SYLLABI AND SCHEME OF EXAMINATIONS FOR

(LIFE SCIENCES/PHYSICAL SCIENCES PROGRAM WITH HONS. IN ONE MAJOR DISCIPLINE)

B.Sc. (Life Sciences/Physical Sciences) with Hons. in CHEMISTRY

(Based on Curriculum and Credit Framework for UG Programs under NEP)

WITH EFFECT FROM THE SESSION 2024-25

MAHARSHI DAYANAND UNIVERSITY ROHTAK (HARYANA)

Syllabi and Scheme of B.Sc. (Life Sciences/Physical Sciences) Program in accordance of NEP 2020

(w.e.f. July 2024-25)

Name of the Program : B.Sc. (Life Science/Physical Sciences)

Duration of the Program : Three/ Four Years

Total credits for the Program : 180

- **Program specific outcomes**

PSO1: Understand the concept of periodic trends, chemical bonding, coordination chemistry and reaction mechanisms.

PSO2: Understand the principles of bonding, structure, Stereochemistry, reaction mechanisms and chemical reactivity in organic molecules.

PSO3: Understand the fundamental principles of thermodynamics, kinetics and quantum mechanics.

PSO4: Able to apply thermodynamic principles to describe the behavior of gases, liquids and solids.

PSO5: Able to interpret various spectroscopic data, including nuclear magnetic resonance (NMR), infrared (IR) and UV spectroscopy.

PSO6: Perform different experimental techniques such as spectroscopy, calorimetry, chromatography and electrochemistry.

PSO7: Understand different synthetic techniques, including functional group transformations, multistep synthesis and purification methods such as chromatography and distillation.

PSO8: Understand the chemistry and application of bioorganic and bioinorganic molecules.

1st Year of B.Sc. (Life Sciences/Physical Sciences) Program

Semester	Discipline-Specific Courses (DSC)	Minor (MIC)/ Vocational (VOC)	Multidisciplinary Courses (MDC)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)	Value added Course (VAC)	Total Credits
I	12	4	3	2	3	--	24
II	12	--	3	2	3	4	24

***Students exiting the Program after semester-II and securing 52 credits including 4 credits of summer internship will be awarded UG Certificate in the relevant Discipline/Subject.*

2nd Year of B.Sc. (Life Sciences/Physical Sciences) Program

Semester	Discipline-Specific Courses (DSC)	Minor (MIC)/ Vocational (VOC)	Multidisciplinary Courses (MDC)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)	Value added Course (VAC)	Total Credits
III	12	4	3	2	3	--	24
IV	12	4	--	2	--	2	20

***Students exiting the Program after semester-IV and securing 96 credits including 4 credits of summer internship will be awarded UG Diploma in the relevant Discipline/Subject.*

3rd Year of B.Sc. (Life Sciences/Physical Sciences) Program

Semester	Discipline-Specific Courses (DSC)	Minor (MIC)/ Vocational (VOC)	Multidisciplinary Courses (MDC)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)	Value added Course (VAC)	Total Credits
V	12	4	--	--	4 (internship)	--	20
VI	12	8	--	--	--	--	20

***Students will be awarded 3-year UG Degree in the relevant Discipline/Subject upon securing 132 credits.*

4th Year of B.Sc. (Life Sciences/Physical Sciences) Program *

Option I*

Semester	Discipline-Specific Courses (DSC)	Minor (MIC)/ Vocational (VOC)	Multidisciplinary Courses (MDC)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)	Value added Course (VAC)	Total Credits
VII	20	4	--	--	--	--	24
VIII	20	4	--	--	--	--	24

Option II*

Semester	Discipline-Specific Courses (DSC)	Minor (MIC)/ Vocational (VOC)	Multidisciplinary Courses (MDC)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)	Value added Course (VAC)	Total Credits
VII	20	4	-	--	--	--	24
VIII	08	4	-	--	12 (RP/ Dissertation)	--	24

***Note:** Students entering 4th year Graduate Program after a 3-year UG Program can choose to do:

Only course work in the semester - VII and VIII (Option - I) OR Course work in semester – VII and research in semester - VIII (Option - II)

Total Credit of the B.Sc. Life Sciences/Physical Sciences 4 Year UG (Hons with Research) are 180

**Student should select one major discipline (Out of A, B, or C studied during first three years of UG Programs) in which he/she wishes to pursue Honors. This framework is subjected to modification as per UGC guidelines at the University level. The universities may decide to offer the Honors degree Programs subject to the fulfilment of credit point table.*

INSTRUCTIONS FOR THE STUDENTS

Course Types:

Discipline Specific Course (DSC)/Major Course:

Discipline specific/Major course is the discipline or subject of main focus in which the degree will be awarded. Students should secure the prescribed number of credits (at least 50% of total credits) through Discipline Specific Course/Major Course in the major discipline.

Minor Course (MIC):

Minor discipline is the discipline that helps a student to gain a broader understanding beyond the major discipline. For example, if a student pursuing Economics as major course may choose Statistics as minor course.

Vocational Course (VOC):

Vocational Course assists student in developing workforce-relevant skills and enhance the employability of student.

Multidisciplinary Course (MDC):

A Multidisciplinary Course is an option to explore disciplines of interest beyond the choices of learners made in their major and minor disciplines.

Ability Enhancement Course (AEC):

Ability Enhancement Course aims to achieve competency in language and communication skills.

Skill Enhancement Course (SEC):

Skill Enhancement Course aims to promote skills pertaining to a particular field of study, impart practical skills, hands-on training, soft skills, etc., in order to enhance the student's employability.

Internship:

Internship is a course to develop a professional ability through an appropriate learning. The duration of Internship is of 120 hours during summer vacation.

Research Project:

Research Project is a course involving applications of knowledge in exploring, analysing and solving real-life situations/problems.

Dissertation:

Dissertation is a long piece of academic writing based on original research.

Value Added Course (VAC):

Value Added Course aims to add the knowledge of learner beyond academic disciplines.

Semester/Academic Year

A semester comprises 90 working days and an academic year is divided into two semesters.

Academic Bank Account

Academic Bank Account is an individual account with the Academic Bank of Credits opened and operated by a student, to which all academic credits earned by the student from course(s) of study are deposited, recognized, maintained, accumulated, transferred, validated or redeemed for the purposes of the award of degree/diploma/certificates etc. by an awarding institution.

Multiple Entry and Exit Points

These are stages where the students may have options for entry and exit as per UGC Guidelines for Multiple Entry and Exit in Academic Programs.

Credit Point: It is the product of the grade point and the number of credits for a course.

Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale.

Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by letters O, A+, A, B+, B, C, P and F.

Semester Grade Point Average (SGPA): The SGPA is the ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.

Cumulative Grade Point Average (CGPA): The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

SCHEME OF EXAMINATIONS FOR LIFE SCIENCES/PHYSICAL SCIENCES PROGRAM WITH HONS. IN ONE MAJOR DISCIPLINE

B.Sc. (Life Sciences/Physical Sciences) with Hons. in Chemistry

Semester I (Session 2024-25)															
Discipline Specific Courses/ Major Course			**Credits Distribution**			**Total Credits**	**Workload**			**Total Workload**	**Marks**				
	Nomenclature	**Course Code**	**L**	**T**	**P**		**L**	**T**	**P**		**Theory**		**Practical**		**Total Marks**
											Internal	**External**	**Internal**	**External**	
DSC - A1 @ 4 credits	Fundamental Chemistry – I	**24CHEM401DS01**	2	0	0	**04**	2	0	0	**06**	15	35	---	---	**100**
	Chemistry Practical (MD) – I		0	0	2		0	0	4		---	---	15	35	
DSC - B1 @ 4 credits	OS (Physics/ Botany/ Zoology)	**Op-I**				**04**									**100**
DSC - C1 @ 4 credits	OS (Maths/ Botany/ Zoology)	**Op-II**				**04**									**100**
Minor Courses															
MIC 1 @ 4 credits	Basic Concepts of Chemistry	**24CHE401MI01**	2	0	0	**04**	2	0	0	**06**	15	35	---	---	**100**
	Minor Chemistry Practical – I		0	0	2		0	0	4		---	---	15	35	
Skill Enhancement Courses (To be chosen from pool of SEC provided by the University)															
SEC 1 @ 3 credits	SECI-Role of Chemistry in Society	**24CHE401SE01**	2	0	0	**03**	2	0	0	**04**	15	35	---	---	**75**
	SEC Chemistry Practical – I		0	0	1		0	0	2		---	---	05	20	
Multidisciplinary Courses (To be chosen from pool of MDC provided by the University)															
MDC1 @ 3 credits	MDCI-Basics of Chemistry	**24CHEX01MD01**	2	0	0	**03**	2	0	0	**04**	15	35	---	---	**75**
	MDC Chemistry Practical – I		0	0	1		0	0	2		---	---	05	20	
Ability Enhancement Courses (To be chosen from pool of AEC provided by the University)															
AEC1 @ 2 credits	AEC-I		2	0	0	**02**	2	0	0	**02**	15	35	---	---	**50**
		Total				**24**									**600**

Semester II (Session 2024-25)															
DSC – A2 @ 4 credits	Fundamental Chemistry – II	**24CHEM402DS01**	2	0	0	**04**	2	0	0	**06**	15	35	---	---	**100**
	Chemistry Practical (MD) – II		0	0	2		0	0	4		---	---	15	35	
DSC – B2 @ 4 credits	OS (Physics/ Botany/ Zoology)	**Op-I**				**04**									**100**
DSC – C2 @ 4 credits	OS (Maths/ Botany/ Zoology)	**Op-II**				**04**									**100**
Skill Enhancement Courses (To be chosen from pool of SEC provided by the University)															
SEC 2 @ 3 credits	SECII-Fuel Chemistry	**24CHE402SE01**	2	0	0	**03**	2	0	0	**04**	15	35	---	---	**75**
	SEC Chemistry Practical – II		0	0	1		0	0	2		---	---	05	20	
Multidisciplinary Courses (To be chosen from pool of MDC provided by the University)															
MDC 2 @ 3 credits	MDCII-Essentials of Chemistry	**24CHEX02MD01**	2	0	0	**03**	2	0	0	**04**	15	35	---	---	**75**
	MDC Chemistry Practical – II		0	0	1		0	0	2		---	---	05	20	
Ability Enhancement Courses (To be chosen from pool of AEC provided by the University)															
AEC 2 @ 2 credits	AEC-II		2	0	0	**02**	2	0	0	**02**	15	35	---	---	**50**
Value Added Courses (To be chosen from pool of VAC provided by the University)															
VAC 1 @ 2 credits	VAC-I		2	0	0	**02**	2	0	0	**02**	15	35	---	---	**50**
VAC 2 @ 2 credits	VAC-II		2	0	0	**02**	2	0	0	**02**	15	35	---	---	**50**
		Total				**24**									**600**

***Students exiting the Program after semester-II and securing 52 credits including 4 credits of summer internship will be awarded UG Certificate in the relevant Discipline/ Subject.*

Semester III (Session 2025-26)															
DSC – A3 @ 4 credits	Fundamental Chemistry – III	**25CHEM403DS01**	2	0	0	**04**	2	0	0	**06**	15	35	---	---	**100**
	Chemistry Practical (MD) – III		0	0	2		0	0	4		---	---	15	35	
DSC – B3 @ 4 credits	OS (Physics/ Botany/ Zoology)	**Op-I**				**04**									**100**
DSC – C3 @ 4 credits	OS (Maths/ Botany/ Zoology)	**Op-II**				**04**									**100**
Minor Courses															
MIC 2 @ 4 credits	Chemistry of Metals & Non-Metals, Hydrocarbons and Solutions	**25CHE403MI01**	2	0	0	**04**	2	0	0	**06**	15	35	---	---	**100**
	Minor Chemistry Practical – II		0	0	2		0	0	4		---	---	15	35	
Skill Enhancement Courses (To be chosen from pool of SEC provided by the University)															
SEC 3 @ 3 credits	SECIII-Batteries	**25CHE403SE01**	2	0	0	**03**	2	0	0	**04**	15	35	---	---	**75**
	SEC Practical – III		0	0	1		0	0	2		---	---	05	20	
Multidisciplinary Courses (To be chosen from pool of MDC provided by the University)															
MDC 3 @ 3 credits	MDCIII-Core Chemistry	**25CHEX03MD01**	2	0	0	**03**	2	0	0	**04**	15	35	---	---	**75**
	MDC Chemistry Practical – III		0	0	1		0	0	2		---	---	05	20	
Ability Enhancement Courses (To be chosen from pool of AEC provided by the University)															
AEC 3 @ 2 credits	AEC-III		2	0	0	**02**	2	0	0	**02**	15	35	---	---	**50**
		Total				**24**									**600**

Semester IV (Session 2025-26)															
DSC – A4 @ 4 credits	Fundamental Chemistry – IV	**25CHEM404DS01**	2	0	0	**04**	2	0	0	**06**	15	35	---	---	**100**
	Chemistry Practical (MD) – IV		0	0	2		0	0	4		---	---	15	35	
DSC – B4 @ 4 credits	OS (Physics/ Botany/ Zoology)	**Op-I**				**04**									**100**
DSC – C4 @ 4 credits	OS (Maths/ Botany/ Zoology)	**Op-II**				**04**									**100**
Minor Courses															
MIC 3 @ 4 credits	Molecular Structure, Thermodynamics, Equilibrium & Alkyl Halides	**25CHE404MV01**	2	0	0	**04**	2	0	0	**06**	15	35	---	---	**100**
	Minor Chemistry Practical – III		0	0	2		0	0	4		---	---	15	35	
Ability Enhancement Courses (To be chosen from pool of AEC provided by the University)															
AEC 4 @ 2 credits	AEC-IV		2	0	0	**02**	2	0	0	**02**	15	35	---	---	**50**
Value Added Courses (To be chosen from pool of VAC provided by the University)															
VAC 3 @ 2 credits	VAC-III		2	0	0	**02**	2	0	0	**02**	15	35	---	---	**50**
		Total				**20**									**500**

***Students exiting the Program after semester-IV and securing 96 credits including 4 credits of summer internship will be awarded UG Diploma in the relevant Discipline/Subject.*

Semester V (Session 2026-27)															
DSC – A5 @ 4 credits	Fundamental Chemistry – V	**26CHEM405DS01**	2	0	0	**04**	2	0	0	**06**	15	35	---	---	**100**
	Chemistry Practical (MD) – V		0	0	2		0	0	4		---	---	15	35	
DSC – B5 @ 4 credits	OS (Physics/ Botany/ Zoology)	**Op-I**				**04**									**100**
DSC – C5 @ 4 credits	OS (Maths/ Botany/ Zoology)	**Op-II**				**04**									**100**
Minor Courses															
MIC 4 (VOC) @ 4 credits	Chemistry of Pnictogens, Ionic Solids, Electrochemistry and Aryl Halides	**26CHE405MV01**	2	0	0	**04**	2	0	0	**06**	15	35	---	---	**100**
	Minor Chemistry Practical – IV		0	0	2		0	0	4		---	---	15	35	
Internship @ 4 credits#	Internship	**26CHE405IN01**	4	0	0	**04**									**100**
		Total				**20**									**500**

Semester VI (Session 2026-27)															
DSC – A6 @ 4 credits	Fundamental Chemistry – VI	**26CHEM406DS01**	2	0	0	**04**	2	0	0	**06**	15	35	---	---	**100**
	Chemistry Practical (MD) – VI		0	0	2		0	0	4		---	---	15	35	
DSC – B6 @ 4 credits	OS (Physics/ Botany/ Zoology)	**Op-I**				**04**									**100**
DSC – C6 @ 4 credits	OS (Maths/ Botany/ Zoology)	**Op-II**				**04**									**100**
Minor Courses															
MIC 5 (VOC) @ 4 credits	Transition Metals, Batteries, Alcohols & Phenols	**26CHE406MV01**	2	0	0	**04**	2	0	0	**06**	15	35	---	---	**100**
	Minor Chemistry Practical – V		0	0	2		0	0	4		---	---	15	35	
MIC 6 (VOC) @ 4 credits	Chemistry of Polymer, Kinetics, Carbonyl Compounds & Coordination Complexes	**26CHE406MV02**	2	0	0	**04**	2	0	0	**06**	15	35	---	---	**100**
	Minor Chemistry Practical – VI		0	0	2		0	0	4		---	---	15	35	
		Total				**20**									**500**

Students will be awarded 3-year UG Degree in the relevant Discipline/Subject upon securing 132 credits.

Note:

1) Health Risk Allowance may be recommended.

2) Practical Groups: 15 students per Group (B.Sc. 1st, 2nd and 3rd year)

3) Workload: B.Sc. Physical Sciences – 20 Hours/Week

Semester VII (Session 2027-28)															
DSC – H1 @ 4 credits	Coordination and Crystal Chemistry	**27CHEH407DS01**	4	0	0	**04**	4	0	0	**04**	30	70	---	---	**100**
DSC – H2 @ 4 credits	Quantum, Thermodynamics and Electrochemistry	**27CHEH407DS02**	4	0	0	**04**	4	0	0	**04**	30	70	---	---	**100**
DSC – H3 @ 4 credits	Organic Bonding, Reactions and Stereochemistry	**27CHEH407DS03**	4	0	0	**04**	4	0	0	**04**	30	70	---	---	**100**
DSC – H4 @ 4 credits	Inorganic Chemistry Practical – I	**27CHEH407DS04**	0	0	4	**04**	0	0	8	**08**	---	---	30	70	**100**
DSC – H5 @ 4 credits	Physical Chemistry Practical – I	**27CHEH407DS05**	0	0	4	**04**	0	0	8	**08**	---	---	30	70	**100**
Student has to opt either a Skill Enhancement Course (SEC 5) or Minor Course (MIC 7)															
Skill Enhancement Courses (To be chosen from pool of SEC provided by the University)															
SEC 5 @ 4 credits (if offered as an option)	Organic Chemistry Practical – I	**27CHE407SE01**	0	0	4	**04**	0	0	8	**08**	---	---	30	70	**100**
Minor Courses															
MIC 7 (VOC) @ 4 credits	Organometallics, Surface Chemistry & Carbohydrates	**27CHE407MV01**	2	0	0	**04**	2	0	0	**06**	15	35	---	---	**100**
	Minor Chemistry Practical – VII		0	0	2		0	0	4		---	---	15	35	
		Total				**24**									**600**

STUDENT SHOULD SELECT ANYONE OPTION FOR THE 8TH SEM. OF THE UG PROGRAM Semester VIII (Session 2027-28) **OPTION-I**															
DSC – H6 @ 4 credits	General Spectroscopy	**27CHEH408DS01**	4	0	0	**04**	4	0	0	**04**	30	70	---	---	**100**
DSC – H7 @ 4 credits	Research Methodology	**27CHEH408DS02**	4	0	0	**04**	4	0	0	**04**	30	70	---	---	**100**
DSC – H8 @ 4 credits	Special Chemistry	**27CHEH408DS03**	4	0	0	**04**	4	0	0	**04**	30	70	---	---	**100**
DSC – H9 @ 4 credits	Inorganic Chemistry Practical – II	**27CHEH408DS04**	0	0	4	**04**	0	0	8	**08**	---	---	30	70	**100**
DSC – H10 @ 4 credits	Physical Chemistry Practical –II	**27CHEH408DS05**	0	0	4	**04**	0	0	8	**08**	---	---	30	70	**100**
Student has to opt either a Skill Enhancement Course (SEC 6) or Minor Course (MIC 8)															
Skill Enhancement Courses (To be chosen from pool of SEC provided by the University)															
SEC 6 @ 4 credits (if offered as an option)	Organic Chemistry Practical – II	**27CHE408SE01**	0	0	4	**04**	0	0	8	**08**	---	---	30	70	**100**
Minor Courses															
MIC 8 (VOC) @ 4 credits	Chemistry of Acid-Base, Dyes, Bio-inorganics, Photochemistry, and Carbohydrates	**27CHE408MV01**	2	0	0	**04**	2	0	0	**06**	15	35	---	---	**100**
	Minor Chemistry Practical – VIII		0	0	2		0	0	4		---	---	15	35	
		Total				**24**									**600**

Semester VIII (Session 2027-28) **OPTION-II**															
DSC – H6 @ 4 credits	General Spectroscopy	**27CHEH408DS01**	4	0	0	**04**	4	0	0	**04**	30	70	---	---	**100**
DSC – H7 @ 4 credits	Research Methodology	**27CHEH408DS02**	4	0	0	**04**	4	0	0	**04**	30	70	---	---	**100**
DSC – H8 @ 4 credits	Research Project/ Dissertation	**27CHE408PD01**	0	0	12	**04**	0	0	24	**24**	---	---	---	---	**300**
Student has to opt either a Skill Enhancement Course (SEC 6) or Minor Course (MIC 8)															
Skill Enhancement Courses (To be chosen from pool of SEC provided by the University)															
SEC 6 @ 4 credits (if offered as an option)	Inorganic Chemistry Practical – II OR Physical Chemistry Practical – II OR Organic Chemistry Practical – II	**27CHE408SE01** **OR** **27CHE408SE02** **OR** **27CHE408SE03**	0	0	4	**04**	0	0	8	**08**	---	---	30	70	**100**
Minor Courses															
MIC 8 (VOC) @ 4 credits	Chemistry of Acid-Base, Dyes, Bio-inorganics, Photochemistry, and Carbohydrates	**27CHE408MV01**	2	0	0	**04**	2	0	0	**06**	15	35	---	---	**100**
	Minor Chemistry Practical – VIII		0	0	2		0	0	4		---	---	15	35	
		Total				**24**									**600**

Note:

Student should select one major discipline (Out of A, B, or C studied during first three years of UG Programs) in which he/she wishes to pursue Honors. This framework is subjected to modification as per UGC guidelines at the university level. The universities may decide to offer the Honors degree Programs subject to the fulfilment of credit point table.

