2. V. K. Mehta. *Principles of Electronics.* S. Chand & Co. Ltd., New Delhi. 2014, 7th Ed.
3. Arthur Beiser. *Concepts of Modern Physics.* Tata McGraw-Hill, New Delhi. 2002, 6th Ed.
4. R. K. Gaur; S. L. Gupta. *Engineering Physics.* Dhanpat Rai Publications, New Delhi. 2012, Revised Ed.
5. Charles Kittel. *Introduction to Solid State Physics.* John Wiley & Sons, New York. 2018, 8th Ed.
6. S. M. Sze; Kwok K. Ng. *Physics of Semiconductor Devices.* Wiley, New York. 1996, 2nd Ed.
7. P. Bhattacharya. *Semiconductor Opto-Electronic Devices.* Prentice Hall of India, New Delhi. 1996, 2nd Ed.
8. M. K. Achuthan; K. N. Bhat. *Fundamentals of Semiconductor Devices.* McGraw Hill Education, New Delhi. 2007, 1st

Ed.
9. J. Allison. *Electronic Engineering Materials and Devices.* McGraw Hill Education, New Delhi. 1990, 1st Ed.

CH2 208: Semiconducting Materials Laboratory (L-T-P-C: 0-0-4-2)

Program: B. Sc. Chemistry	**Semester:** IV
Course code: CH2 208	**Course name:** Semiconducting Materials Laboratory

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
--	4 per week	2	60	Lab	CCE, ESE	50	20

Course Objectives: The students will learn

- The fundamentals of optical and electronic instruments.
- They will understand the concept of optical fiber and able to relate the application in real life such as communication, internet, etc.
- They will learn to measure the optical activity of any chemical compound.

Course Learning Outcomes: At the end of this course students will be able to
CLO1: Record different types of data for different instruments.
CLO2: Classify the devices according to their properties.
CLO3: Apply the theoretical knowledge of the course for the solving the given problem.
CLO4: Explain different characteristics of different devices such as memory device, optical device, coupled device and etc.
CLO5: Determine different parameters for various experiments.

Syllabus

Sr. No.	Name of the Experiment	Hours
1	To determine the radius of curvature of a given plano-convex lens using the phenomenon of interference of light viz. Newton's rings.	**10**
2	To determine the specific rotation of sugar solution using Laurent's half shade.	**8**
3	To estimate the numerical aperture of fiber.	**8**
4	To study diffraction of light using a diffraction grating spectrometer and to measure the wavelengths of certain lines in the spectrum of the mercury arc lamp.	**8**
5	To study the intensity distribution due to diffraction from single slit and to determine the slit width (d).	**8**
6	To study the angle of deviation (d) with angle of incidence (i) and to find the angle of minimum deviation (D) from i-d curve.	**8**
7	To determine the wavelength of light source using Michelson's Interferometer	**10**

Reference books:

1. V. K. Mehta. *Principles of Electronics.* S. Chand & Co. Ltd., New Delhi. 2007, Revised Ed.
2. P. R. S. Kumar. *Practical Physics.* PHI Learning Pvt. Ltd., New Delhi. 2011, 1st Ed.
3. Harnam Singh; P. S. Hemne. *Practical Physics.* S. Chand & Co. Ltd., New Delhi. 2000, 1st Ed.
4. S. K. Ghosh. *Advanced Practical Physics.* New Central Book Agency (NCBA), Kolkata. 2010, 1st Ed.

CH2 209: Professional Communication (L-T-P-C: 2-0-0-2)

Program: B. Sc. Chemistry	**Semester: IV**
Course code: CH2 209	**Course name:** Professional Communication

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
2 per week	--	2	30	Lecture	CCE, ESE	50	20

Course Objectives: This course is designed to:

- Develop students' ability to communicate effectively in scientific, academic, and professional contexts.
- Familiarize students with the formats and language used in research writing and patent documentation.
- Strengthen soft skills such as teamwork, leadership, conflict resolution, and public speaking.
- Enhance students' personality traits through grooming, self-presentation, and confidence-building activities.
- Encourage creative expression and professional etiquette suited for higher education and workplace success.

Course Learning Outcomes: At the end of this course students will be able to

CLO1: Communicate professionally in both oral and written formats, including emails, reports, and presentations.

CLO2: Apply effective interpersonal skills such as active listening, respectful feedback, and workplace etiquette.

CLO3: Work collaboratively using soft skills such as teamwork, adaptability, and conflict resolution.

CLO4: Present themselves with professionalism**,** using appropriate grooming, body language, and etiquette.

Syllabus

Units	Content	Hours
Unit I: Scientific and Academic Communication	• Fundamentals of Scientific English • Introduction to Research Writing • Structure of a Research Paper (IMRAD format) • Basics of Patent Writing: Structure, Language, and Types • Avoiding Plagiarism and Referencing Styles	10
Unit II: Creative Expression and Soft Skills	• Foundation of Creative Expression • Public Speaking and Presentation Skills • Teamwork and Conflict Resolution • Role Plays and Group Activities	10
Unit III: Professional Image and Personality Enhancement	• Skill Enhancement Techniques • Personal Grooming and Self-Presentation • Body Language and Social Etiquette • Building Self-Confidence and Positive Image	10

References:

1. Meenakshi Raman; Sangeeta Sharma. *Technical Communication: Principles and Practice.* Oxford University Press, New Delhi. 2015, 2nd Ed.
2. C. L. Bovee; J. V. Thill; M. Chaturvedi. *Business Communication Today.* Pearson Education, New Delhi. 2010, 11th Ed.
3. Barun K. Mitra. *Personality Development and Soft Skills.* Oxford University Press, New Delhi. 2011, 1st Ed.
4. TED Talks. *Ideas Worth Spreading.* Available at: https://www.ted.com/talks

CH2 210: Software for Scientific Learning (L-T-P-C: 2-0-0-2)

Program: B. Sc. Chemistry	**Semester:** IV
Course Code: CH2 210	**Course Name:** Software for Scientific Learning

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
2 per week	--	2	30	Lecture	CCE, ESE	50	40

Course Objectives:

- Introduce students to a range of software tools used in chemistry
- Build skills in digital data handling and scientific reporting.
- Enable analysis and visualization of scientific data digitally.
- Promote effective use of digital resources and lab documentation.

Course Learning Outcomes: At the end of this course, students will be able to

CLO1: Identify and use basic scientific software relevant to chemical data analysis and simulation.

CLO2: Interpret experimental data through digital tools

CLO3: Prepare technical reports and presentations using appropriate software

CLO4: Demonstrate digital literacy by integrating online resources

Syllabus

Units	Content	Hours
Unit I: Chemical Information Tools	Introduction to scientific software in chemistry, File formats and extensions (.mol, .cml, .csv, .pdb), Drawing and visualization tools. SMILES, IUPAC name generation, 2D to 3D structure conversion. Reference management software: citation styles, bibliography management, introduction to ELNs (Electronic Lab Notebooks), and lab data organization.	**10**
Unit II: Molecular Modeling and Spectral Analysis Tools	Introduction to computational chemistry software: Avogadro, GaussView, ORCA Viewers (theoretical overview), Geometry optimization, energy minimization, charge visualization. Overview of spectroscopy interpretation software: MestReNova, Spekwin32, JSpecView, Reading IR, NMR, UV-Vis spectra (basic interpretation from raw files).	**10**
Unit III: Scientific Data Handling	Scientific data types and analysis: Tabular, graphical, and time-series data, Using spreadsheets in chemistry: Microsoft Excel, Google Sheets for titration, kinetics, and thermodynamics data Introduction to scientific graphing tools: Origin, GraphPad Prism, Plotting, regression, fitting, and result visualization, understanding data reproducibility, and good data practices. Error Analysis.	**10**

Reading references:

1. Prof. Dr. Stefan Bienz. *Short Manual to the Chemical Drawing Program ChemDraw®.* University of Zurich, Switzerland. 2016, User Manual.
2. RMIT University Library. *EndNote: A Beginner's Guide.* Library Subject Guide, RMIT University, Melbourne. 2020.
3. James W. Zubrick. *Spreadsheet Applications in Chemistry Using Microsoft Excel.* John Wiley & Sons, New York. 2004, 1st Ed.
4. K. V. Raman. *Computers in Chemistry.* Tata McGraw-Hill Publishing Co. Ltd., New Delhi. 2003, 1st Ed.

CH2 211: Indian Culture and Civilization (L-T-P-C: 2-0-0-2)

Program: B. Sc. Chemistry	**Semester:** III
Course Code: CH2 211	**Course Name:** Indian Culture and Civilization

Lecture (Hours)	Practical (Hours)	Credits	Total Hours	Evaluation Scheme			
				Component	Exam	Max. Marks	Passing %
2 per week	--	2	30	Lecture	CCE, ESE	50	40

Course Objectives:

- To introduce students to the foundational concepts of culture, society, and civilization
- To enable students to appreciate the importance of values and ethical living by exploring core human values
- To promote holistic development by encouraging a balance between intellectual, emotional, and ethical growth through the integration of cultural awareness and value systems.

Course Learning Outcomes: At the end of this course students will be able to

CLO1: Understand Indian culture and history.

CLO2: Describe Indian heritage and ethnicity.

CLO3: Explain Indian science, art, literature, and architecture.

CLO4: Analyze the underlying unity amidst diversity in all aspects of India's culture.

Syllabus

Units	Content	Hours
Unit I: Concept of Culture	Understanding Culture: Definitions of culture; Types of culture; Three aspects of culture; Features of Culture, Society and its institutions, Role of culture in society, cultural variability of society, Indian culture and its characteristics	**10**
Unit II: Value and Ethics	Value education: Definition of value and value education; Purpose and significance in the present world. Value system: Holistic living – balancing the outer and inner; Body, Mind, and Intellectual level – Duties and responsibilities. Salient values for life: Truth, commitment, honesty and integrity, forgiveness and love, empathy and ability to sacrifice, care, unity, and inclusiveness; Self-esteem and self-confidence; Interpersonal and Intra personal relationship; Team work – Positive and creative thinking.	**10**
Unit III: Culture and Civilization	Definitions of civilization, Relation between culture and civilization, Concept of Indianness and value system, The role of culture and civilization, Famous cultural remains and monuments of India and Gujarat	**10**

Reading references:

1. Pramod K. Nayar. *An Introduction to Cultural Studies.* Viva Books, New Delhi. 2008, 1st Ed.
2. S. S. Sastri. *Indian Culture: A Compendium of Indian History, Culture and Heritage.* Notion Press, Chennai. 2021, 1st Ed.
3. Nitin Singhania. *Indian Art and Culture.* McGraw Hill Education, Chennai. 2021, 3rd Ed.

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