#Four credits of internship earned by a student during summer internship after semester-II or semester-IV will be counted in semester-V of a student who pursue 3-year UG Programs without taking exit option.

Syllabi for B.Sc. (Life Sciences/Physical Sciences) with Hons. in Chemistry

Semester — I (Session: 2024-25)

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – I**	**Nomenclature**	**Fundamental Chemistry – I**
Name of the Course	**Discipline Specific Course**	**Course Code**	**24CHEM401DS01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The course reviews basic knowledge about ionic, covalent and metallic bonding and explains that chemical bonding is best regarded as a continuum between the three cases. It further discusses the patterns and trends exhibited by p-block elements and their compounds with emphasis on structure, synthesis, bonding and uses. The aim of this course is also to make students understand the ideal and real gas behaviour. It is infused with the recapitulation of fundamentals of organic chemistry and the introduction of a new concept of visualizing the organic molecules in a three-dimensional space.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Develop the ability to predict and explain the shapes of simple inorganic molecules and ions using the hybridization, VB and MO theories.

CLO2: Demonstrate problem-solving skills related to ionic bonding, including the calculation of percentage ionic character from dipole moment and electronegativity difference.

CLO3: Understand the concept of acid-base reactions in aqueous and non-aqueous solvents.

CLO4: Derive mathematical expressions for different properties of real and ideal gases and also understand their physical significance.

CLO5: Explain the behaviour of real gases and the concept of gas equations.

CLO6: Understand and explain the different nature and behavior of organic compounds based on fundamental concepts learnt.

CLO7: Understand the fundamental concepts of stereochemistry.

Unit–I

Chemical Bonding and Molecular Structure

Ionic bond, lattice energy, Born-Haber cycle and its applications, Fajan's rules, hydration energy, bond moment, dipole moment and percentage ionic character. Resonance and resonance energy: study of some inorganic and organic compounds. Molecular Orbital Approach: LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combination of atomic orbitals, non- bonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as O_2^-, O_2^{2-}, N_2^-, CO, NO^+, CN^-. Comparison of VB and MO approaches.

Unit–II
p-Block Elements Oxides – structures of oxides of N, P. Oxyacids – structure and relative acid strengths of oxyacids of nitrogen and phosphorus. Structure of white, yellow and red phosphorus. Oxyacids of sulphur – structures and acidic strength, H_2O_2–structure, properties and uses. Basic properties of halogen, interhalogen compounds-types and properties, halogen-acids and oxyacids of chlorine – structure and comparison of acidic strength. **Acids and Bases:** Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept.
Unit–III
Gaseous States Maxwell's distribution of velocities and energies (derivation excluded), calculation of root mean square velocity, average velocity and most probable velocity. Collision diameter, collision number, collision frequency and mean free path, deviation of real gases from ideal behaviour, derivation of Van der Waals Equation of state and its applications in the calculation of Boyle's temperature (compression factor), explanation of behavior of real gases using Van der Waals equation. **Critical Phenomenon:** Critical temperature, critical pressure, critical volume and their determination. PV isotherms of real gases, continuity of states, isotherms of Van der Waals equation, relationship between critical constants and Van der Waals constants, compressibility factor. Law of corresponding states.
Unit–IV
Basics of Organic Chemistry and Stereochemistry Electronic displacements and its applications, reaction intermediates and concept of aromaticity. Concept of isomerism, types of isomerism, optical isomerism, optical activity, elements of symmetry, molecular chirality, enantiomers, stereogenic centre, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization, relative and absolute configuration, sequence rules, R & S system of nomenclature.
Books Recommended/References:
1. Concise Inorganic Chemistry by J. D. Lee. 2. Inorganic Chemistry- Principles of Structure and Reactivity by J. E. Huheey, E. A Keiter, R. L. Keiter and O. K. Medhi. 3. Concepts and Models of Inorganic Chemistry by B. E. Douglas, D. H. McDaniel and J. J. Alexander. 4. Physical Chemistry by P. W. Atkins and J. de. Paula. 5. A Textbook of Physical Chemistry (Vol. 1) by K. L. Kapoor. 6. Organic Chemistry by R. T. Morrison, R. N. Boyd. 7. Basic Organic Chemistry by R. Chandra, S. Singh and A. Singh. 8. Stereochemistry of Organic Compounds by E. L. Eliel and S. H. Wilen.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – I**	**Nomenclature**	**Chemistry Practical (MD) – I**
Name of the Course	**Discipline Specific Course**	**Course Code**	**24CHEM401DS01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**04**	**External Marks**	**35**

Duration of Examination	04 Hrs.	Internal Marks	15

Syllabus Objectives: This course aims to provide a fundamental knowledge of acidity, basicity and redox reaction. It further develops a clear understanding of principle of Abbe's refractometer, refractive index and its determination. Students will gain a comprehensive understanding of the fundamental principles of distillation. This course also provides an overview of the purification of organic compounds and the criteria of purity.

***Note: Examiner will set two experiments for practical examinations*.** **(12×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:
CLO1: Prepare different types of solutions.
CLO2: Estimate the strength of various unknown solution in acid-base and redox titrations.
CLO3: Determine the refractive index by using Abbe's refractometer.
CLO4: Calibrate thermometer and can determine the B.P. and M.P. of organic compounds.
CLO5: Learn preparation and purification of organic compounds.

List of Experiments

Unit–I (Inorganic)

1. Acid-Base Titrations

(i) Determination of strength of HCl and CH_3COOH using NaOH.

(ii) Estimation of sodium carbonate using standardized HCl.

2. Redox titrations: Determination of Fe^{2+}, $C_2O_4^{2-}$ (using $KMnO_4$ and $K_2Cr_2O_7$).

Unit–II (Physical)

1. Refractometry

(i) Determine the refractive index of given solutions: Ethyl acetate, benzene, ethylene dichloride, chloroform, water and n-hexane by using Abbe's refractometer.

(ii) Determine the specific refraction of given liquids: Ethyl acetate, benzene, ethylene dichloride, chloroform, water and n-hexane by using Abbe's refractometer.

Unit–III (Organic)

1. Purification of organic compounds by crystallization using the following solvents:

(i) Water

(ii) Alcohol

(iii) Alcohol-Water

2. Preparation and purification through crystallization or distillation and ascertaining their purity through melting point:

(i) Dibenzalacetone from acetone and benzaldehyde.

(ii) Phenylhydrazone of cyclohexanone.

Viva-Voce **(06 Marks)**

Note Book **(05 Marks)**

Books Recommended/References:

1. A text Book of Quantitative Inorganic Analysis by A. I. Vogel.
2. Applied Analytical Chemistry by O. P. Vermani.
3. Vogel's Quantitative Chemical Analysis by J. Mendham.
4. Vogel's Qualitative Inorganic Analysis by G. Svehla.
5. Practical Inorganic Chemistry by Marr & Rockett.
6. Synthesis and Characterization of Inorganic Compounds by W. L. Jolly.
7. Instrumental Methods of Analysis by B. K. Sharma.
8. Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler, and S. R. Crouch.
9. Senior Practical Physical Chemistry by B. D. Khosla.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – I**	**Nomenclature**	**Basic Concepts of Chemistry**
Name of the Course	**Minor Course**	**Course Code**	**24CHE401MI01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus objectives: The course reviews the structure of atom, which is a necessary pre-requisite in understanding the nature of chemical bonding in compounds. It discusses the periodicity in properties with reference to the s and p-block, which is necessary in understanding their group chemistry. The students will learn about mole concept, molar mass and molecular formula and stoichiometry principle. The course is infused with the recapitulation of fundamentals of organic chemistry. To establish the applications of these concepts, aliphatic and aromatic hydrocarbons are introduced. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Understand the atomic models by various atomic theories.

CLO2: Understand the structural idea and relevance in describing shapes of s, p and d orbitals.

CLO3: Understand the periodicity in atomic and ionic radii, electronegativity, ionization energy, electron affinity of elements of the periodic table and anomalous behavior of elements.

CLO4: Recapitulate the mole concept.

CLO5: Learn to apply stoichiometric principles to determine the quantities of reactants and products involved in chemical reactions.

CLO6: Understand the basic concepts of organic chemistry.

Unit–I

Atomic Structure

Atomic models, Rutherford's model and its limitations, Bohr's model and its applications, dual nature of matter and light, de Broglie's relationship, Heisenberg uncertainty principle, concept of orbitals, quantum numbers, shapes of s, p and d orbitals, rules for filling electrons in orbitals - Aufbau principle, Pauli's exclusion principle and Hund's rule, electronic configuration of atoms, stability of half-filled and completely filled orbitals.

Unit–II

Periodic Table and Atomic Properties

Brief history of the development of periodic table, modern periodic law and the present form of periodic table, periodic trends in properties of elements -atomic radii, ionic radii, inert gas radii, ionization enthalpy, electron gain enthalpy, electronegativity, valency. Nomenclature of elements with atomic number greater than 100.

Unit–III

Mole Concept

Atomic mass, mole concept and molar mass, Avogadro's number and its significance, percentage composition, empirical and molecular formula, chemical reactions, ways of expressing concentration of solutions (molarity, normality, molality, mole percentage, strength), stoichiometric calculations involving reactants and products.

Unit–IV
Fundamentals of Organic Chemistry Electronic displacements: Inductive effect, electromeric effect, resonance, hyperconjugation. Cleavage of bonds: homolysis and heterolysis. Reaction intermediates: carbocations, carbanions, free radicals, and carbenes. Electrophiles and nucleophiles. Aromaticity: benzenoids and Huckel's rule.
Books Recommended/References:
1. NCERT Chemistry Textbook for class 11^{th} and 12^{th}. 2. Modern Inorganic Chemistry by R. D. Madan. 3. A Textbook Inorganic Chemistry by O. P. Tandon. 4. Essentials of Physical Chemistry by A. Bahl, B. S. Bahl and G. D. Tuli. 5. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania. 6. Organic Chemistry by R. T. Morrison and R. N. Boyd. 7. Organic Chemistry by I. L. Finar. 8. Basic Organic Chemistry by R. Chandra, S. Singh and A. Singh.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – I**	**Nomenclature**	**Minor Chemistry Practical – I**
Name of the Course	**Minor Course**	**Course Code**	**24CHE401MI01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**04**	**External Marks**	**35**
Duration of Examination	**04 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The objective of this course is to furnish students with fundamental knowledge in volumetric titration. Students will be able to demonstrate a comprehensive understanding of surface tension including its principles, measurement techniques and practical applications in various fields. It further develops a clear understanding of the purification of organic compounds by crystallization and the criteria of purity.

***Note: Examiner will set two experiments for practical examinations*.** **(12×2) Marks**

Course Learning Outcomes: By the end of the course, the students will be able to:
CLO1: Learn the preparation of various solutions.
CLO2: Understand estimation of strength of various unknown solution in acid-base titrations.
CLO3: Determine the surface tension using drop number method.
CLO4: Do purification of organic compounds.
CLO5: Learn about the calibration of thermometer and determination of B.P. and M.P. of organic compounds.

List of Experiments

Unit–I (Inorganic)

1. Determination of strength of oxalic acid using NaOH by volumetric titration.
2. Estimation of oxalic acid with acidified $KMnO_4$ by volumetric titration.

Unit–II (Physical)

1. Determination of strength of HCl using NaOH by volumetric titration.
2. Determination of the surface tension of a liquid by drop number method.

(i) Water
(ii) Alcohol

Unit–III (Organic)	
1. Purification of organic compounds by crystallization using the following solvents: (i) Water (ii) Alcohol (iii) Alcohol-Water 2. Criteria of purity: Determination of M.P./B.P.	
Viva-Voce	**(06 Marks)**
Note Book	**(05 Marks)**
Books Recommended/References:	
1. A text Book of Quantitative Inorganic Analysis by A. I. Vogel. 2. Applied Analytical Chemistry by O. P. Vermani. 3. Vogel's Quantitative Chemical Analysis by J. Mendham. 4. Instrumental Methods of Analysis by B. K. Sharma. 5. Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler, and S. R. Crouch. 6. Senior Practical Physical Chemistry by B. D. Khosla.	

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**SEC Paper – I**	**Nomenclature**	**Role of Chemistry in Society**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**24CHE401SE01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: This course aims to provide a comprehensive understanding of analytical techniques in chemistry and environmental science. Students will learn soil and water analysis methods, including pH measurement, complexometric titrations and estimation of ions. Additionally, it covers the preparation and uses of various personal care products, introduction to pesticides and the principles behind fuel production and purification processes, emphasizing sustainability and environmental impact.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Demonstrate proficiency in analysing soil and water samples, including pH measurement and estimation of ions.

CLO2: Understand the preparation and applications of personal care products.

CLO3: Gain knowledge of pesticides, their synthesis methods, benefits and adverse effects.

CLO4: Know the principles behind fuel production processes including fractional distillation and cracking, emphasizing sustainability and clean fuel technologies.

Unit–I

Analysis of Soil and Water

Composition of soil, concept of pH and pH measurement of soil, complexometric titrations, chelation, chelating agents, use of indicators, estimation of calcium and magnesium ions in soil. Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods, determination of dissolved oxygen of a water sample.

Unit–II
Chemistry in Cosmetics A general study including preparation and uses of the following: Hair dye, soap, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel.
Unit–III
Pesticides General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, brief introduction of structure activity relationship, synthesis and technical manufacture and uses of representative pesticides in the following classes: organochlorines (gammexene), organophosphates (malathion).
Unit–IV
Experimental Techniques Basic principle of pH metric, potentiometric and conductometric titrations, applications of conductivity measurements: determination of degree of dissociation, determination of K_a of acids and base, buffer solution, buffer action, Henderson–Hazel equation, buffer mechanism of buffer action.
Books Recommended/References:
1. Instrumental Methods of Analysis by D. A. Skoog, F. J. Holler and S. R. Crouch. 2. Chemistry In Daily Life by K. Singh. 3. General Chemistry Principles, Patterns, and Applications by B. Averill. 4. Engineering Chemistry by P. C. Jain and M. Jain. 5. Industrial Chemistry by B. K. Sharma. 6. Pesticides by R. J. Cremlyn. 7. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**SEC Paper – I**	**Nomenclature**	**SEC Chemistry Practical – I**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**24CHE401SE01**
Credits	**01**	**Maximum Marks**	**25**
Hours per Week	**02**	**External Marks**	**20**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**05**
Syllabus Objectives: This course aims to make the students understand the colloidal solution, their preparation and principle of paper chromatography. It aims to build concepts related to the detection of sulphur in organic compounds as well as purity and purification methods for organic compounds.			
***Note: Examiner will set two experiments for practical examinations*.** **(7×2) Marks**			
Course Learning Outcomes (CLO): By the end of the course, the students will be able to: **CLO1:** Learn preparation of colloidal solution. **CLO2:** Check the purity of compounds. **CLO3:** Explore detection of sulphur. **CLO4:** Learn about the purification methods of organic compounds. **CLO5:** Understand the principle of paper chromatography.			

List of Experiments
1. Preparation of colloidal solution of ferric hydroxide [$Fe(OH)_3$]. 2. Check the purity of organic compounds. (By determination of melting and boiling points). 3. Detection of sulphur in organic compound by Nitroprusside test and Lead acetate test. 4. Purification of the organic compounds by crystallization (from water and alcohol) and distillation methods. 5. Separation of mixture of organic compounds by paper chromatography. 6. Separation of mixture of inks (blue, red and green) by paper chromatography.
Viva-Voce **(03 Marks)**
Note Book **(03 Marks)**
Books Recommended/References:
1. Laboratory Manual Chemistry of NCERT for class 11^{th} and 12^{th}. 2. Basic Concepts: Physical Chemistry Experiments by N. Seedher. 3. Senior Practical Physical Chemistry by B. D. Khosla. 4. Practical Chemistry by O. P. Pandey, D. N. Bajpai and S. Giri. 5. Practical Organic Chemistry – A Primer by V. Peesapati. 6. Practical Organic Chemistry by A. K. Manna.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**MDC Paper – I**	**Nomenclature**	**Basics of Chemistry**
Name of the Course	**Multidisciplinary Course**	**Course Code**	**24CHEX01MD01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The course aims to provide a foundational understanding of basic chemistry concepts such as Dalton's atomic theory, atomic structure, chemical reactions and states of matter. It is also infused with the atomic models, electronic configurations and laws governing gases, liquids, and solids. Additionally, it explores practical applications of chemistry in everyday life, including the classification of drugs, food additives and cleansing agents like soaps and detergents.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:
CLO1: Understand the fundamental principles of chemistry and classification of matter.
CLO2: Demonstrate proficiency in molecular mass calculations and the mole concept for quantifying substances.
CLO3: Analyse atomic structure, quantum numbers and the stability of orbitals.
CLO4: Apply the knowledge of states of matter and characteristics of liquids and solids.
CLO5: Know about drugs, food adulterants and preservatives.

Unit–I

Basic Concepts of Chemistry

Introduction, Dalton atomic theory, concept of atom, element and molecule, matter and its classification, chemical reactions, empirical and molecular formula, atomic mass, molecular mass, mole concept, ways of expressing concentration of solutions (molarity, normality, molality, mole fraction, strength).

Unit–II
Atomic Structure Thomson's model, Rutherford's model, Bohr's model, electron, proton, neutron and their characteristics, atomic number, atomic mass, isotopes, isobars and isotones, dual nature of matter and light, de Broglie's relationship, Heisenberg Uncertainty principle, concept of orbit and orbital, quantum numbers, shapes of s, p and d orbitals, rules for filling electrons in the orbitals (Aufbau principle, Pauli exclusion principle and Hund's rule), electronic configuration of atoms, extra stability of half-filled and completely filled orbitals.
Unit–III
States of Matter Introduction to the three states of matter and intermolecular interactions. Gaseous state: Boyle's law, Charles' law, Gay Lussac's law and Avogadro's Law with practical implications. Elementary idea of kinetic energy, molecular speeds, ideal gas equation and deviation from ideal behavior. Liquid state: Melting and boiling points, vapor pressure, viscosity and surface tension. Solid state: General characteristics of solid state, crystalline and amorphous solids, classification of crystalline solids.
Unit–IV
Chemistry in Everyday Life Drugs and their classification with suitable examples, food adulterants and preservatives, artificial sweetening agents, antioxidants, soaps and detergents and their cleansing action.
Books Recommended/References:
1. Text Books of N.C.E.R.T for 11th and 12th class. 2. Principles of Physical Chemistry by M. S. Pathania, B. R. Puri and L. R. Sharma. 3. Advanced Physical Chemistry by G. Raj. 4. Chemistry in Everyday Life by R. Tyagi. 5. A Textbook of Organic Chemistry by B. S. Bahl and A. Bahl. 6. Chemistry in Everyday Life by O. P. Agarwal.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**MDC Paper – I**	**Nomenclature**	**MDC Chemistry Practical – I**
Name of the Course	**Multidisciplinary Course**	**Course Code**	**24CHEX01MD01**
Credits	**01**	**Maximum Marks**	**25**
Hours per Week	**02**	**External Marks**	**20**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**05**
Syllabus Objectives: This course aims to provide a fundamental knowledge of calibration and use of apparatus, preparation of solution of titrants of different molarity/normality, acidity and basicity. It further develops a clear understanding of pH and its determination. Students will gain a comprehensive understanding of the fundamental principles of distillation. This course also provides an overview of the purification of organic compounds and the criteria of purity.			
***Note: Examiner will set two experiments for practical examinations*.** **(7×2) Marks**			
Course Learning Outcomes (CLO): By the end of the course, the students will be able to: **CLO1:** Prepare different types of solution. **CLO2:** Calibrate and use the apparatus properly.			

CLO1: Determine the pH, acidity and basicity of water samples.
CLO2: Analyse the pH of soil samples.
CLO3: Learn lime water test.
CLO4: Check adulteration in different food materials.
CLO5: Purify impure sample of water by using simple distillation.

List of Experiments

1. Titrimetric analysis:
   a) Calibration and use of apparatus.
   b) Preparation of solution of different molarity/normality.
2. To check acidity, alkalinity and pH of water by litmus paper or pH strips.
3. To determine pH of soil.
4. Lime water test: for the detection of CO_2.
5. Checking the adulteration in given food materials (Milk, edible oil, sugar, turmeric and chilli powder).
6. To obtain pure water from impure water containing ink by simple distillation method.

Viva-Voce **(03 Marks)**

Note Book **(03 Marks)**

Books Recommended/References:

1. Laboratory Manual Chemistry of NCERT for class 11^{th} and 12^{th}.
2. Food Processing and Preservation by G. Subbulakshmi.
3. Basic Concepts: Physical Chemistry Experiments by N. Seedher.
4. B.Sc. Chemistry Practical by S. Goyal.

Semester — II (Session: 2024- 25)

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – II**	**Nomenclature**	**Fundamental Chemistry – II**
Name of the Course	**Discipline Specific Course**	**Course Code**	**24CHEM402DS01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The objective of this paper is to develop basic understanding of the non-aqueous solvents, noble gases, laws of thermodynamics & hydrocarbons. It discusses about the structure of noble gases, their properties and their use in daily life as well as industrial applications. This makes students understand thermodynamic concepts, terminology, properties of thermodynamic systems, laws of thermodynamics and their correlation with other branches of physical chemistry. This also includes the concept, structure, methods of preparation and reactions for the following classes of compounds: alkanes, alkenes, alkynes, dienes and aromatic hydrocarbons.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:
CLO1: Understand the basic characteristics and reactions in non-aqueous solvents.
CLO2: Learn about the structure of noble gases, their properties and discuss their use in daily life as well as industrial applications.

CLO3: Derive the expressions of various thermodynamic potentials for ideal and real gases under different conditions.
CLO4: Understand the concept of entropy and change in entropy by changing different thermodynamic variables.
CLO5: Understand basic chemistry of alkanes and alkenes.
CLO6: Learn and identify many organic reaction mechanisms including free radical substitution, electrophilic addition and electrophilic aromatic substitution.

Unit–I

Non-aqueous Solvents

Physical properties of a solvent, types of solvents and their general characteristics, solvent system concept, reactions in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2. Hard and soft acids and bases (HSAB concept), applications of HSAB principle.

Noble Gases

Occurrence and uses, rationalization of inertness of noble gases, clathrates, preparation and properties, chemical properties of the noble gases, chemistry of xenon: structure and bonding in xenon fluorides, oxides and oxyfluorides (XeF_2, XeF_4, XeF_6, XeO_3, XeO_4, $XeOF_2$, XeO_2F_2, $XeOF_4$, XeF_5^+, XeF_5^-), nature of bonding in noble gas compounds (valence bond treatment and MO treatment for XeF_2 and XeF_4), molecular shapes of noble gas compounds (VSEPR theory).

Unit–II

Thermodynamics

Brief discussion upto first law of thermodynamics, heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law, Joule–Thomson coefficient for ideal gases and real gases and inversion temperature, calculation of work and heat, dU & dH for the expansion of ideal gases and real gases under isothermal and adiabatic conditions for reversible and irreversible processes, enthalpy and internal energy change at constant P, V &T, Kirchhoff's equation.

Second law of thermodynamics and its limitations, different statements of the law, Carnot's cycle and its efficiency, Carnot's theorem, thermodynamics scale of temperature. Concept of entropy– entropy as a state function, entropy change in ideal gases, entropy as a function of V & T, entropy as a function of P & T, entropy as a function of P & V, entropy as a criterion of spontaneity and equilibrium.

Unit–III

Hydrocarbons

Alkanes: Physical and chemical properties of alkanes, free radical substitutions, halogenation, concept of relative reactivity v/s selectivity.

Alkenes: Structure and isomerism, general methods of preparation, physical and chemical properties. Mechanism of E1, E2, E1cb reactions, Saytzeff and Hoffmann elimination, electrophilic addition (mechanism with suitable examples), Markownikoff rule, *syn* and *anti*-addition, addition of H_2, X_2 oxymercuration-demercuration, hydroboration- oxidation, ozonolysis, hydroxylation.

Alkynes: General methods of preparation, reactions of alkynes: acidity, electrophilic and nucleophilic additions, hydration to form carbonyl compounds, alkylation of terminal alkynes.

Unit–IV

Aromatic Hydrocarbons and Dienes

Concept of aromaticity, Huckel's rule, aromatic character of arenes, 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, nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of butadiene, chemical reactions- 1, 2 and 1, 4 additions (electrophilic and free radical mechanism), Diels – Alder reaction.

Books Recommended/References:
1. Concise Inorganic Chemistry by J. D. Lee. 2. Inorganic Chemistry- Principles of Structure and Reactivity by J. E. Huheey, E. A. Keiter, R. L. Keiter and O. K. Medhi. 3. Principles of Inorganic Chemistry by B. R. Puri, L. R. Sharma and K. C. Kalia. 4. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania. 5. An Introduction to Chemical Thermodynamics by R. P. Rastogi and R. R. Mishra. 6. A Textbook of Physical Chemistry (Vol. 2) by K. L. Kapoor. 7. Organic Chemistry by T. W. G. Solomons, C. B. Fryhle and S. A. Snyder. 8. Organic Chemistry by P. Y. Bruice. 9. Organic Chemistry by J. Clayden, N. Greeves and S. Warren.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – II**	**Nomenclature**	**Chemistry Practical (MD) – II**
Name of the Course	**Discipline Specific Course**	**Course Code**	**24CHEM402DS01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**04**	**External Marks**	**35**
Duration of Examination	**04 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The objective of this paper is to provide basic understanding of the fundamental principles of iodometric, complexometric and redox titrations. The course illustrates the diversity and fascination of physical chemistry through the study of viscosity and refractive index measurements. The students will learn about the preparation and purification of organic compounds through crystallization. This course also disseminates the concepts and methodology of sublimation process.

***Note: Examiner will set two experiments for practical examinations*.** **(12×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:
CLO1: Learn preparation of various solutions.
CLO2: Estimate the ions by iodometric and complexometric titrations.
CLO3: Determine the viscosity and molar refraction.
CLO4: Explore preparation & purification of organic compounds and study the sublimation process.

List of Experiments

Unit–I (Inorganic)

1. Volumetric Analysis

(i) **Iodometric titrations:** Determination of Cu^{2+} (using standard hypo solution).

(ii) **Complexometric titrations:** Determination of Ca^{2+}, Mg^{2+}, Zn^{2+} by EDTA.

2. Determination of water of crystallization in mohr's salt and oxalic acid by redox titration with $KMnO_4$.

Unit–II (Physical)

1. Viscometry

(i) Determine the relative and absolute viscosity of given liquid at room temperature by using Wilhelm Ostwald viscometer.

(ii) Determine the viscosity coefficient of given solution by using Wilhelm Ostwald viscometer.

2. Refractometry

(i) Determine the molar refraction of given liquids: Ethyl acetate, benzene, ethylene dichloride, chloroform, water, n-hexane by using Abbe's refractometer.

Unit–III (Organic)
1. Preparation and purification through crystallization or distillation and ascertaining their purity through melting point: (i) *m*-Dinitrobenzene from nitrobenzene. (ii) Iodoform from ethanol (or acetone). 2. Study the process of sublimation of camphor and phthalic acid. 3. Determination of boiling point of liquid compounds (by distillation method).
Viva-Voce **(06 Marks)**
Note Book **(05 Marks)**
Books Recommended/References:
1. Practical Inorganic Chemistry by Marr & Rockett. 2. Synthesis and Characterization of Inorganic Compounds by W. L. Jolly. 3. Instrumental Methods of Analysis by B. K. Sharma. 4. Advanced Physical Chemistry, Practical Handbook by G. Raj. 5. Advanced Practical Physical Chemistry by J. B. Yadav. 6. Practical Organic Chemistry by A. K. Manna. 7. Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and S. R. Crouch.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**SEC Paper – II**	**Nomenclature**	**Fuel Chemistry**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**24CHE402SE01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: This course provides an introduction to the chemistry of fuels, focusing on the composition, properties, combustion processes and environmental impacts of various types of fuels. Topics covered include solid fuels (such as coal), liquid fuels (such as crude oil, petroleum etc.), gaseous fuels (coal gas, natural gas and blast furnace gas), nuclear fuels, combustion chemistry, emissions control technologies, and sustainable energy solutions.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Gain knowledge of different types of fuels, including fossil fuels (such as petroleum, coal and natural gas), nuclear fuel, hydrogen fuel and alternative fuels (such as synthetic fuels).

CLO2: Understand the fundamental principles of fuel chemistry, including combustion mechanisms & thermochemistry relevant to fuel reactions.

CLO3: Understand the processes involved in the production, refining, synthesis of different types of fuels, including extraction, distillation, cracking, hydrogenation and fermentation.

CLO4: Learn about the chemical composition, physical properties and characteristics of various fuels.

Unit–I

Solid Fuels

Coal - origin, chemical composition, calorific value, classification, characteristics & distribution of Indian coals, storage and spontaneous combustion of coal, coal washing and blending, petrographic constituents of coal, carbonization of coal, manufacture and properties of metallurgical coke, recovery of by-products.

Unit–II
Liquid Fuels Origin and composition of crude oil, crude oil distillation and its products with special reference to gasoline, kerosene and diesel oil, cracking and reforming, coal tar distillation products, shale oil.
Unit–III
Gaseous Fuels Natural gas, coal gas, coke oven and blast furnace gas, manufacture of water gas and producer gas, carburetted water gas. Synthetic fuels: hydrogenation of coal, Fischer–Tropsch synthesis.
Unit–IV
Nuclear Fuels Introduction, nuclear fuels and nuclear reactors, moderators and structural materials, introduction to renewable energy sources. Combustion: combustion of solids fuels, calculation of volume and weight of air necessary for combustion of fuels, gas analysis.
Books Recommended/References:
1. Fuels and Combustion by S. Sarkar. 2. Elements of Fuels, Furnaces & Refractories by O. P. Gupta. 3. The Elements of Fuel Technology by G. W. Himus and L. Hill. 4. Fuel: Solid, Liquid and Gaseous by J. S. S. Brame and J. G. King.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**SEC Paper – II**	**Nomenclature**	**SEC Chemistry Practical – II**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**24CHE402SE01**
Credits	**01**	**Maximum Marks**	**25**
Hours per Week	**02**	**External Marks**	**20**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**05**

Syllabus Objectives: The course introduces the learner to prepare washing and liquid soaps, to check hardness, dissolved oxygen (DO) and chemical oxygen demand (COD) of water. This course also deals with analysis of saturation and unsaturation in organic compounds.

***Note: Examiner will set two experiments for practical examinations*.** **(7×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:
CLO1: Prepare soap by saponification.
CLO2: Check hardness of water by EDTA method.
CLO3: Detect unsaturation in organic compounds.
CLO4: Determine DO and COD values in given water sample.

List of Experiments

1. Preparation of washing soap from oils/fats.
2. Preparation of liquid soap from oils/fats.
3. To check hardness of water volumetrically by EDTA method.
4. To check saturation and unsaturation in organic compounds by Br_2 water and Bayer's reagent.
5. To determine DO and COD values in given water sample.

Viva-Voce	**(03 Marks)**
Note Book	**(03 Marks)**

Books Recommended/References:

1. Soap-Making Manual-A practical handbook on the raw materials, their manipulation, analysis and control in the modern soap plant by E. G. Thomssen.
2. Practical Chemistry by O. P. Pandey, D. N. Bajpai and S. Giri.
3. Practical Organic Chemistry by A. K. Manna.
4. Water Pollution Causes, Effects and Control by P. K. Goyal.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**MDC Paper – II**	**Nomenclature**	**Essentials of Chemistry**
Name of the Course	**Multidisciplinary Course**	**Course Code**	**24CHEX02MD01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The course aims to provide a comprehensive understanding of classification of elements and periodic properties, emphasizing on the importance of the periodic table and periodic trends. Additionally, it covers the utility of hydrocarbons in daily life, including their nomenclature, structure and use as fuels. Furthermore, the course includes polymers, their classification, synthesis methods and environmental implications, including strategies for pollution control.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:
CLO1: Understand the periodic law and periodic properties.
CLO2: Know the classification and properties of different hydrocarbons.
CLO3: Understand the preparation and uses of polymers.
CLO4: Know about causes and effects of environmental pollution.

Unit–I

Classification of Elements and Periodic Properties

Importance of classification of elements, overview and history of periodic system, modern periodic law and periodic table, periodic properties of elements, atomic and ionic size, ionization energy, electron affinity and electronegativity.

Unit–II

Hydrocarbons and their Utility in Daily Life

Introduction of hydrocarbons, classification of hydrocarbons, types of hydrocarbons(aliphatic and aromatic hydrocarbons).

Nomenclature, structure, physical properties of alkanes, alkenes and alkynes and their uses in everyday life. Aromatic hydrocarbons- Nomenclature, structure of benzene, resonance and aromaticity. Combustion and pyrolysis, hydrocarbon as fuels (natural gas, petrol, LPG, kerosene, diesel and CNG.)

Unit–III
Polymer Introduction to polymers, classification of polymers, natural and synthetic polymers, biodegradable and non-biodegradable polymers, methods of polymerization (addition and condensation polymers), preparation and use of polythene, nylon, PVC, teflon and bakelite.
Unit–IV
Environmental Chemistry Causes and effects of air, water and soil pollution, greenhouse effect and global warming, smog formation, acid rain, depletion of ozone layer, pollution due to industrial waste, strategies to control environmental pollution.
Books Recommended/References:
1. Text Books of N.C.E.R.T for 11^{th} and 12^{th} class. 2. Textbook of Inorganic Chemistry by O. P. Tandon. 3. Organic Chemistry by M. S. Chouhan. 4. Polymer Science by V. R. Gowariker, N. V. Viswanathan and J. Sreedhar. 5. Environmental Chemistry by B. K. Sharma and M. Sharma.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**MDC Paper – II**	**Nomenclature**	**MDC Chemistry Practical – II**
Name of the Course	**Multidisciplinary Course**	**Course Code**	**24CHEX02MD01**
Credits	**01**	**Maximum Marks**	**25**
Hours per Week	**02**	**External Marks**	**20**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**05**

Syllabus Objectives: This course provides the understanding of pH measurement. Students will be able to understand the chemistry behind the suspected bribery case. It further helps students to prepare hand sanitizer and shampoo. Students will be able to determine acid value of oils and fats. Also able to determine chloride in water sample.

***Note: Examiner will set two experiments for practical examinations*.** **(7×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:
CLO1: Determine the nature of some salt solutions and their pH values.
CLO2: Understand chemistry of phenolphthalein used in suspected bribery case.
CLO3: Prepare the hand sanitizer.
CLO4: Determine R_f value of oils and fats.
CLO5: Determine chloride in water sample by $AgNO_3$ method.
CLO6: Determination of carbonates and bicarbonates in given solution.

List of Experiments

1. Determination of the pH and nature of solution of some salts using pH paper or universal indicator. (NH_4Cl, Na_2CO_3, CH_3COONa, NaCl, unknown salt).
2. Chemistry of phenolphthalein used in suspected bribery case: A forensic investigation.
3. Preparation of hand sanitizer.
4. Determination of retention factor (R_f value) of oils and fats.
5. Determination of chloride in water sample by $AgNO_3$ method.
6. Determination of carbonates and bicarbonates in given solution.

Viva-Voce	**(03 Marks)**
Note Book	**(03 Marks)**

Books Recommended/References:

1. Practical Chemistry by O. P. Pandey, D. N. Bajpai and S. Giri.
2. Dissociation of phenolphthalein helps in solving Bribe Trap Case: Forensic approach by R. Verma and S. Manik.
3. Hand Sanitizer, Easy Guide to Make Anti-Bacterial and Anti-Viral Homemade Hand Sanitizers by H. Miller.
4. Practical Organic Chemistry – A Primer by V. Peesapati.
5. Practical Organic Chemistry by A. K. Manna.
6. Senior Practical Physical Chemistry by B. D. Khosla.

Semester — III (Session: 2025- 26)

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – III**	**Nomenclature**	**Fundamental Chemistry – III**
Name of the Course	**Discipline Specific Course**	**Course Code**	**25CHEM403DS01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The students will learn about general characteristics of transition metal and about the concept of partial molar properties. In electrochemical cells, the students will learn about electrolytic and galvanic cells, measurement of conductance and its applications, measurement of emf and its applications. It is designed in a manner to give a better understanding of the organic functional groups, which include halogenated hydrocarbons. This course helps the students to relate the structure of an organic compound to its physical and chemical properties.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Understand the general characteristics of transition metals.

CLO2: Explain the concept of partial molar properties & use the concepts learnt to predict feasibility of chemical reactions.

CLO3: Explain the factors that affect conductance, migration of ions and application of conductance measurement.

CLO4: Understand concept of pH and its effect on the various physical and chemical properties of the compounds.

CLO5: Learn the working of electrochemical cells using different electrodes.

CLO6: Understand preparation, properties and reactions of haloalkanes and haloarenes.

Unit–I

Chemistry of Transition series elements

General characteristics of transition metals, brief discussion of differences between the first, second and third transition series, stability of various oxidation states, magnetic and spectral properties. Binary compounds and complexes illustrating relative stability of their oxidation states. Chemistry of Ti, V, Cr, Mn, Fe, Co, Mo and W in various oxidation states, some important compounds as laboratory reagents: potassium dichromate, potassium permanganate, potassium ferrocyanide, potassium ferricyanide, sodium nitroprusside and sodium cobaltinitrite.

Unit–II

Thermodynamics-II

Third law of thermodynamics: Nernst heat theorem, concept of residual entropy, evaluation of absolute entropy from heat capacity data. Gibbs and Helmholtz functions, Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for spontaneity, thermodynamic equilibrium and their advantage over entropy change. Variation of G and A with P, V and T. Partial molar quantities.

Unit–III

Electrochemistry

Arrhenius theory of ionization, Ostwald's Dilution Law. Debye-Huckel–Onsager's equation for strong electrolytes (elementary treatment only), transport number, definition and determination by Hittorf's methods. Electrolytic conduction, factors affecting electrolytic conduction. Applications of conductivity measurements: determination of dissociation constant (Ka) and degree of dissociation, determination of solubility product of sparingly soluble salts, conductometric titrations. Definition of pH and pKa, buffer solution, buffer action, Henderson – Hasselbalch equation, buffer mechanism of buffer action.

Reversible electrodes – Metal- metal ion gas electrode, metal – metal insoluble salt- anion electrode and redox electrode.

Unit–IV

Alkyl and aryl halides

Alkyl halide: Nomenclature and classes of alkyl halides, general methods of preparation, physical properties and chemical reactions, mechanisms (SN1, SN2, E1, E2 and E1cb) and stereochemistry of nucleophilic substitution reactions of alkyl halides with energy profile diagrams, elimination vs substitution reactions.

Aryl halides: Methods of preparation, Reactions: Aromatic nucleophilic substitution and effect of substituents on reactivity. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$), reactivity and relative strength of C-halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Books Recommended/References:

1. Principal of Inorganic Chemistry- P. S. Kalia, B. R. Puri, L. R. Sharma and K. C. Kalia.
2. Coordination Chemistry by A. Kumar.
3. Inorganic Chemistry- Principles of Structure and Reactivity by J. E. Huheey, E. A. Keiter, R. L. Keiter and O. K. Medhi.
4. An Introduction to Chemical Thermodynamics by R. P. Rastogi and R. R. Mishra.
5. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania.
6. A Textbook of Physical Chemistry (Vol. 3) by K. L. Kapoor.
7. Organic Chemistry by R. T. Morrison and R. N. Boyd.
8. Organic Chemistry by I. L. Finar.
9. Intermediate for Organic Synthesis by V. K. Ahluwalia, P. Bhagat, R. Aggarwal, R. Chandra.
10. Organic Chemistry by T. W. G. Solomons, C. B. Fryhle and S. A. Snyder.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – III**	**Nomenclature**	**Chemistry Practical (MD) – III**
Name of the Course	**Discipline Specific Course**	**Course Code**	**25CHEM403DS01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**04**	**External Marks**	**35**

Duration of Examination	**04 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: This course aims to make the students understand gravimetric analysis, inorganic synthesis, surface tension and conductometric measurements. It aims to build the concept of identification of simple organic compounds including the detection of extra elements, functional groups, determination of melting or boiling points and preparation of their derivatives.

***Note: Examiner will set two experiments for practical examinations*.** **(12×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:
CLO1: Understand quantitative estimation of ions using gravimetric analysis and inorganic preparation.
CLO2: Determine the surface tension by using drop number method.
CLO3: Determine the solubility and enthalpy of neutralization.
CLO4: Learn identification of organic compounds and preparation of their derivatives.

List of Experiments

Unit–I (Inorganic)

1. Gravimetric Analysis

(i) Quantitative estimations of Cu^{2+} as copper thiocyanate and Ni^{2+} as Nickel bis(dimethylglyoxime).

2. Preparations:

(i) Tetra ammine copper (II) sulphate.
(ii) Chromium (III) potassium sulphate (chrome alum).
(iii) Potassium tris (oxalato) chromate (III).

Unit–II (Physical)

1. Surface tension

(i) Determine the surface tension of given solutions using stalagmometer by drop number method (Water, CH_3OH, C_2H_5OH, n-hexane, etc).

2. Conductometry

(i) Determine the cell constant of the conductivity cell.
(ii) Determine the specific conductance, equivalent & molar conductance of given electrolyte solutions: KCl, $BaCl_2$, NaCl, $CaCl_2$, NaOH, HCl etc.

Unit–III (Organic)

1. Systematic identification (detection of extra elements, functional groups, determination of melting point or boiling point and preparation of at least one pure solid derivative) of the following simple organic compounds:

Naphthalene, anthracene, acenaphthene, benzyl chloride, *p*-dichlorobenzene, *m*-dinitrobenzene, *p*-nitrotoluene, resorcinol, hydroquinone, α-naphthol, β-naphthol, benzophenone, ethyl methyl ketone.

Viva-Voce **(06 Marks)**

Note Book **(05 Marks)**

Books Recommended/References:

1. A text Book of Quantitative Inorganic Analysis by A. I. Vogel.
2. Vogel's Qualitative Inorganic Analysis by G. Svehla.
3. Synthesis and Characterization of Inorganic Compounds by W. L. Jolly.
4. Senior Practical Physical Chemistry by B. D. Khosla.
5. Advanced Practical Physical Chemistry by J. B. Yadav.
6. Vogel's Textbook of Practical Organic Chemistry by A. I. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hanaford and P. W. G. Smith.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – II**	**Nomenclature**	**Chemistry of Metals & Non-Metals, Hydrocarbons and Solutions**
Name of the Course	**Minor Course**	**Course Code**	**25CHE403MI01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The aim of this course is to make students learn about occurrence of elements in nature, physical and chemical aspects of metals and non-metals. The course aims to provide students with a comprehensive understanding of the properties, behavior and applications of solutions in chemistry. It aims to build the concept of chemical synthesis, properties and reactions of aliphatic and aromatic hydrocarbons.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:
CLO1: Learn about classification of elements with their properties.
CLO2: Understand the minerals and ores, metallurgical processes and refining of metals.
CLO3: Understand the concept of Raoult's law, different types of solutions and colligative properties.
CLO4: Basic chemistry of alkane, alkene and alkynes.
CLO5: Learn and identify the basic organic reaction mechanisms.

Unit–I

Metal and Non-Metals

Occurrence of elements in nature, physical and chemical properties of metals and non-metals, minerals and ores, metallurgical processes (benefaction, roasting, calcination and reduction of metal oxides processes), refining of metals, metallurgy of Fe, Zn, Al and Cu.

Unit–II

Solution

Types of solutions, expression of concentration of solutions of solids in liquids, solubility of gases in liquids, solid solutions, Raoult's law, colligative properties - relative lowering of vapour pressure, elevation of boiling point, depression in freezing point, osmotic pressure, determination of molecular masses using colligative properties, abnormal molecular mass, Van't Hoff factor.

Unit–III

Hydrocarbons

Alkanes: General methods of preparation and Reactions: free radical substitution.

Alkenes: General methods of preparation and Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), addition of HX (Markownikoff's and anti-Markownikoff's addition), hydration, ozonolysis, oxymecuration-demercuration, hydroboration oxidation.

Alkynes: General methods of preparation and Reactions: formation of metal acetylides and acidity of alkynes, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$, hydration to form carbonyl compounds.

Unit–IV
Aromatic Hydrocarbons Structure of benzene (Kekule, hybrid and resonance), preparation of benzene. Reactions**:** electrophilic substitution reactions in benzene citing examples of nitration, halogenation, sulphonation and Friedel-Craft's alkylation and acylation with special emphasis on carbocationic rearrangement, side chain oxidation of alkyl benzene.
Books Recommended/References:
1. NCERT Chemistry Textbook for class 11^{th} and 12^{th}. 2. Modern Inorganic Chemistry by R. D. Madan. 3. A Textbook of Inorganic Chemistry by O. P. Tandon. 4. Essentials of Physical Chemistry by A. Bahl, B.S. Bahl, and G.D. Tuli. 5. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania. 6. Organic Chemistry by R. T. Morrison and R. N. Boyd. 7. Organic Chemistry by I. L. Finar. 8. Basic Organic Chemistry by R. Chandra, S. Singh and A. Singh.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – II**	**Nomenclature**	**Minor Chemistry Practical – II**
Name of the Course	**Minor Course**	**Course Code**	**25CHE403MI01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**04**	**External Marks**	**35**
Duration of Examination	**04 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The course introduces the learner to various types of soap preparations, pH determination of different food items, the concept of viscosity as a measure of a fluid's resistance to flow and about their importance in various industries. This course also deals with sublimation process, preparation and purification of organic compound by crystallization and distillation methods.

***Note: Examiner will set two experiments for practical examinations*.** **(12×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:
CLO1: Learn preparation of soaps and detergent.
CLO2: Identify the pH of different samples of food items.
CLO3: Determine the viscosity of given solutions.
CLO4: Explain preparation & purification of organic compounds.
CLO5: Have an idea of sublimation process.

List of Experiments

Unit–I (Inorganic)

1. Preparation of soaps and detergents by using vegetable oils (olive oil and coconut oil).
2. Determination of the pH of different samples of food items by pH strip method.

Unit–II (Physical)

1. Determination of viscosity of aqueous solutions of ethanol and sugar at room temperature.
2. Determination of the solubility of benzoic acid at various temperatures.

Unit–III (Organic)

1. Preparation and purification of iodoform from ethanol (or acetone) through crystallization and distillation and ascertaining purity through melting point.
2. Study the process of sublimation of camphor and phthalic acid.

Viva-Voce	**(06 Marks)**
Note Book	**(05 Marks)**

Books Recommended/References:

1. Soap-Making Manual-A practical handbook on the raw materials, their manipulation, analysis and control in the modern soap plant by E. G. Thomssen.
2. Vogel's Qualitative Inorganic Analysis by G. Svehla.
3. Advanced Physical Chemistry Practical by G. Raj.
4. Advanced Practical Physical Chemistry by J. B. Yadav.
5. Advanced Practical Organic Chemistry by N. K. Vishnoi.
6. Practical Organic Chemistry – A Primer by V. Peesapati.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**SEC Paper – III**	**Nomenclature**	**Batteries**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**25CHE403SE01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus objectives: The aim of this paper is to make the students learn the basic principle, design, working of batteries and their applications in daily life. It includes comprehensive overview of general characteristics and applications of some primary and secondary batteries.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:
CLO1: Understand battery fundamentals.
CLO2: Analyse battery types.
CLO3: Examine battery chemistry.
CLO4: Evaluate battery performance.
CLO5: Study battery materials.

Unit–I

Basic Concepts

Components of cells and batteries, classification of cells and batteries, operation of a cell, theoretical cell voltage, capacity, energy, specific energy and energy density of practical batteries.

Unit–II

Battery Design and Factors Affecting Battery Performance

General introduction, designing to eliminate potential safety problems, battery safeguards when using discrete batteries, battery construction, design of rechargeable batteries, factors affecting battery performance.

Unit–III

Primary Batteries

General characteristics and applications of primary batteries, types and characteristics of primary batteries, comparison of the performance characteristics of primary battery systems, recharging primary batteries.

A) Zinc-Carbon Batteries (Leclanche´ and Zinc Chloride Cell Systems):
General characteristics, cell chemistry, types of cells and batteries, construction, cell components.
B) Magnesium and Aluminum Batteries:
General characteristics, cell chemistry, construction of Mg/MnO_2 batteries, performance characteristics of Mg/MnO_2 batteries, sizes and types of Mg/MnO_2 batteries, other types of magnesium primary batteries.

Unit–IV

Secondary Batteries

General characteristics and applications of secondary batteries, types and characteristics of secondary batteries, comparison of performance characteristics for secondary battery systems and introduction, chemistry, construction, performance characteristics, charging characteristics of following batteries: Lead batteries, Lithium ion batteries, Iron electrode batteries, Nickel-Cadmium, Nickel-Metal hydride, Nickel-Zinc batteries.

Books Recommended/References:

1. Understanding Batteries by R. M. Dell and D. A. J.
2. The TAB Battery Book: An In-Depth Guide to Construction, Design and Use by M. Root.
3. Fuel Cell- principles and applications by M. A. Scibioh and B. Vishwanathan.
4. Energy Storage Systems – Batteries and Their Chemistry by M. Cultu.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**SEC Paper – III**	**Nomenclature**	**SEC Chemistry Practical – III**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**25CHE403SE01**
Credits	**01**	**Maximum Marks**	**25**
Hours per Week	**02**	**External Marks**	**20**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**05**

Syllabus Objectives: This course aims to provide knowledge of total dissolved solid (TDS) of water, retention factor (R_f value) of oil, estimation of iron from alloy and to detect aldehyde group. It also aims to enable student to identify the adulteration in given food materials.

***Note: Examiner will set two experiments for practical examinations*.** **(7×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:
CLO1: Determine the TDS of given water sample.
CLO2: Determine retention factor (R_f value) of oil.
CLO3: Estimation of iron from alloy.
CLO4: Detect aldehyde group present in given organic compound.
CLO5: Identify the adulteration in given food materials.

List of Experiments

1. Determination of TDS in a given water sample.
2. Determine retention factor (R_f value) of oil.
3. Estimation of iron from alloy.
4. Detection of aldehyde group by Silver Mirror test and Felhing's solution.
5. Checking the adulteration in given food materials (Milk, edible oil, sugar, turmeric and chilli powder).

Viva-Voce	**(03 Marks)**
Note Book	**(03 Marks)**

Books Recommended/References:

1. Water Treatment, How To Make Water Safe To Drink by D. Holman.
2. Organic Chemistry by S. N. Dhawan.
3. B.Sc. Chemistry Practical by S. Goyal.
4. Food Processing and Preservation by G. Subbulakshmi.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**MDC Paper – III**	**Nomenclature**	**Core Chemistry**
Name of the Course	**Multidisciplinary Course**	**Course Code**	**25CHEX03MD01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The course aims to elucidate the types of chemical bonding, including ionic, covalent, coordinate, hydrogen bonding and Van der Waals interactions. It covers valence electrons, hybridization, molecular shapes, VSEPR theory and molecular orbital theory. Additionally, it explores organic chemistry principles, corrosion mechanisms and biomolecules such as carbohydrates, proteins and nucleic acids, emphasizing their structures, functions and significance in biological processes.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Understand the types of chemical bonding.
CLO2: Understand the basic principles of organic chemistry.
CLO3: Know the causes and prevention of corrosion.
CLO4: Know the types and functions of biomolecules.

Unit–I

Chemical Bonding

Types of chemical bonding- ionic bond, covalent bond, coordinate bond, hydrogen bonding, Van der Waals interactions, Valence bond theory, concept of hybridization and shapes of simple molecules, VSEPR theory, Molecular orbital theory.

Unit–II

Basic Principles of Organic Chemistry

Types of organic reactions, electrophiles and nucleophiles, homolytic and heterolytic fission of a covalent bond, inductive effect, electromeric effect and resonance effect.

Unit–III

Corrosion

Introduction and causes of corrosion, types of corrosion, dry and wet corrosion, factors affecting corrosion, methods to prevent corrosion.

Unit–IV
Biomolecules Carbohydrates- Classification of carbohydrates, structure and importance of monosaccharides, importance of disaccharides and polysaccharides. Proteins- Amino acids, peptide linkage, primary, secondary, tertiary and quaternary structure of proteins, importance of proteins, denaturation of proteins. Nucleic Acids- Structure and function of DNA and RNA.
Books Recommended/References:
1. NCERT Chemistry Textbook for class 11^{th} and 12^{th}. 2. Inorganic Chemistry by O. P. Tandon. 3. Organic Chemistry by M. S. Chouhan. 4. Corrosion and Corrosion Control R. K. Upadhyay. 5. Biochemistry by U. Satyanarayana and U. Chakrapani.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**MDC Paper – III**	**Nomenclature**	**MDC Chemistry Practical – III**
Name of the Course	**Multidisciplinary Course**	**Course Code**	**25CHEX03MD01**
Credits	**01**	**Maximum Marks**	**25**
Hours per Week	**02**	**External marks**	**20**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**05**

Syllabus Objectives: The aim of this paper is to make the students learn about the purity of organic compounds. This course will also help the students to understand role of emulsifying agent in stabilizing the emulsion of an oil. It also encompasses the detection of alcohol and CO_2. It also includes the preparation of colloidal solution.

***Note: Examiner will set two experiments for practical examinations*.** **(7×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Check purity of organic compounds.
CLO2: Understand role of emulsifying agent in stabilizing the emulsion of an oil.
CLO3: Detect the alcohol by ester formation.
CLO4: Prepare colloidal solution of starch and albumin each.
CLO5: Determination of carbonates and bicarbonates in given solution.

List of Experiments

1. To check the purity of compounds (determination of melting and boiling points).
2. Study of role of emulsifying agent in stabilizing the emulsion of an oil.
3. Alcohol detection test by ester formation (fruity smell).
4. Preparation of colloidal solution of starch and albumin each.
5. Determination of carbonates and bicarbonates in given solution.

Viva-Voce	**(03 Marks)**
Note Book	**(03 Marks)**

Books Recommended/References:
1. Basic Concepts: Physical Chemistry Experiments by N. Seedher. 2. Senior Practical Physical Chemistry by B.D. Khosla. 3. Practical Chemistry by O. P. Pandey, D. N. Bajpai and S. Giri. 4. Practical Organic Chemistry – A Primer by V. Peesapati. 5. Practical Organic Chemistry by A. K. Manna.

Semester — IV (Session: 2025- 26)

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – IV**	**Nomenclature**	**Fundamental Chemistry – IV**
Name of the Course	**Discipline Specific Course**	**Course Code**	**25CHEM404DS01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The course introduces the students to coordination compounds, their magnetic properties and thermodynamic and kinetic aspects of metal complexes. It includes the kinetics of chemical reaction and chemical equilibrium. It acquaints the students with the functional group approach to study organic chemistry. This course helps the students to understand preparation, properties and reactions of oxygen containing functional groups.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Explain the coordination compounds–its nomenclature, theories, d-orbital splitting in complexes, chelate.
CLO2: Understand the qualitative ideas of valence bond theory.
CLO3: Understand the crystal field splitting theory and spectrochemical series.
CLO4: Know about the magnetic, spectral properties and stereochemistry of transition metals.
CLO5: Learn about various theories of reaction rates and how these account for experimental observations.
CLO6: Have understand about chemical equilibrium and its various equations.
CLO7: Understand preparation, properties and reactions of oxygen containing functional groups.

Unit–I

Coordination Compounds

Coordination compounds, ligands, coordination number, oxidation states, coordination entity, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds with coordination numbers 4 and 6. Chelates and chelate effect, Valence bond theory and its application to complexes of coordination numbers 4 and 6. Examples of inner and outer orbital complexes, limitations of VBT. Basic idea of Crystal field theory.

Unit–II

Magnetic Properties of Transition Metal Complexes

Types of magnetic behavior, methods of determining magnetic susceptibility, spin-only formula. L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, applications of magnetic moment data for 3d metal complexes.

Thermodynamic and Kinetic Aspects of Metal Complexes: A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, substitution reactions of square planar complexes of Pt (II).

Unit–III

Kinetics and Chemical Equilibrium

Integrated rate expression for first, second and third order reaction and their half-life period. Methods of determination of order of reaction. 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.

Equilibrium constant and free energy, concept of chemical potential, thermodynamic derivation of law of chemical equilibrium. Temperature dependence of equilibrium constant, Van't Hoff reaction isochores, Van't Hoff reaction isotherm. Le-Chatelier's principle and its applications, Clapeyron equation and Clausius – Clapeyron equation & its applications.

Unit–IV

Alcohols, Phenols and Ethers

Alcohols: General methods of preparation using Grignard reagent, ester hydrolysis, reduction of aldehydes, ketones, carboxylic acid and esters. Reactions: with sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acid. dichromate, con. HNO_3). Oppeneauer oxidation. Diols: Oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: Methods of preparation, physical properties and acidic character. Reactions: electrophilic substitution (nitration, halogenation and sulphonation). Reimer-Tiemann reaction, Gattermann-Koch reaction, Houben-Hoesch condensation, Schotten-Baumann reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Books Recommended/References:

1. Coordination Chemistry by A. Kumar.
2. Inorganic Chemistry- Principles of Structure and Reactivity by J. E. Huheey, E. A. Keiter, R. L. Keiter and O. K. Medhi.
3. Chemical Kinetics by K. J. Laidler.
4. A Textbook of Physical Chemistry (Vol. 5) by K. L. Kapoor.
5. Physical Chemistry by P. W. Atkins and J. Paula.
6. Organic Chemistry by R. T. Morrison and R. N. Boyd.
7. Organic Chemistry by I. L. Finar.
8. Intermediate for Organic Synthesis by V. K. Ahluwalia, P. Bhagat, R. Aggarwal, R. Chandra.
9. Organic Chemistry by T. W. G. Solomons, C. B. Fryhle, S. A. Snyder.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – IV**	**Nomenclature**	**Chemistry Practical (MD) – IV**
Name of the Course	**Discipline Specific Course**	**Course Code**	**25CHEM404DS01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**04**	**External Marks**	**35**
Duration of Examinations	**04 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The objective of this course is to make students aware of the concept of Beer-Lambert law, complexometric titration, conductometer and critical solution temperature (CST). Students will be able to identify the

extra elements and functional groups in the organic compounds. The practicals expose students to latest instrumentation and they learn to detect analytes in a mixture.

***Note: Examiner will set two experiments for practical examination*.** **(12×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:
CLO1: Understand practical handling of colorimeter.
CLO2: Get practical knowledge about complexometric titrations and inorganic preparations.
CLO3: Determine strength of given acid by conductometrically.
CLO4: Determine critical solution temperature (CST) of given solution.
CLO5: Explore identification of organic compounds.

List of Experiments

Unit–I (Inorganic)

1. Colorimetry

(i) Verify Beer-Lambert law for $KMnO_4/K_2Cr_2O_7$ and determine the concentration of the given $KMnO_4/K_2Cr_2O_7$ solution.

2. **Complexometric titrations:** Determination of Zn^{2+}, Ca^{2+} by EDTA.
3. **Preparations:** Preparation of cuprous chloride, prussian blue from iron fillings.

Unit–II (Physical)

1. Conductometry

(i) Determine the concentration of HCl using NaOH conductometrically.
(ii) Determine the concentration of CH_3COOH using NaOH conductometrically.

2. **Solution:** Determine critical solution temperature

(i) Water - phenol system.
(ii) Water - aniline system.

Unit–III (Organic)

1. **Systematic identification (detection of extra elements, functional groups, determination of melting point or boiling point and preparation of at least one pure solid derivative) of the following simple organic compounds:**

Benzaldehyde, vanillin, oxalic acid, succinic acid, benzoic acid, salicylic acid, aspirin, phthalic acid, cinnamic acid, benzamide, urea, acetanilide, benzanilide, aniline hydrochloride, p-toluidine, phenyl salicylate (salol), glucose, fructose, sucrose, o-, m-, p-nitroanilines, thiourea.

Viva-Voce **(06 Marks)**

Note Book **(05 Marks)**

Books Recommended/References:

1. B.Sc. Chemistry Practical by S. Goyal
2. Vogel's Qualitative Inorganic Analysis by G. Svehla.
3. Synthesis and Characterization of Inorganic Compounds by W. L. Jolly.
4. Advanced Practical Physical Chemistry by J. B. Yadav.
5. Vogel's Textbook of Practical Organic Chemistry by A. I. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hanaford and P. W. G. Smith.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – III**	**Nomenclature**	**Molecular Structure, Thermodynamics, Equilibrium & Alkyl Halides**
Name of the Course	**Minor Course**	**Course Code**	**25CHE404MV01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus objectives: The course provides basic knowledge about ionic, covalent and metallic bonding. It discusses VSEPR theory and concept of hybridization which is necessary in understanding the structure of molecules. The course is infused with the basic understanding of the chemical energetics, laws of thermodynamics, chemical and ionic equilibrium. It acquaints the students with the methods of preparation and reactions of alkyl halides.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Draw the plausible structures and geometries of molecules using radius ratio Rule, VSEPR theory and MO diagrams (homo-nuclear diatomic molecules).

CLO2: Understand the structural idea and relevance in describing shapes of s, p and d orbitals.

CLO3: Understand the laws of thermodynamics, thermochemistry and equilibria.

CLO4: Understand concept of pH and its effect on the various physical and chemical properties of the compounds.

CLO5: Understand the preparation, properties and reactions of alkyl halides.

Unit–I

Chemical Bonding and Molecular Structure

Valence electrons, ionic bond, covalent bond, bond parameters, Lewis' structure, polar character of covalent bond, valence bond theory and its limitations, resonance, geometry of covalent molecules, VSEPR theory, concept of hybridization, involving s, p and d orbitals and shapes of some simple molecules, molecular orbital theory of homonuclear diatomic molecules (qualitative idea only), hydrogen bond and its types with examples, Van der Waal forces.

Unit–II

Thermodynamics

Concept of system, types of system, surroundings, extensive and intensive properties, state functions and variables. Laws of thermodynamics – internal energy and enthalpy, heat capacity and specific heat, entropy, Gibbs free energy & Helmholtz function, measurement of ΔU and ΔH, Hess's law of constant heat summation, enthalpy of bond dissociation, combustion, formation, atomization, sublimation, phase transition, ionization.

Unit–III

Chemical and ionic equilibrium

Dynamic nature of equilibrium, law of mass action, equilibrium constant, factors affecting equilibrium - Le Chatelier's principle & its applications, Theories of acid and base, ionization of acids and bases, strong and weak electrolytes, degree of ionization, acidic and basic strength, concept of pH, hydrolysis of salts (elementary idea), buffer solution, solubility product, common ion effect.

Unit–IV
Alkyl halides Structure of haloalkanes and their classification as 1º, 2º & 3º, general methods of preparation, chemical reactions: nucleophilic substitution reactions with mechanism and their types (SN1, SN2 and SNi, E1, E2 & E1cB), nucleophilic substitution reactions with specific examples from: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation and Williamson's ether synthesis.
Books Recommended/References:
1. NCERT Chemistry Textbook for class 11^{th} and 12^{th}. 2. Modern Inorganic Chemistry by R. D. Madan. 3. A Textbook of Inorganic Chemistry by O. P. Tandon. 4. Essentials of Physical Chemistry by A. Bahl, B. S. Bahl and G. D. Tuli. 5. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania. 6. Organic Chemistry by R. T. Morrison and R. N. Boyd. 7. Organic Chemistry by I. L. Finar. 8. Basic Organic Chemistry by R. Chandra, S. Singh and A. Singh.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – III**	**Nomenclature**	**Minor Chemistry Practical – III**
Name of the Course	**Minor Course**	**Course Code**	**25CHE404MV01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**04**	**External Marks**	**35**
Duration of Examination	**04 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The objective of this course is to make students aware of the concept the water quality, purification techniques, principle of total dissolved solids (TDS) in water and critical solution temperature (CST). Students are exposed to identify the nature of reaction (exothermic or endothermic). It also provides an overview of the systematic approach to identify organic compounds based on elemental composition.

***Note: Examiner will set two experiments for practical examinations*.** **(12×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:
CLO1: Determine TDS of different samples of water.
CLO2: Identify the nature of reaction (Exo/Endothermic).
CLO3: Purify the given sample of water.
CLO4: Determine the CST of phenol-water system.
CLO5: Determine extra elements of the simple organic compounds.

List of Experiments

Unit–I (Inorganic)

1. Determine the TDS of different water samples.
2. Determine nature of reaction of water with quick lime (Exo/Endothermic).

Unit–II (Physical)

1. Purification of the different water samples by using different techniques.
2. Determine the CST of phenol-water system.

Unit–III (Organic)

1. Systematic detection of extra elements of the simple organic compounds.

Viva-Voce **(06 Marks)**

Note Book **(05 Marks)**

Books Recommended/References:
1. Water Treatment, How To Make Water Safe To Drink by D. Holman. 2. B.Sc. Chemistry Practical by S. Goyal. 3. Organic Chemistry by S. N. Dhawan. 4. Practical Organic Chemistry by A. K. Manna.

Semester — V (Session: 2026- 27)

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – V**	**Nomenclature**	**Fundamental Chemistry – V**
Name of the Course	**Discipline Specific Course**	**Course Code**	**26CHEM405DS01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The purpose of the course is to introduce students to organometallic compounds which are currently frontier areas of chemistry providing an interface between organic chemistry & inorganic chemistry. This also makes the students understand the limitations of classical mechanics and the need of quantum chemistry. The functional group approach to organic chemistry introduced in the previous courses is reinforced through the study of the chemistry of carbonyl compounds and carboxylic acids. This course also deals with some classes of organic compounds finding applications in everyday life namely carbohydrates and dyes.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Apply 18-electron rule to rationalize the stability of metal carbonyls and related species.
CLO2: Understand the nature of Zeise's salt and compare its synergic effect with that of carbonyls.
CLO3: Identify important structural features of the metal alkyls and explain the concept of multicentre bonding in these compounds.
CLO4: Learn about limitations of classical mechanics in terms of quantum mechanics for atomic/molecular systems.
CLO5: Develop an understanding of quantum mechanical operators, quantization, probability distribution, uncertainty principle.
CLO6: Understand the preparation and chemical reactions of carbonyl compounds and carboxylic acids.
CLO7: Have the understanding of carbohydrates and synthetic dyes.

Unit–I

Organometallic Chemistry

Definition, nature of metal carbon bond, classification of organometallic compounds by bond types viz. i) covalent ii) ionic iii) electron deficient iv) cluster compounds v) π bond compounds including sandwich derivatives. Structure and bonding in metal-ethylenic, metal-acetylenic complexes, metal carbonyls and cyclopentadienyl derivative. Properties and bonding of alkyls of Li, Al, Hg and Sn, concept of hapticity of organic ligand, Zeise salt and ferrocene. EAN rule applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. π – acceptor behavior of carbon monoxide. Synergic effects (VB approach, MO diagram of CO can be referred for synergic effect to IR frequencies). Applications of organometallic compounds.

Unit–II

Quantum Mechanics-I

Black-body radiation, Plank's radiation law, photoelectric effect, heat capacity of solids, Compton effect, wave function and its significance, postulates of quantum mechanics, quantum mechanical operator, commutation relations, Hamiltonian operator, Hermitian operator, average value of square of Hermitian as a positive quantity, role of operators in quantum mechanics, Heisenberg uncertainty principle.

Unit–III

Carbonyl Compounds and Carboxylic acid derivatives

Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer-Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC). 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, Hoffmann-bromamide degradation and Curtius rearrangement.

Unit–IV

Carbohydrates

Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides, erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of glucose and fructose. Open chain and cyclic structure of D(+) glucose & D(-) fructose. Mechanism of mutarotation, structures of ribose and deoxyribose.

An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

Synthetic Dyes

Colour and constitution (electronic concept). Classification of dyes, chemistry and synthesis of methyl orange, congo red, malachite green, crystal violet, phenolphthalein, fluorescein, alizarin and indigo.

Books Recommended/References:

1. Coordination Chemistry by A. Kumar.
2. Inorganic Chemistry- Principles of Structure and Reactivity by J. E. Huheey, E. A. Keiter, R. L. Keiter; O. K. Medhi.
3. Concise Inorganic Chemistry by J. D. Lee.
4. Quantum Chemistry Classical to Computational by A. Dua.
5. Quantum Chemistry by R. K. Prasad.
6. Organic Chemistry by L. Finar.
7. Organic Chemistry by R. T. Morrison & R. N. Boyd.
8. Advanced Organic Chemistry by A. Bahl and B. S. Bahl.
9. A Guide Book to Mechanism in Organic Chemistry by P. Sykes.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – V**	**Nomenclature**	**Chemistry Practical (MD) – V**
Name of the Course	**Discipline Specific Course**	**Course Code**	**26CHEM405DS01**
Credits	**02**	**Maximum Marks**	**50**

Hours per Week	**04**	**External Marks**	**35**
Duration of Examination	**04 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The aim of this course is to make students understand the concept of qualitative analysis, paper chromatography, pH metry and adsorption. Students are exposed to important separation methods like steam distillation and chromatography. The practicals expose the students to latest instrumentation and they learn to detect analytes in a mixture.

***Note: Examiner will set two experiments for practical examinations*.** **(12×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Identify the cation and anion present in the salt sample using systematic qualitative analysis techniques.
CLO2: Explore estimation of various ions present in salt.
CLO3: Standardize the pH meter and can prepare the buffer solution.
CLO4: Learn about the adsorption phenomenon and its industrial applications.
CLO5: Get knowledge about laboratory techniques: steam distillation and column chromatography.
CLO6: Explain qualitative analysis of green leaf pigments using paper chromatography.

List of Experiments

Unit–I (Inorganic)

1. **Analysis of one cation** (NH_4^+, Ba^{2+}, Al^{3+}, Fe^{2+}, Pb^{2+}, Ni^{2+}, Zn^{2+}, Sr^{2+}, Na^+) **and one anion** (Cl^-, Br^-, I^-, F^-, NO_3^-, SO_4^{2-}, CH_3COO^-, $C_2O_4^{2-}$, NO_2^-, PO_4^{3-}, S^{2-}) in the salt.
2. **Paper Chromatography**

(i) Qualitative analysis of any one of the following Inorganic cations (Pb^{2+}, Cu^{2+}, Ca^{2+}, Ni^{2+}) and anions by paper chromatography (Cl^-, Br^-, I^-, PO_4^{3-}, NO_3^-).

Unit–II (Physical)

1. pH metry

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

2. Adsorption

(i) Study adsorption of acetic acid on the surface of activated charcoal.

Unit–III (Organic)

1. Chromatography

(i) Determination of R_f values and identification of organic compounds:

Separation of a mixture of coloured organic compounds using common organic solvents by TLC.

2. Synthesis of the following organic compounds

(i) Synthesize benzoic acid from ethyl benzoate.
(ii) Synthesize benzanilide from aniline.
(iii) Selective reduction of *m*-dinitrobenzene to *m*-nitroaniline.
(iv) Hydrolysis of amides and esters.

Viva-Voce **(06 Marks)**

Note Book **(05 Marks)**

Books Recommended/References:

1. B.Sc. Chemistry Practical by S. Goyal.
2. Vogel's Qualitative Inorganic Analysis by G. Svehla.
3. Advanced Practical Physical Chemistry by J. B. Yadav.
4. Advanced Physical Chemistry, Practical Handbook by G. Raj.

5. Vogel's Textbook of Practical Organic Chemistry by A. I. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hanaford and P. W. G. Smith.
6. Practical Organic Chemistry by A. K. Manna.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – IV**	**Nomenclature**	**Chemistry of Pnictogens, Ionic Solids, Electrochemistry and Aryl Halides**
Name of the Course	**Minor Course**	**Course Code**	**26CHE405MV01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus objectives: The course illustrates the diversity and fascination of inorganic chemistry through the study of properties and utilities of p-block elements and their compounds. The students will learn about the properties of solids with details about crystal structure. It reviews the terms redox reactions, oxidation number, balancing redox reactions, dry cell – electrolytic cells and galvanic cells, EMF of a cell, standard electrode potential and Nernst equation. The students will also learn about the general methods of preparation, chemical reaction of aryl halides.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Learn about the structure of p-block elements, their properties and discuss their use in daily life as well as industrial applications.

CLO2: Understand anomalous behavior of nitrogen, phosphorus, oxygen and sulphur.

CLO3: Explain the crystal structure and calculate related properties of cubic systems.

CLO4: Explain the concept of oxidation and reduction, redox reactions, oxidation number, balancing redox reactions.

CLO5: Understand different types of galvanic cells and their Nernst equations.

CLO6: Understand the preparation, properties and reactions of aryl halides.

Unit–I

p - Block Elements

General electronic configuration of p-block elements, inert pair effect, atomic and ionic radii, oxidation states, ionization energy, electron gain enthalpy, electronegativity, color and their oxidizing power, allotropy and catenation. Diagonal relationship and anomalous behavior of first member of each group, compounds of p-block elements. Reactivity towards hydrogen, oxygen, halogen and metals. Anomalous behavior of nitrogen, phosphorus, oxygen and sulphur. Interhalogen compounds, compounds of Xe with F and O.

Unit–II

Ionic Solids

Forms of solids, symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Voids, packing in solids, packing efficiency in crystalline solids, radius ratio rule, expanded structure of ionic solids, structures of NaCl, KCl and CsCl, CaF_2 and Na_2O (qualitative treatment only), defects in crystals. Brief introduction to metallic bond, band theory of metallic bond. Semiconductors-Introduction, types and applications.

Unit–III
Electrochemistry Concept of oxidation and reduction, redox reactions, oxidation number, balancing redox reactions, dry cell – electrolytic cells and galvanic cells, EMF of a cell, standard electrode potential, Nernst equation and its application to chemical cells. Definition of corrosion, mechanism of corrosion, classification of corrosion.
Unit–IV
Aryl Halides Structure and resonance, general methods of preparation, chemical reaction: nucleophilic aromatic substitution ArSN1, ArSN2, (bimolecular displacement mechanism), effect of substituent on reactivity of haloarenes, reaction with strong bases $NaNH_2/NH_3$ (elimination addition mechanism involving benzyne intermediate), relative reactivity and strength of C-X bond in alkyl, allyl, benzyl, vinyl and aryl halides.
Books Recommended/References:
1. NCERT Chemistry Textbook for class 11^{th} and 12^{th}. 2. Modern Inorganic Chemistry by R. D. Madan. 3. A Textbook of Inorganic Chemistry by O. P. Tandon. 4. Essentials of Physical Chemistry by A. Bahl, B. S. Bahl and G. D. Tuli. 5. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania. 6. Organic Chemistry by R. T. Morrison and R. N. Boyd. 7. Organic Chemistry by I. L. Finar. 8. Basic Organic Chemistry by R. Chandra, S. Singh and A. Singh.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – IV**	**Nomenclature**	**Minor Chemistry Practical–IV**
Name of the Course	**Minor Course**	**Course Code**	**26CHE405MV01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**04**	**External Marks**	**35**
Duration of Examination	**04 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: Objective of this course is to make students learn the volumetric titration, principles of refractometry and preparation of buffer solutions. The course exposes students to learn the techniques for measuring refractive indices and pH of solutions by using refractometer and pH meter respectively. It acquaints the students with systematic approach to identify organic compounds based on functional groups.

***Note: Examiner will set two experiments for practical examinations*.** **(12×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Determine the strength of HCl and CH_3COOH using NaOH volumetrically.

CLO2: Estimate sodium carbonate using standardized HCl volumetrically.

CLO3: Determine the refractive index of a pure liquid.

CLO4: Prepare some buffer solutions.

CLO5: Identify organic compounds based on functional groups.

List of Experiments

Unit–I (Inorganic)

1. Determination of strength of HCl using NaOH by volumetric titration.
2. Determination of strength of CH_3COOH using NaOH by volumetric titration.
3. Estimation of sodium carbonate solution using standardized HCl by volumetric.
4. Estimation of water of crystallization in washing soda by volumetric titration with HCl.

Unit–II (Physical)
1. Determine the refractive index of a given liquid. 2. Preparation of buffer solutions: (i) Sodium acetate-acetic acid. (ii) Ammonium chloride-ammonium acetate. (iii) Carbonate-bicarbonate buffer. 3. Measurement of pH of buffer solutions and comparison of the values with theoretical values.
Unit–III (Organic)
1. Systematic identification of functional groups in the given organic compounds: Benzaldehyde, vanillin, oxalic acid, succinic acid, benzoic acid, salicylic acid, aspirin, phthalic acid, cinnamic acid, benzamide, urea, acetanilide, benzanilide.
Viva-Voce **(06 Marks)**
Note Book **(05 Marks)**
Books Recommended/References:
1. B.Sc. Chemistry Practical by S. Goyal. 2. Advanced Physical Chemistry Practical by G. Raj. 3. Advanced Practical Physical Chemistry by J. B. Yadav. 4. Advanced Practical Organic Chemistry by N K Vishnoi. 5. Practical Organic Chemistry – A Primer by V. Peesapati.

Semester — VI (Session: 2026- 27)

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – VI**	**Nomenclature**	**Fundamental Chemistry – VI**
Name of the Course	**Discipline Specific Course**	**Course Code**	**26CHEM406DS01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The student is familiarized with the d and f block elements and get an idea about horizontal similarity in a period in addition to vertical similarity in a group. Students also learn about bioinorganic chemistry. This course introduces the knowledge of the laws of absorption of light energy by molecules and the subsequent photochemical reactions. It will also make students understand the basics of molecular thermodynamics. This course introduces the learner to various tools and techniques for identifying and characterizing the organic compounds through their interactions with electromagnetic radiation viz. UV-Visible and IR spectroscopy.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Understand the d and f block elements & bioinorganic chemistry.
CLO2: Explain the different laws of photochemistry and photochemical processes.
CLO3: Learn the basics of statistical thermodynamics.
CLO5: Gain insight into the basic principles of UV and IR.

Unit–I

Bioinorganic Chemistry

Metal ions present in biological system, classification based on action (essential, non-essential, trace, toxic), Na/K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, use of chelating agents in medicine. Metalloporphyrins with special reference to hemoglobin and myoglobin. Biological role of Na^{+}, K^{+}, Ca^{+2}, Mg^{+2}, Fe^{+2} ions.

Chemistry of f-Block Elements

Lanthanides: Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, lanthanide compounds.

Actinides: General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, comparison of properties of lanthanides and actinides and transition elements.

Unit–II

Photochemistry

Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus - Drapper law, Stark-Einstein law (law of photochemical equivalence) Jablonski diagram depicting various processes occurring in excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions-energy transfer processes (simple examples).

Unit–III

Statistical Thermodynamics

Introduction to statistical thermodynamics, types of statistics: Maxwell-Boltzmann statistics, Bose- Einstein statistics and Fermi-Dirac statistics (derivation excluded). Maxwell-Boltzmann law, Maxwell-Boltzmann law of distribution of energy and velocity, evaluation of energy. Derivation of equation of states for a monatomic ideal gas.

Unit–IV

Ultraviolet and Infra-Red spectroscopy

Ultraviolet absorption spectroscopy-absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation, concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts.

Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds.

Books Recommended/References:

1. Coordination Chemistry by A. Kumar.
2. Inorganic Chemistry- Principles of Structure and Reactivity by J. E. Huheey, E. A. Keiter, R. L. Keiter and O. K. Medhi.
3. A Textbook of Physical Chemistry (Vol. 5) by K. L. Kapoor.
4. Principles of physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania.
5. Textbook of physical Chemistry by H. K. Moudgil.
6. Fundamentals of Photochemistry by K. K. Rohtagi and Mukherjee.
7. Introduction to Spectroscopy- A Guide for Students of Organic Chemistry by D. L. Pavia, G. M. Lampman and G. S. Kriz.

Name of Program	B.Sc. (Life Sciences/Physical Sciences)	Program Code	
Paper No.	Paper – VI	Nomenclature	Chemistry Practical (MD) – VI
Name of the Course	Discipline Specific Course	Course Code	26CHEM406DS01
Credits	02	Maximum Marks	50
Hours per Week	04	External Marks	35
Duration of Examination	04 Hrs.	Internal Marks	15

Syllabus Objectives: This course encompasses detailed instruction on systematic mixture analysis, gravimetric analysis, preparation of salt bridge, setting of a galvanic cell, determination of its cell voltage, pH and potentiometric titration. Furthermore, students will be exposed to the synthesis of organic compounds and important separation methods like chromatography.

***Note: Examiner will set two experiments for practical examinations*.** **(12×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Hand on practice in preparation of solutions and estimation of some physical properties of compounds.
CLO2: Analyse the anion and cation present in unknown mixture.
CLO3: Get practical knowledge about gravimetric titrations.
CLO4: Prepare different types of salt bridge.
CLO5: Set the galvanic cell and can determine its cell voltage.
CLO6: Learn separation of mixtures of coloured organic compounds by using thin layer chromatography.

List of Experiments

Unit–I (Inorganic)

1. **Analysis of mixture containing any two anions** (Cl^-, Br^-, I^-, F^-, NO_2^-, NO_3^-, CO_3^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, SO_4^{2-}, CH_3COO^-, $C_2O_4^{2-}$, S^{2-}) and **two cations** (Hg^{2+}, Hg_2^{2+}, Ag^+, Bi^{3+}, Cu^{2+}, Cd^{2+}, As^{3+}, Sb^{3+}, Sn^{2+}, Fe^{2+}, Fe^{3+}, Cr^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, NH_4^+, Pb^{2+}, Sr^{2+}, Na^+) in the mixture. (Note: Avoid interfering anion radicals).

2. Gravimetry

(i) Estimation of copper as CuSCN.
(ii) Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.
(ii) Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate).

Unit–II (Physical)

1. pH metry

(i) Determine the strength of HCl using NaOH pH metrically.
(ii) Determine the strength of CH_3COOH using NaOH pH metrically.

2. Potentiometry

(i) Study the preparation of salt bridge using KCl and agar-agar.
(ii) Setting of a galvanic cell and determination of cell voltage.
(ii) Potentiometric titration of strong/weak acid against strong base.

Unit–III (Organic)

1. Steam distillation (non evaluative)

(i) Naphthalene from its suspension in water.
(ii) Separation of o-and p-nitrophenols.

2. Chromatography Method

Determination of R_f values and identification of organic compounds:

(i) Separation of green leaf pigments (spinach leaves may be used) by paper chromatographic method.

Viva-Voce	**(06 Marks)**
Note Book	**(05 Marks)**

Books Recommended/References:

1. Vogel's Quantitative Chemical Analysis by J. Mendham.
2. Vogel's Qualitative Inorganic Analysis by G. Svehla.
3. Practical Chemistry by O. P. Pandey, D. N. Bajpai and S. Giri.
4. Senior Practical Physical Chemistry by B.D. Khosla.
5. Advanced Practical Physical Chemistry by J. B. Yadav.
6. Practical Organic Chemistry – A Primer by V. Peesapati.
7. Practical Organic Chemistry by A. K. Manna.
8. Principles of Instrumental Analysis: D. A. Skoog, F. J. Holler and S. R. Crouch.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – V**	**Nomenclature**	**Transition Metals, Batteries, Alcohols & Phenols**
Name of the Course	**Minor Course**	**Course Code**	**26CHE406MV01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus objectives: The aim of this course is to make students understand properties of the transition metals, principle, working and applications of the battery. It acquaints the students with the functional group approach to study organic chemistry and establish applications of this concept structure, methods of preparation and reactions for alcohols and phenols.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Understand the characteristics of transition metals, interstitial compounds and alloy formation.

CLO2: Understand the preparation and properties of $K_2Cr_2O_7$ and $KMnO_4$.

CLO3: Understand the different types of battery.

CLO4: Understand the preparation and reactions of alcohols and phenols.

Unit–I

d-Block Elements

General introduction, electronic configuration, occurrence and characteristics of transition metals, general trends in properties of the transition metals – metallic character, ionization enthalpy, oxidation states, ionic radii, color, catalytic property, magnetic properties, interstitial compounds, alloy formation, preparation and chemical properties of $K_2Cr_2O_7$ and $KMnO_4$.

Unit–II

Primary and Secondary Batteries

Characteristics of an ideal battery, principle, working, applications and comparison of the following batteries: Pb- acid battery, Li-metal batteries, Li-ion batteries, Li-polymer batteries, solid state electrolyte batteries, fuel cells.

Unit–III

Alcohols

Structure and classification of alcohols as 1º, 2º & 3º, methods of preparation of 1º, 2º & 3º by using Grignard reagent, ester hydrolysis and reduction of aldehydes, ketones, carboxylic acids and esters. Chemical Reactions: Acidic character of alcohols and reaction with sodium, with HX (Lucas Test), esterification, oxidation (with PCC, alkaline $KMnO_4$, acidic $K_2Cr_2O_7$ and conc. HNO_3), Oppeneauer oxidation.

Unit–IV

Phenols

Acidity of phenols and factors affecting their acidity, methods of preparation from cumene, diazonium salts and benzene sulphonic acid. Chemical Reactions: Directive influence of OH group and electrophilic substitution reactions, viz. nitration, halogenation, sulphonation, Reimer-Tiemann reaction, Gattermann–Koch reaction, Houben-Hoesch condensation, Schotten-Baumann reaction.

Books Recommended/References:

1. NCERT Chemistry Textbook for class 11th and 12th.
2. Modern Inorganic Chemistry by R. D. Madan.
3. A Textbook of Inorganic Chemistry by O. P. Tandon.
4. Essentials of Physical Chemistry by A. Bahl, B. S. Bahl and G. D. Tuli.
5. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania.
6. Organic Chemistry by R. T. Morrison and R. N. Boyd.
7. Organic Chemistry by I. L. Finar.
8. Basic Organic Chemistry by R. Chandra, S. Singh and A. Singh.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – V**	**Nomenclature**	**Minor Chemistry Practical – V**
Name of the Course	**Minor Course**	**Course Code**	**26CHE406MV01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**04**	**External Marks**	**35**
Duration of Examination	**04 Hrs.**	**Internal Marks**	**15**

Syllabus objectives: The objective of this course is to make students aware of the preparation of potash alum and effect of acid on baking and washing soda. It gives an insight into principle of conductometric titrations and its industrial applications. This course also deals with the principle of paper chromatography as a separation technique and some rapid test for carbohydrates analysis.

***Note: Examiner will set two experiments for practical examinations*.** **(12×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Prepare potash alum.

CLO2: Explain effect of acid on baking and washing soda.

CLO3: Determine the cell constant of conductometer and strength of unknown acid solution using conductometric titrations.

CLO4: Explain qualitative analysis of green leaf pigments using paper chromatography.

CLO5: Understand qualitative analysis of carbohydrates.

List of Experiments

Unit–I (Inorganic)

1. Preparation of potash alum.
2. Preparation of mohr's salt.
3. Determination of strength of HCl acid by baking and washing soda using anyone method.

Unit–II (Physical)
1. Conductometry: (i) Determination of cell constant. (ii) Perform the following conductometric titrations: a) Strong acid vs strong base. b) Weak acid vs strong base.
Unit–III (Organic)
1. Separation of amino acids by paper chromatography (Tryptophan & Threonine). 2. Qualitative tests for carbohydrates- Molisch test, Barfoed's reagent test, rapid furfural test, Tollen's test and Fehling solution test.
Viva-Voce **(06 Marks)**
Note Book **(05 Marks)**
Books Recommended/References:
1. Laboratory Manual Chemistry of NCERT for class 11^{th} and 12^{th}. 2. Basic Concepts: Physical Chemistry Experiments by N. Seedher. 3. Senior Practical Physical Chemistry by B. D. Khosla. 4. Practical Chemistry by O. P. Pandey, D. N. Bajpai and S. Giri. 5. Practical Organic Chemistry – A Primer by V. Peesapati. 6. Practical Organic Chemistry by A. K. Manna.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – VI**	**Nomenclature**	**Chemistry of Polymer, Kinetics, Carbonyl Compounds & Coordination Complexes**
Name of the Course	**Minor Course**	**Course Code**	**26CHE406MV02**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus objectives: The course introduces the students to coordination compounds which find manifold applications in diverse areas like qualitative and quantitative analysis, metallurgy, as catalysts in industrial processes as medicines, paints and pigments as well as in life. The student is also familiarized with kinetics of chemical reaction and gets an idea about order and molecularity, temperature dependence and catalysis of the reactions. This course also deals with basic understanding of polymeric materials and preparation, physical properties and reactions of carbonyls.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Understand types of coordination complexes.
CLO2: Understand the theories for bonding in coordination compounds.
CLO3: Know the basics of polymers, their classification and uses.
CLO4: Have a detail idea about some specific polymers like polythene, nylon polyesters, bakelite and rubber.
CLO5: Have the understanding of preparation, physical properties and reactions of carbonyls.
CLO6: Learn the important name reactions.

Unit–I
Coordination Chemistry Coordination entity, ligands and their types, coordination number, coordination sphere, coordination polyhedron, homoleptic and heteroleptic complex, types of coordination complexes, IUPAC nomenclature of coordination compounds, recapitulation of Werner's coordination theory, VBT for complexes, CFST for octahedral and tetrahedral complexes, success of CFST, spectrochemical series and calculation of CFSE for low spin and high spin complexes of 3d -series elements.
Unit–II
Chemical Kinetics Rate of a reaction (Average and instantaneous), rate of appearance and disappearance, factors affecting rate of reaction: concentration, temperature, catalyst; order and molecularity of a reaction, rate law and specific rate constant, integrated rate equations of zero & 1^{st} order, half-life of reactions. Temperature dependence on reaction rates, catalysts and catalysis & its types.
Unit–III
Polymer Introduction and history of polymeric materials, different schemes of classification of polymers, methods of polymerization (addition and condensation polymerisation), copolymerization and some important polymers: natural and synthetic like polythene, nylon polyesters, bakelite and rubber. Biodegradable and non-biodegradable polymers, conducting polymers with examples.
Unit–IV
Aldehydes and Ketones (Aliphatic and Aromatic) General methods of preparation, reactions: nucleophilic addition, nucleophilic addition-elimination reaction including reaction with HCN, ROH, $NaHSO_3$, ammonia and its derivatives. Iodoform test, Aldol & cross Aldol condensation, Cannizzaro's and cross Cannizzaro's reaction with mechanisms, Wittig reaction, Benzoin condensation. Clemmensen reduction, Wolff Kishner reduction, Meerwein Ponndorf Verley reduction.
Books Recommended/References:
1. NCERT Chemistry Textbook for class 11^{th} and 12^{th}. 2. Modern Inorganic Chemistry by R. D. Madan. 3. A Textbook of Inorganic Chemistry by O. P. Tandon. 4. Essentials of Physical Chemistry by A. Bahl, B. S. Bahl and G. D. Tuli. 5. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania. 6. Organic Chemistry by R. T. Morrison and R. N. Boyd. 7. Organic Chemistry by I. L. Finar. 8. Basic Organic Chemistry by R. Chandra, S. Singh and A. Singh.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – VI**	**Nomenclature**	**Minor Chemistry Practical – VI**
Name of the Course	**Minor Course**	**Course Code**	**26CHE406MV02**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**04**	**External Marks**	**35**
Duration of Examination	**04 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: This course aims to make the students understand iodometric titration and pH metry. Students will gain a comprehensive understanding of the pesticide market, including the selection, usage, and implications of potent pesticides in agricultural and public health contexts.
***Note: Examiner will set two experiments for practical examinations*.** **(12×2) Marks**
Course Learning Outcomes (CLO): By the end of the course, the students will be able to: **CLO1:** Explore iodometric titration. **CLO2:** Determine the strength of acid solution by using pH meter. **CLO3:** Evaluate the benefits and risks associated with pesticide use. **CLO4:** Explore alternative pest control methods that minimize the use of chemical pesticides. **CLO5:** Understand preparation of neem based botanical pesticides.
List of Experiments
Unit–I (Inorganic)
1. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator. 2. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
Unit–II (Physical)
1. pH- metry: Perform following pH- metric titrations: (i) Strong acid vs strong base. (ii) Weak acid vs strong base.
Unit–III (Organic)
1. Carryout market survey of potent pesticides with details as follows: a) Name of pesticide b) Chemical name, class and structure of pesticide c) Type of formulation available and Manufacturer's name d) Useful information on label of packaging regarding: Toxicity, LD50 ("Lethal Dose, 50%"), Side effects and Antidotes. 2. Preparation of neem based botanical pesticides.
Viva-Voce **(06 Marks)**
Note Book **(05 Marks)**
Books Recommended/References:
1. B.Sc. Chemistry Practical by S. Goyal. 2. Advanced Physical Chemistry, Practical Handbook by G. Raj. 3. Basic Concepts: Physical Chemistry Experiments by N. Seedher. 4. Advanced Practical Organic Chemistry by N. K. Vishnoi.

B.Sc. 4th (4 Year UG Hons. with Research in Chemistry)

Semester — VII (Session: 2027- 28)

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – VII**	**Nomenclature**	**Coordination and Crystal Chemistry**
Name of the Course	**Discipline Specific Course**	**Course Code**	**27CHEH407DS01**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**04**	**External Marks**	**70**

Duration of Examination	03 Hrs.	Internal Marks	30

Syllabus Objectives: The course aims to provide students with a profound theoretical understanding of metal-ligand bonding, transition metal complexes, and related reaction mechanisms. Additionally, the course seeks to develop practical skills in applying these theories to solve complex problems in inorganic chemistry. Students will gain insight into the structural aspects of isopoly and heteropoly acids, salts and crystal structures of diverse compounds, fostering a comprehensive understanding of advanced inorganic chemistry concepts. Ultimately, the course prepares students for analytical and research roles in the field of inorganic chemistry.

Note: Examiner will set nine questions, and the candidates must attempt five questions. Out of nine questions, one question will be compulsory, containing seven short answer type questions covering the entire syllabus. Further, the examiner will set two questions from each unit, and the candidates must attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Have a firm foundation in coordination chemistry.
CLO2: Understand metal-ligand bonding using molecular orbital diagrams.
CLO3: Describe various thermodynamic aspects of coordination complexes.
CLO4: Introduce mechanism of ligand substitution in transition metal complexes.
CLO5: Get the knowledge of redox chemistry of coordination complexes.
CLO6: Understand the structures and properties of isopoly/heteropoly acids and salts.
CLO7: Explain crystal structures of selected binary and ternary compounds.

Unit–I

Metal-Ligand Bonding

Crystal field theory, spectrochemical series, calculation of CFSE for low and high spin complexes of 3d-series elements, applications of CFSE, limitations of Crystal field theory, Jahn-Teller effect and its applications, ligand field theory, molecular orbital theory, M.O. diagrams of octahedral and square planar complexes including both σ and π bonding, factors affecting ΔE.

Unit–II

Reaction Mechanism of Octahedral Transition Metal Complexes-I

Inert and labile complexes, mechanisms for ligand replacement reactions, formation of complexes from aqua ions, ligand displacement reactions in octahedral complexes–acid hydrolysis, base hydrolysis, Anation reaction, H_2O ligand exchange reactions, factors affecting ligand substitution in octahedral complexes (leaving-group effects, effects of spectator ligands, steric effects), optical rotation, cotton effect, racemization of tris-chelate complexes, electrophilic attack on ligands.

Thermodynamic aspects: Factors affecting stability of metal complexes, Irving–Williams series.

Unit–III

Reaction Mechanism of Square-Planar Transition Metal Complexes-II

Mechanism of ligand displacement reactions in square planar complexes and related numerical, oxidative addition & reductive elimination reactions, trans effect and theories of trans effect, applications of trans effect.

Electron Transfer Processes: Types and mechanism-outer sphere electron transfer and inner sphere electron transfer reactions, electron exchange reactions, factors affecting rate of electron transfer reactions and role of non-bridging ligand on rate of electron transfer.

Unit–IV

Isopoly and Heteropoly Acids and Salts of Mo & W

Isopoly acids and isopoly-ions, preparation and structure of paramolybdate and octamolybdate, heteropoly acids (only classification into six groups), Keggins's structure of 1:11 & 1:12–heteropoly acids and structure of 1:6 heteropoly acids and heteropoly blue.

Crystal Structures: Structures of some binary and ternary crystalline solid such as fluorite, anti-fluorite, rutile, anti-rutile, crystobalite, layered lattices – CdI_2, BiI_3; ReO_3, Mn_2O_3, NiAs, corundum, pervoskite, Ilmenite, calcite, normal spinel & inverse spinel minerals, Well equation and tolerance factor.

Books Recommended/References:

1. Inorganic Chemistry: Principles of Structure and Reactivity by J.E. Huheey, E.A. Keiter, R.L. Keiter, O.K. Medhi.
2. Inorganic Chemistry by Shriver and Atkins.
3. Inorganic Chemistry by C. E. Housecroft and A. G. Sharpe.
4. Advanced Inorganic Chemistry by Cotton and Wilkinson.
5. Inorganic Chemistry by G. L. Miessler, P. J. Fischer and D. A. Tarr.
6. Modern Aspects of Inorganic Chemistry by H. J. Emeleus and A. G. Sharpe.
7. Comprehensive Coordination and Organometallic Chemistry by D. Singh.
8. Coordination Chemistry by A. Kumar.
9. Structural Principles in Inorganic Compounds by W. E. Addison.
10. Chemical bonding & Crystal structure by R. K. Malik.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – VIII**	**Nomenclature**	**Quantum, Thermodynamics and Electrochemistry**
Name of the Course	**Discipline Specific Course**	**Course Code**	**27CHEH407DS02**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**04**	**External Marks**	**70**
Duration of Examination	**03 Hrs.**	**Internal Marks**	**30**

Syllabus Objectives: This comprehensive course aims to provide students with an in-depth understanding of Quantum Mechanics, Thermodynamics, Chemical Dynamics and Electrochemistry. The overarching goal of this course is to equip students with a strong theoretical foundation and practical skills in these diverse areas of physical chemistry. The course objectives include fostering a deep understanding of quantum mechanics principles, thermodynamic concepts, chemical kinetics and electrochemical processes. Upon completion, students should be well-prepared for advanced studies or applications in various fields of physical chemistry.

Note: Examiner will set nine questions, and the candidates must attempt five questions. Out of nine questions, one question will be compulsory, containing seven short answer type questions covering the entire syllabus. Further, the examiner will set two questions from each unit, and the candidates must attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Understand the concept of quantum mechanics.

CLO2: Solve the Schrodinger equation for simple systems like rigid rotator, simple harmonic oscillator, hydrogen atom, particle in a box, etc.

CLO3: Understand the concept of different laws of thermodynamics.

CLO4: Study thermodynamics of dilute solutions-phase rule and its applications.

CLO5: Study the kinetics of complex reactions.

CLO6: Study the kinetics of chain reactions and enzymatic reactions.

CLO7: Discuss Debye-Huckel theory of ion-ion interaction and activity coefficient, its applicability, limitations and its modification for finite-sized ions, the effect of ion-solvent interaction on activity coefficient.

CLO8: Derive the D-H-O equation, its applicability and limitations, Pair-wise association of ions (Bjerrum treatment) and its modifications for ion-pair formation.

Unit–I

Quantum Mechanics

Elementary idea of quantum mechanics, Schrodinger wave equation for a particle in 1-D box and its pictorial representation, Schrodinger wave equation for a particle in a 3-D box, concept of degeneracy, Schrodinger wave equation for a linear harmonic oscillator & its solution by polynomial method, zero point energy of a particle possessing harmonic motion. Schrodinger wave equation for 3-D rigid rotator, energy of rigid rotator, space quantization. Schrodinger wave equation for hydrogen atom, separation of variable in polar spherical coordinates and its solution.

Unit–II

Thermodynamics

Introduction to laws of thermodynamics, Law of mass action and its thermodynamic derivation. Classius-Clapeyron equation and its applications. Phase diagram for two completely miscible components system. Eutectic systems, calculation of eutectic point, systems forming solid compounds A_xB_y with congruent and incongruent melting points, phase diagram and thermodynamic treatment of solid solutions.

Unit–III

Chemical Dynamics

Rate law for consecutive & parallel reactions (first order), ionic reactions: single and double sphere models, influence of solvent and ionic strength, chain reactions: hydrogen-bromine reaction & hydrogen-chlorine reaction, ortho-para hydrogen conversion, chain length, apparent activation energy of chain reactions. Photochemical reactions (hydrogen-bromine & hydrogen-chlorine reactions). Rice- Herzfeld mechanism of organic molecules decomposition (ethane, acetaldehyde), enzyme kinetics, Michaelis-Menton treatment, Lineweaver-Burk plot and Eadie–Hofstee methods. Competitive and non-competitive inhibition.

Unit–IV

Electrochemistry

Debye-Hückel theory of ion-ion interaction and activity coefficient, applicability and limitations of Debye-Hückel limiting law, its modification for finite-sized ions, effect of ion-solvent interaction on activity coefficient. Physical significance of activity coefficients, mean activity coefficient of an electrolyte. Debye-Huckel-Onsager treatment for aqueous solution and its limitations. Debye-Huckel Onsager theory for non-aqueous solutions, solvent effect on the mobility at infinite dilution, equivalent conductivity (λeq) vs. concentration $c^{1/2}$ as a function of solvent, effect of ion association upon conductivity (Debye-Huckel-Bjerrum equation).

Ion Transport in solutions: Ionic movement under the influence of an electric field, mobility of ions, ionic drift velocity and its relation with current density, Einstein relation between absolute mobility and diffusion coefficient, Stokes-Einstein relation, Nernst-Einstein equation, Walden's rule.

Books Recommended/References:

1. Thermodynamics for Chemists by S. Glasstone.
2. Physical Chemistry by G.M. Barrow.
3. Thermodynamics by R.C. Srivastava, S. K. Saha and A. K. Jain.
4. Modern electrochemistry Vol.1 by J. O. M. Bockris and A. K. N. Reddy.
5. Chemical Kinetics by K. J. Laidler.
6. Kinetics & Mechanism of Reaction Rates by A. Frost and G. Pearson.
7. Modern chemical kinetics by H. Eyring.
8. Theories of Reaction Rates by K. J. laidler, H. Eyring and S. Glasstone.
9. Theoretical Chemistry by S. Glasstone.
10. Introduction to Quantum Mechanics by R. Chandra.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – IX**	**Nomenclature**	**Organic Bonding, Reactions and Stereochemistry**
Name of the Course	**Discipline Specific Course**	**Course Code**	**27CHEH407DS03**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**04**	**External Marks**	**70**
Duration of Examination	**03 Hrs.**	**Internal Marks**	**30**

Syllabus Objectives: The course aims to provide a comprehensive understanding of advanced concepts in organic chemistry, specifically focusing on the nature of bonding in organic molecules, stereochemistry, reaction mechanisms, elimination reactions and addition reactions. The course aims to equip students with a thorough understanding of advanced organic chemistry concepts, enabling them to apply this knowledge to analyse and design complex organic reactions.

Note: Examiner will set nine questions, and the candidates must attempt five questions. Out of nine questions, one question will be compulsory, containing seven short answer type questions covering the entire syllabus. Further, the examiner will set two questions from each unit, and the candidates must attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Explain the nature of bonding in organic molecules.
CLO2: Know about host guest chemistry and supramolecular complexes.
CLO3: Understand the concept of chiral molecules and asymmetric synthesis.
CLO4: Compare different reaction mechanisms and reaction intermediates.
CLO5: Understand different types of elimination and addition reactions.

Unit–I

Nature of Bonding in Organic molecules

Delocalized chemical bonding, conjugation, cross-conjugation, resonance, hyperconjugation and tautomerism.

Aromaticity in benzenoid and non-benzenoid compounds, Huckel's rule, energy level of π-molecular orbitals, annulenes, antiaromaticity, homoaromaticity, PMO approach, alternant and non-alternant hydrocarbons.

Bonds weaker than covalent, addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes.

Unit-II

Stereochemistry

Chirality, elements of symmetry, molecules with more than one chiral center, diastereomerism, methods of resolution, optical purity. Prochirality, enantiotopic and diastereotopic atoms, groups and faces, asymmetric synthesis, Cram's rule and its modifications, Prelog's rule, conformational analysis of decalins. Optical activity in the absence of chiral carbon (Biphenyls, Allenes and Spiranes), chirality due to helical shape. Geometrical isomerism in alkenes and oximes, methods of determining the configuration.

Unit-III

Reaction Mechanism

Structure and Reactivity: types of mechanisms, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle, potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. effect of

structure on reactivity, Hammett equation and linear free energy relationship, substituent and reaction constants, Taft equation.

Unit-IV

Elimination Reactions

The E1, E2 and E1cB mechanisms, orientation of the double bond. effects of substrate structures, attacking base, leaving group and medium on reactivity. Mechanism and orientation in pyrolytic elimination.

Addition to Carbon-Carbon Multiple Bonds: Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, orientation and reactivity, addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings, hydroboration reaction, Michael reaction, Sharpless asymmetric epoxidation.

Books Recommended/References:

1. Advanced Organic Chemistry: Reactions, Mechanism and Structure by J. March.
2. Advanced Organic Chemistry by F. A. Carey and R. J. Sundberg.
3. Structure and Mechanism in Organic Chemistry by C. K. Ingold.
4. Stereochemistry of Organic Compounds by P. S. Kalsi.
5. Organic Chemistry by R. T. Morrison and R. N. Boyd.
6. Principles of Organic Synthesis by R. O. C. Norman and J. M. Coxon.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Chemistry Practical Paper – VII**	**Nomenclature**	**Inorganic Chemistry Practical – I**
Name of the Course	**Discipline Specific Course**	**Course Code**	**27CHEH407DS04**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**08**	**External Marks**	**70**
Duration of Examination	**08 Hrs.**	**Internal Marks**	**30**

Syllabus Objectives: The course aims to provide students with a comprehensive understanding of analytical chemistry through the study of volumetric analysis and green methods of preparation. Through practical applications, students will develop essential laboratory skills, critical thinking abilities and an appreciation for the principles of green chemistry. The course aims to bridge theoretical knowledge with practical expertise, promoting a holistic understanding of analytical techniques and environmentally conscious synthesis methods.

***Note: Examiner will set two experiments for practical examinations*.**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Determine Cu (II), $K_2Cr_2O_7$ using iodometric titrations.
CLO2: Determine aluminium, magnesium and zinc using potassium bromate.
CLO3: Determine calcium, copper and barium using EDTA (forward and back titrations).
CLO4: Determine the strength of metal ions in the presence of masking agents.
CLO5: Synthesize selected metal acetylacetonato complexes employing green methods.

List of Experiments

1. Volumetric Analysis: (25 Marks)

(a) Iodo/Iodimetric Titrations

(i) Estimation of Cu(II) using sodium thiosulphate solution iodometrically.

(ii) Estimation of $K_2Cr_2O_7$ using sodium thiosulphate solution iodometrically.

(b) Potassium Iodate Titrations: Determination of iodide, hydrazine.

(c) Potassium Bromate Titrations

(i) Determination of aluminium, magnesium, cobalt and zinc (by Oxine method).

(d) EDTA Titrations

(i) Determination of magnesium, calcium, barium, nickel, copper.

(ii) Back titration.

(iii) Titration of mixtures using masking and demasking agents.

(iv) Determination of hardness of water.

2. Green methods of preparation of the following: (25 Marks)

(i) Bis(acetylacetonato)copper(II)

(ii) Tris(acetylacetonato)iron(III)

(iii) Tris(acetylacetonato)managnese(III)

(iv) Synthesis of Ag nanoparticles by plant extract and characterization using UV-Visible spectrophotometer.

Viva-Voce (10 Marks)

Note Book (10 Marks)

Books Recommended/References:

1. A text Book of Quantitative Inorganic Analysis by A. I. Vogel.
2. Applied Analytical Chemistry by O. P. Vermani.
3. Vogel's Quantitative Chemical Analysis by J. Mendham.
4. Vogel's Qualitative Inorganic Analysis by G. Svehla.
5. Practical Inorganic Chemistry by Marr and Rockett.
6. Synthesis and Characterization of Inorganic Compounds by W. L. Jolly.
7. Instrumental Methods of Analysis by B. K. Sharma.
8. Principles of Instrumental Analysis by D.A. Skoog, F.J. Holler and S.R. Crouch.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Chemistry Practical Paper – VIII**	**Nomenclature**	**Physical Chemistry Practical – I**
Name of the Course	**Discipline Specific Course**	**Course Code**	**27CHEH407DS05**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**08**	**External Marks**	**70**
Duration of Examination	**08 Hrs.**	**Internal Marks**	**30**

Course Objectives: This course is designed to provide students with a comprehensive understanding of various experimental techniques in physical chemistry, focusing on surface tension, conductometry, refractometry and thermochemistry. Through these experiments, students will develop practical laboratory skills, enhance their understanding of physical chemistry principles and gain valuable insight into the applications of these techniques in chemical analysis and research.

***Note: Examiner will set two experiments for practical examinations*.**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Understand the concept of surface tension and its determination for various organic solvents.

CLO2: Understand the parachor value, molecular surface energy and association factor.

CLO3: Understand and master the fundamentals of conductometric titrations in aqueous media.

CLO4: Understand and master the fundamentals of refractometry experiments.

CLO5: Determine the heat of solution and heat of hydration.

List of Experiments

1. Surface Tension **(25 Marks)**

(i) Study the effect of soap concentration on the lowering of surface tension of water

(ii) Determine surface tension of methyl alcohol, ethyl alcohol, n-hexane at room temperature and also calculate the parachor of C, H and O.

(iii) Determine the composition of given mixture of two components A and B.

(iv) Determine the molecular surface energy and association factor of ethanol.

2. Conductometry

(i) Determine the strength of strong acid and weak acid in a mixture by conductometric titration with a strong base

(ii) Study precipitation titration between KCl and $AgNO_3$ conductometrically. Determine the strength of given solution of $AgNO_3$.

(iii) Determine the equivalent conductivity of strong electrolyte at different dilution and also find out the equivalent conductivity of weak electrolyte at infinite dilution.

(iv) Estimate conductometrically the quantities of NH_4OH and NH_4Cl in their mixture.

3. Refractometry **(25 Marks)**

(i) Determine atomic refractivities of C, H and O by methyl alcohol, ethyl alcohol and n-hexane.

(ii) Determine the percentage composition of liquids in the given binary mixture by using refractometry.

(iii) Determine the molecular refractivity of p-dichlorobenzene.

4. Heat of Solution and Hydrations

(i) Determine heat of solution of potassium nitrate in water.

(ii) Determine heat of hydration of sodium sulphate and copper suphate.

Viva-Voce **(10 Marks)**

Note Book **(10 Marks)**

Books Recommended/References:

1. Practical Physical Chemistry by A. M. James and F. E. Prichard, Longman.
2. Findley's Practical Physical Chemistry by B. P. Lavitt.
3. Practical Physical Chemistry by S. R. Palit and S. K. Science.
4. Experimental Physical Chemistry by R. C. Das, B. S. Behera.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**SEC Paper – V**	**Nomenclature**	**Organic Chemistry Practical – I**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**27CHE407SE01**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**08**	**External Marks**	**70**
Duration of Examination	**08 Hrs.**	**Internal Marks**	**30**

Syllabus Objectives: This course in organic chemistry focuses on qualitative analysis and simple organic preparations thereby providing the students with practical skills of separation, purification and identification of organic compounds. Through these objectives, students will acquire a well-rounded skill set that prepares them for further studies in organic chemistry and applications in various scientific and industrial contexts.

***Note: Examiner will set two experiments for practical examinations*.**
Course Learning Outcomes (CLO): By the end of the course, the students will be able to: **CLO1:** Handle organic chemicals in a safe and competent manner. **CLO2:** Understand the separation of organic compounds from binary mixtures. **CLO3:** Perform the standard techniques used in practical organic chemistry. **CLO4:** Recognize different procedures for separation, identification and purification of organic compounds. **CLO5:** Apply the basic chemical concepts to understand the mechanism of chemical reactions.
List of Experiments
1. **Qualitative Analysis** **(50 Marks)** Separation, purification and identification of organic compounds in binary mixtures by chemical tests and preparation of their derivatives.
Viva-Voce **(10 Marks)**
Note Book **(10 Marks)**
Books Recommended/References:
1. Experiments and Techniques in Organic chemistry by D. J. Pasto, C. R. Johnson and M. J. Miller. 2. Macroscale and Microscale Organic Experiments by K. L. Williamson and D. C. Heath. 3. Systematic Qualitative Organic Analysis by H. Middleton. 4. A Handbook of Organic Analysis-Qualitative and Quantitative by H. Clark. 5. Vogel's Textbook of Practical Organic chemistry by A. I. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hanaford and P. W. G. Smith.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – VII**	**Nomenclature**	**Organometallics, Surface Chemistry & Carbohydrates**
Name of the Course	**Minor Course**	**Course Code**	**27CHE407MV01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus objectives: The course introduces the students to organometallic compounds, the concept of hapticity and the 18-electron rule governing the stability of a wide variety of organometallic species. The students will learn about surface phenomenon, adsorption isotherms and colloidal systems including their interactions, dynamics and methods of characterization to appreciate their significance in industrial, environmental and biological contexts. Students will delve into carbohydrate structures, preparation and their properties.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Have a detail idea about the basics of organometallic compounds.
CLO2: Apply 18-electron rule to rationalize the stability of metal carbonyls and related species.
CLO3: Understand the fundamental principles of adsorption and desorption.
CLO4: Understand the principles of colloidal science, including colloidal stability, aggregation, and surface chemistry.
CLO5: Explore the applications of colloidal systems in various fields, such as pharmaceuticals, food science and nanotechnology.
CLO6: Have the understanding of structure, preparation and properties of carbohydrates.

Unit–I

Organometallic Compounds

Definition, nature of metal carbon bond, classification of organometallic compounds by bond types viz. i) covalent ii) ionic iii) electron deficient iv) cluster compounds v) π bond compounds including sandwich derivatives. Structure and bonding in, metal- ethylenic, metal carbonyls and cyclopentadienyl derivative. Properties and bonding of alkyls of Li, Al, Hg and Sn, concept of hapticity of organic ligand, Zeise salt and ferrocene. EAN rule as applied to carbonyls.

Unit–II

Adsorption

Physical and chemical adsorption, difference between physisorption and chemisorption, Freundlich adsorption isotherm (derivation excluded), Langmuir adsorption isotherm, applications of adsorption. Concept of desorption.

Unit – III

Colloidal states

Introduction, types of colloidal systems, classification of colloids, true solutions, colloidal solutions and suspensions. General properties of colloidal systems, properties of hydrophobic colloidal systems.

(a) electrical properties: charge on colloidal particles, coagulation of colloidal sols: Hardy and Schulze rule, Gold number

(b) electrokinetic properties: electrophoresis and electro-osmosis. Surfactants, types of emulsions, emulsifiers, gels, preparation of gels, importance and applications of colloids.

Unit–IV

Carbohydrates

Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Conversion of glucose into mannose. Determination of ring size of glucose and fructose. Open chain and cyclic structure of D (+)-glucose & D (-) fructose.

Books Recommended/References:

1. Modern Inorganic Chemistry by R. D. Madan.
2. A Textbook of Inorganic Chemistry by O. P. Tandon.
3. Organometallic and Bioinorganic Chemistry by A. Kumar.
4. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania.
5. Organic Chemistry by R. T. Morrison and R. N. Boyd.
6. Basic Organic Chemistry by R. Chandra, S. Singh and A. Singh.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – VII**	**Nomenclature**	**Minor Chemistry Practical – VII**
Name of the Course	**Minor Course**	**Course Code**	**27CHE407MV01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**04**	**External Marks**	**35**
Duration of Examination	**04 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: This course aims to make the students understand the principle of redox and potentiometric titration. Students will gain a comprehensive understanding of reaction mechanism behind the preparation of some simple organic compounds.

***Note: Examiner will set two experiments for practical examinations*.** **(12×2) Marks**
Course Learning Outcomes (CLO): By the end of the course, the students will be able to: **CLO1:** Explore redox titration with $KMnO_4$ and determine the water of crystallization in mohr's salt and oxalic acid. **CLO2:** Prepare the salt bridge by using KCl and agar-agar. **CLO3:** Set the galvanic cell and can determine its cell voltage. **CLO4:** Determine the strength of given acid by potentiometric titration. **CLO5:** Explore the adsorption phenomena. **CLO7:** Understand the reaction of some simple organic compounds.
List of Experiments
Unit–I (Inorganic)
1. Determination of water of crystallization in mohr's salt by redox titration with $KMnO_4$. 2. Determination of water of crystallization in oxalic acid by redox titration with $KMnO_4$. 3. Determine strength of given $KMnO_4$ solution using mohr's salt. 4. Determine strength of $KMnO_4$ solution using oxalic acid solution.
Unit–II (Physical)
1. Potentiometry (i) Study the preparation of salt bridge using KCl and agar-agar. (ii) Setting of a galvanic cell and determination of cell voltage. (iii) Potentiometric titration of strong acid against strong base. (iv) Potentiometric titration of weak acid against strong base. 2. Study adsorption of acetic acid on the surface of activated charcoal.
Unit–III (Organic)
1. Simple organic preparations and checking the purity of samples prepared: (i) Chalcone from benzaldehyde and acetophenone. (ii) Pheny-azo-β-naphthol dye from aniline. (iii) Adipic acid from cyclohexene. (iv) 2-Butoxynaphthalene from 2-naphthol and 1-iodobutane. (v) 3,4-Dihydropyrimidin-2(1H)-ones from aldehyde, β-ketoester and urea (Biginelli reaction). (vi) Benzilic acid from benzil.
Viva-Voce **(06 Marks)**
Note Book **(05 Marks)**
Books Recommended/References:
1. B.Sc. Chemistry Practical by S. Goyal. 2. Advanced Physical Chemistry, Practical Handbook by G. Raj. 3. Basic Concepts: Physical Chemistry Experiments by N. Seedher. 4. Advanced Practical Organic Chemistry by N. K. Vishnoi. 5. Comprehensive Practical Organic Chemistry: Qualitative Analysis by V. K. Ahluwalia and S. Dhingra.

B.Sc. 4th (4 Year UG Hons. with Research in Chemistry)

Semester — VIII (Session: 2027- 28)

(Option –I)

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – X**	**Nomenclature**	**General Spectroscopy**
Name of the Course	**Discipline Specific Course**	**Course Code**	**27CHEH408DS01**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**04**	**External marks**	**70**
Duration of Examination	**03 Hrs.**	**Internal Marks**	**30**

Syllabus Objectives: The course is designed to provide students with a comprehensive understanding of advanced topics in spectroscopy which include developing a strong theoretical foundation, enhancing practical skills in spectroscopic techniques and fostering the ability to apply these methods to solve complex problems in the structural elucidation of organic and inorganic compounds. The ultimate goal is to prepare students for advanced research and applications in the diverse and dynamic field of spectroscopy.

Note: Examiner will set nine questions, and the candidates must attempt five questions. Out of nine questions, one question will be compulsory, containing seven short answer type questions covering the entire syllabus. Further, the examiner will set two questions from each unit, and the candidates must attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Learn about point symmetry groups for various molecules.
CLO2: Explore different regions of the electromagnetic spectrum.
CLO3: Analyse vibrational and vibrational-rotational spectra of polyatomic molecules.
CLO4: Understand the role of UV, IR, and NMR in determining molecular structures.
CLO5: Apply NMR techniques in the characterization of inorganic compounds.

Unit–I

Symmetry and Group Theory in Chemistry

Symmetry elements and symmetry operation, point group and its properties, group multiplication table, Schonflies symbol, representation of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, C_s, D_{nh} etc. groups to be worked out explicitly). Point groups of following molecules: H_2O, NH_3, CH_4, SF_6, $CHCl_3$, BF_3, C_6H_6, C_5H_5, NSF_3, C_2H_2, HCl, HCN, CO_2 etc. Irreducible representation of groups. The Great Orthogonality theorem (without proof) and its importance. Character tables and its applications in spectroscopy.

Unit–II

Introduction to spectroscopy

Electromagnetic radiations, interaction of electromagnetic radiation with matter, regions of the spectrum, width and intensity of spectral transitions. Resolving power, transition probability.

Rotational spectra: Rotational spectra of diatomic molecules (rigid rotator), spectrum of non-rigid rotator, effect of isotopic substitutions, rotational spectra of linear and symmetric top polyatomic molecules.

Vibrational and Vibrational-Rotational Spectra: Vibrating diatomic molecule (simple harmonic vibrator), anharmonicity, diatomic vibrating rotator, interaction of rotations and vibrations, vibrational spectra of polyatomic molecules, analysis by infrared technique.

Electronics Spectra: Electronic spectra of diatomic molecules, vibrational course structure and rotational fine structure of electronic band. Frank-Condon principle (intensity of vibrational-electronic band, dissociation energy), Fortrat diagram.

Unit–III

Ultraviolet and Visible Spectroscopy

Principle, electronic energy levels and transitions, chromophores and auxochromes, bathochromic and hypsochromic shift, hypochromic and hyperchromic effect.

Infrared Spectroscopy: Principle, functional group and fingerprint regions, absorption of infrared radiation and molecular vibrations (stretching and bending), fundamental vibrations and overtones.

NMR Spectroscopy: Spin active nuclei, chemical shift, shielding and deshielding, spin-spin coupling, equivalent and non-equivalent protons, effect of changing solvents and hydrogen bonding on chemical shifts, anisotropic effect.

Applications of UV, IR, and NMR spectra in the structural elucidation of organic compounds.

Unit–IV

Electronic Absorption Spectroscopy

Energy levels in diatomic molecules, introduction to electronic transition, assignment of transitions, selection rules for EAS, p-d intermixing.

Nuclear Magnetic Resonance: Quantum concept of NMR, larmor frequency, coupling constant, applications of spin-spin coupling in structure determination of inorganic compounds, population excess and types of relaxation, standard references for inorganic compounds, calculation of rates from NMR-spectrum, determination of order by NMR, double resonance technique for inorganic compounds like B_2H_6, $Al(BH_4)_3$ etc. Characterization of metal hydrides complexes (counting signals), inorganic applications of NMR like ^{1}H NMR, ^{11}B NMR, ^{19}F NMR, ^{31}P NMR (dynamic and frozen spectra), fluxional behaviour of inorganic molecules.

Finger print regions of IR spectroscopy, Hooke's law & its applications for determination of stretching frequency. Application of infrared spectroscopy in the determination of inorganic compounds: Determination of coordination site, identification of cis-and trans isomers, structure elucidation of covalent molecules, H-bonding etc.

Books Recommended/References:

1. Chemical Applications of Group Theory by F. A. Cotton.
2. Physical Methods in Inorganic Chemistry by R. S. Drago.
3. Infrared Spectra of Inorganic and Coordination Compound by K. Nakamoto.
4. Fundamentals of Molecules Spectroscopy by C. N. Banwel.
5. Introduction to Magnetic Resonance Spectroscopy ESR, NMR, NQR by D. N. Sathyanarayana.
6. Physical Chemistry by P.W. Atkins and J. Paula.
7. Introduction to Spectroscopy by D. L. Pavia, G. M. Lampman, G. S. Kriz and J. R. Vyvyan.
8. Organic Spectroscopy: Principles and Applications by J. Mohan.
9. Spectroscopy (Vol. 2) by R. K. Malik.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – XI**	**Nomenclature**	**Research Methodology**
Name of the Course	**Discipline Specific Course**	**Course Code**	**27CHEH408DS02**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**04**	**External Marks**	**70**

Duration of Examination	03 Hrs.	Internal Marks	30

Syllabus Objectives: This course aims to provide a comprehensive understanding of research fundamentals, including various types and methods. It focuses on effective data collection, documentation and ethical conduct in scientific research. Students will learn about literature review, laboratory procedures, publication processes and ethical considerations, equipping them with essential skills for conducting responsible and impactful research in diverse fields.

Note: Examiner will set nine questions, and the candidates must attempt five questions. Out of nine questions, one question will be compulsory, containing seven short answer type questions covering the entire syllabus. Further, the examiner will set two questions from each unit, and the candidates must attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Understand the different types of research.
CLO2: Understand the research methods and methodology.
CLO3: Understand the data collection and maintaining laboratory record.
CLO4: Understand the different research areas of chemistry.
CLO5: Understand various instruments to characterize the research.
CLO6: Understand publication of research.

Unit–I

Basic concepts of research

Research-definition and types of research (Descriptive vs analytical, applied vs fundamental, quantitative vs. qualitative, conceptual vs empirical). Research methods vs methodology.
Literature-review and its consolidation, library research, field research; laboratory research.

Unit–II

Data collection and documentation of observations

Maintaining a laboratory record, tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.

Unit–III

Basic knowledge of publication house, journals and instrumentation

Introduction, research publications, access to different publication house and journals associated with it, research articles. Code of conduct - while entering in the lab, while working with the chemicals, while disposal of chemicals, storage and disposal of chemical wastes – aqueous wastes, organic wastes and radioactive wastes, human contribution to reduce hazardous wastes. characterization of samples, instruments used for characterization.

Unit–IV

Ethics with respect to science and research

Scientific misconducts – Falsification, fabrication and plagiarism (FFP),
Redundant publications – Duplicate and overlapping publications, selective reporting and misrepresentation of data.
Publication ethics – Definition, introduction and importance.
Publication misconduct – Definition, concept, problems that lead to unethical behaviour, conflicts of interest, violation of publication ethics authorship and contributionship.

Books Recommended/References:
1. Conducting Research Literature Reviews by A. Fink. 2. Research Methods: A Process of Inquiry by M. Graziano, A. M. Anthony and M. L. Raulin. 3. Research Methods: the concise knowledge base by W. M. K. Trochim. 4. Practical Research: Planning and Design by P. D. Leedy and J. E. Ormrod. 5. An introduction to Research Methodology by L. Garg, R. Karadia, F. Agarwal and U. K. Agarwal. 6. How to Write and Publish a Scientific Paper by R. A. Day. 7. Research Methodology: Methods and Techniques by C. R. Kothari.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – XII**	**Nomenclature**	**Special Chemistry**
Name of the Course	**Discipline Specific Course**	**Course Code**	**27CHEH408DS03**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**04**	**External Marks**	**70**
Duration of Examination	**03 Hrs.**	**Internal Marks**	**30**

Syllabus Objectives: The course aims to provide an in-depth understanding of advanced topics in organometallic chemistry, spectroscopy, electro-analytical methods and reaction mechanisms. The course aims to equip students with a robust foundation in these advanced topics, fostering their ability to analyse and comprehend complex chemical systems.

Note: Examiner will set nine questions, and the candidates must attempt five questions. Out of nine questions, one question will be compulsory, containing seven short answer type questions covering the entire syllabus. Further, the examiner will set two questions from each unit, and the candidates must attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Understand the structure and bonding of various types of clusters.
CLO2: Provide a basic understanding of electronic spectra of metal complexes.
CLO3: Explain the colour of transition metal complexes.
CLO4: Understand the potentiometric methods.
CLO5: Know about the electrodes.
CLO6: Get knowledge of bonding and basic organic reaction mechanism.

Unit–I

Organometallic

18-electron rule, counting methods and ligand contributions, haptoligands with hapticity from two to eight. **Clusters:** Multi-nuclear carbonyl clusters: Low nuclearity carbonyl clusters (LNCC), High nuclearity carbonyl clusters (HNCC), clusters having interstitial atom, electron counting schemes for high nuclearity clusters, polyhedral skeletal electron pair approach/Mingo's rules, structure and bonding in higher boranes, Wade's rules, carboranes, applications of Wade's rules, zintl-ions, isolobal analogy, dinuclear clusters (metal clusters containing M-M multiple bonds).

Unit-II

Electronic Spectra of Transition Metal Complexes

Spectroscopic ground states, spin-orbit coupling in free metal ions for 3d- series of transition metals, ground state terms for transition metals/ions, Racah parameters and nephalauxetic effect, orgel diagrams (d^1 to d^{10}) and Tanabe-Sugano diagrams for transition metal complexes (d^1 & d^2 states), elementary concept of Dq, B

and β parameters, effect of Jahn-Teller distortion on electronic spectra of 3d-series metal complexes, charge transfer spectra, electronic spectra of molecular addition compounds of iodine.

Unit-III

Electro-Analytical & Potentiometric Methods

Polarization phenomenon and its theories, effect of concentration on cell potential. Concept of Liquid-Junction potential, reference electrodes (Calomel, Ag/AgCl, Tl/TlCl). Metallic redox indicator electrode: Membrane and ion-selective electrodes, electrical properties of membrane, glass electrode with special reference to H^+, Na^+, K^+ ions, operation of solid membrane electrode and liquid membrane electrode and coated type ion electrode. Applications of ion selective electrode in determination of some toxic metals and some anions (F^-, Cl^-, Br^-, I^- and NO_3^-).

Unit-IV

Bonding in Organic molecules

Aromaticity in benzenoid and non-benzenoid compounds, antiaromaticity, homoaromaticity, energy level of π-molecular orbitals, PMO approach, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, phase transfer catalysis, catenanes and rotaxanes.

Reaction Mechanism: Kinetic and thermodynamic control of reactions, Hammond's postulate, Curtin-Hammett principle, transition states and intermediates, methods of determining reaction mechanisms, generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. The Hammett equation and linear free energy relationship, Taft equation.

Books Recommended/References:

1. Inorganic Chemistry by C. E. Housecroft and A. G. Sharpe.
2. Inorganic Chemistry by Shriver and Atkins.
3. Basic Organometallic Chemistry: Concepts, Syntheses and Applications by B.D. Gupta and A.J. Elias.
4. Comprehensive Coordination and Organometallic Chemistry by D. Singh.
5. Physical Methods of Chemists by R. S. Drago.
6. Electroanalytical Chemistry: A Series of Advances by A. J. Bard.
7. Organic Chemistry by J. Clayden, N. Greeves, and S. Warren.
8. Organic Chemistry by P. Y. Bruice.
9. Advanced Organic Chemistry: Reactions, Mechanisms, and Structure by M. B. Smith and J. March.
10. Advanced Organic Chemistry by F.A. Carey and R.J. Sundberg.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Chemistry Practical Paper – IX**	**Nomenclature**	**Inorganic Chemistry Practical – II**
Name of the Course	**Discipline Specific Course**	**Course Code**	**27CHEH408DS04**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**08**	**External Marks**	**70**
Duration of Examination	**08 Hrs.**	**Internal Marks**	**30**

Syllabus Objectives: The course on quantitative inorganic analysis is designed to equip students with comprehensive knowledge and practical skills in separating and determining metal ions through various analytical methods. Additionally, students will delve into the principles and applications of cerimetry for determining Ferrous, Oxalate, and Nitrite ions. The course emphasizes hands-on experience in laboratory settings, ensuring proficiency in analytical

techniques. Overall, the course aims to foster a deep understanding of inorganic analytical methods, enhance problem-solving skills, and promote awareness of sustainable practices in chemical analysis.

***Note: Examiner will set two experiments for practical examinations*.**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Separate and determine binary mixtures of metal ions using gravimetric and volumetric methods.
CLO2: Determine strengths of ferrous and oxalate using cerimetry.
CLO3: Determine the strengths of nitrite ions using cerimetry (also by indirect method).
CLO4: Synthesize some metal acetyl acetonato complexes employing green methods.

List of Experiments

1. Quantitative Inorganic Analysis (25 Marks)

a) Separation and determination of two metal ions *via* volumetric and gravimetric methods

(i) Silver-Copper
(ii) Copper-Nickel
(iii) Copper-Zinc
(iv) Nickel-Zinc
(v) Copper-Iron

2. (a) Determination by Cerimetry (25 Marks)

(i) Ferrous
(ii) Oxalate
(iii) Nitrite

(b) Green methods of preparation of the following

(i) Bis(acetylacetonato) zinc (II)
(ii) Bis(acetylacetonato) chromium (II)

Viva-Voce (10 Marks)

Note Book (10 Marks)

Books Recommended/References:

1. A Text Book of Quantitative Inorganic Analysis by A.I. Vogel.
2. Applied Analytical Chemistry by O.P. Vermani.
3. Vogel's Quantitative Chemical Analysis by J. Mendham.
4. Vogel's Qualitative Inorganic Analysis by G. Svehla.
5. Practical Inorganic Chemistry by Marr and Rockett.
6. Principles of Instrumental Analysis by D.A. Skoog, F.J. Holler and S.R. Crouch.
7. Quantitative Chemical Analysis by D.C. Harris.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Chemistry Practical Paper – X**	**Nomenclature**	**Physical Chemistry Practical – II**
Name of the Course	**Discipline Specific Course**	**Course Code**	**27CHEH408DS05**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**08**	**External Marks**	**70**
Duration of Examination	**08 Hrs.**	**Internal Marks**	**30**

Syllabus Objectives: The course on experimental techniques in physical chemistry aims to provide students with a thorough understanding of various experimental methods used in the study of physical chemistry principles. The objectives include developing hands-on experimental skills in physical chemistry techniques and enhancing the understanding of fundamental principles governing physical and chemical processes. This course aims to prepare

students for advanced studies or careers in physical chemistry, research and industrial applications by combining theoretical knowledge with practical skills in experimental techniques.

***Note: Examiner will set two experiments for practical examinations*.**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Know the concept of viscosity and determine the viscosity of various liquids.
CLO2: Study the conductometric and pH metric titration for determination of normality and strength of acids.
CLO3: Study the potentiometric titration and determine strength and thermodynamic properties of given acids.
CLO4: Determine the partition coefficient of a solute between two immiscible solvents using distribution law.
CLO5: Study the kinetics of hydrolysis of ethyl or methyl acetate and calculation of thermodynamic parameters.
CLO6: Develop the ability to compile interpreted information in the form of lab record.

List of Experiments

1. Viscosity **(25 Marks)**

(i) Study the variation of viscosity with concentration for a glycerol/amyl alcohol solution using Ostwald viscometer and thereafter determine the concentration of unknown solution of glycerol and amyl alcohol.
(ii) Determination of molar mass of a polymer by using viscometer.
(iii) Determine the temperature coefficient of given liquid.

2. Conductometry

(i) Study the equivalent conductance versus square root of concentration relationship of a strong electrolyte (KCl or NaCl) and weak electrolyte (acetic acid).
(ii) Determine the strength of NaOH and NH_4OH in a given mixture by titrating it against HCl.
(iii) Estimate conductometrically the quantities of HCl and NH_4Cl in their mixture.

3. pH-metry

(i) Titration of a mixture of (HCl + CH_3COOH) against NaOH pH-metrically and comment on the shape of the curve.

4. Potentiometry **(25 Marks)**

(i) Determine the strength of acetic acid by titrating it against NaOH potentiometrically. Also calculate dissociation constant of acid using quinhydrone electrode.
(ii) Study the effect of ionic strength on mean activity coefficient of HCl in a given solution.
(iii) Determine the standard free energy change and equilibrium constant for the reaction.
$Cu + 2Ag^+ \rightarrow Cu^{2+} + 2Ag$

5. Distribution Law

(i) Study the complex formation of cuprammonium ion or study the complex formation between copper sulphate and ammonia solution.
(ii) Determination of equilibrium constant for $I_2 + I^- = I^-_3$

6. Chemical Kinetics

(i) Determination of the rate constant and activation energy for hydrolysis of ethyl or methyl acetate.
(i) Determination of the temperature coefficient for hydrolysis of ethyl or methyl acetate and calculation of thermodynamic parameters.

Viva-Voce **(10 Marks)**

Note Book **(10 Marks)**

Books Recommended/References:

1. Practical Physical Chemistry by A. M. James and F. E. Prichard.
2. Findley's Practical Physical Chemistry by B. P. Lavitt.
3. Practical Physical Chemistry by S. R. Palit and S. K. De.
4. Experimental Physical Chemistry by R. C. Das and B. Behera.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**SEC Paper – VI**	**Nomenclature**	**Organic Chemistry Practical – II**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**27CHE408SE01**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**08**	**External Marks**	**70**
Duration of Examination	**08 Hrs.**	**Internal Marks**	**30**

Syllabus Objectives: The organic synthesis and purity analysis course aims to provide students with a complete understanding of organic synthesis techniques and the methods for assessing the purity of synthesized compounds. The course aims to prepare students for advanced work in organic chemistry, research or industrial applications by combining theoretical knowledge with practical skills in organic synthesis and analytical techniques.

***Note: Examiner will set two experiments for practical examinations*.**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Handle organic chemicals in a safe and competent manner.
CLO2: Perform the standard techniques used in practical organic chemistry.
CLO3: Carry out multistep synthesis of organic compounds following a prescribed procedure.
CLO4: Apply the basic chemical concepts to understand the mechanism of chemical reactions.
CLO5: Characterize and purify the synthesized compounds.

List of Experiments

1. Simple organic preparations and checking the purity of samples prepared: (20 Marks)

(i) Chalcone from benzaldehyde and acetophenone.
(ii) Phenyl-azo-β-naphthol dye from aniline.
(iii) Adipic acid from cyclohexene.
(iv) 2-Butoxynaphthalene from 2-naphthol and 1-iodobutane.
(v) 3,4-Dihydropyrimidin-2(1H)-ones from aldehyde, β-ketoester and urea (Biginelli reaction).
(vi) Benzilic acid from benzil.

2. Two-step organic synthesis and checking purity of samples prepared: (30 Marks)

(i) Acetanilide from acetophenone *via* acetophenone oxime.
(ii) *p*-Nitroaniline from acetanilide *via p*-nitroacetanilide.
(iii) Methyl orange from sulphanilic acid *via* diazotized sulphanilic acid.
(iv) 2,4-Dinitrophenylhydrazine from chlorobenzene *via* 1-chloro-2,4-dinitrobenzene.
(v) Anthranilic acid from phthalic anhydride *via* phthalimide.
(vi) *m*-Nitroaniline from nitrobenzene *via m*-dinitrobenzene

Viva-Voce (10 Marks)

Note Book (10 Marks)

Books Recommended/References:

1. Experiments and Techniques in Organic Chemistry by D. J. Pasto, C. R. Johnson and M. J. Miller.
2. Macroscale and Microscale Organic Experiments by K. L. Williamson and D. C. Heath.
3. Systematic Qualitative Organic Analysis by H. Middleton.
4. A Handbook of Organic Analysis-Qualitative and Quantitative by H. Clark.
5. Vogel's Textbook of Practical Organic Chemistry by A. I. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hanaford and P. W. G. Smith.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – VIII**	**Nomenclature**	**Chemistry of Acid-Base, Dyes, Bio-inorganics, Photochemistry, and Carbohydrates**
Name of the Course	**Minor Course**	**Course Code**	**27CHE408MV01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus objectives: The objective of this course is to deliver information about bioinorganic and acid-base chemistry. The student learns the importance of inorganic chemical species, specially metals in biological systems through discussions on metal-containing enzymes such as the sodium-potassium pump. This course also aims to provide students with a comprehensive understanding of the principles and applications of photochemistry. Students will gain a comprehensive understanding of the chemistry and applications of disaccharides, polysaccharides and dyes.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Understand the concept of acid-base reactions in aqueous solvents.
CLO2: Define and explain terms such as absorption, fluorescence, phosphorescence and intersystem crossing.
CLO3: Describe the Jablonski diagram and its significance in photochemistry.
CLO4: Identify common disaccharides and polysaccharides.
CLO5: Classify dyes based on their chemical structure and applications.

Unit–I

Acids and Bases

Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.

Unit–II

Bioinorganic Chemistry

Metal ions present in biological system, classification based on action (essential, non-essential, trace, toxic), Na/K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity. Metalloporphyrins with special reference to hemoglobin and myoglobin. Biological role of Na^{+}, K^{+}, Ca^{+2}, Mg^{+2}, Fe^{+2} ions.

Unit–III

Photochemistry

Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus - Drapper law, Stark-Einstein law (law of photochemical equivalence) Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions-energy transfer processes (simple examples).

Unit–IV
Disaccharides and polysaccharides An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination. **Synthetic Dyes** Colour and constitution (electronic concept). Classification of dyes. Chemistry and synthesis of Methyl orange, Congo red, Malachite green, Crystal violet, Phenolphthalein, Fluorescein, Alizarin and Indigo.
Books Recommended/References:
1. Modern Inorganic Chemistry by R. D. Madan. 2. Organometallic and Bioinorganic Chemistry by A. Kumar. 3. Fundamental of Photochemistry by K. K. Rohtagi and Mukherjee. 4. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania. 5. Organic Chemistry by R. T. Morrison and R. N. Boyd. 6. Basic Organic Chemistry by R. Chandra, S. Singh and A. Singh.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – VIII**	**Nomenclature**	**Minor Chemistry Practical – VIII**
Name of the Course	**Minor Course**	**Course Code**	**27CHE408MV01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**04**	**External Marks**	**35**
Duration of Examination	**04 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The objective of this course is to furnish students with fundamental knowledge in preparation of some inorganic compounds. Students will be able to demonstrate a comprehensive understanding of colligative properties and Rast method for determining molecular weight and kinetics of acid hydrolysis of ester. It further develops a clear understanding of the synthesis and purification of organic compounds.

***Note: Examiner will set two experiments for practical examinations*.** **(12×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Learn preparation of some inorganic compounds.

CLO2: Explore the concept of colligative properties and their role in determining the boiling point elevation of solutions.

CLO3: Understand the principles and procedures of the Rast method for determining molecular weight.

CLO4: Understand the hydrolysis of esters, particularly the acid-catalyzed mechanism and the role of catalysts in chemical reactions.

CLO5: Learn and employ synthesis and purification of some organic compounds.

List of Experiments

Unit–I (Inorganic)

1. Preparation of cuprous chloride.
2. Preparation of prussian blue from iron fillings.
3. Preparation of Potassium tri (oxalato) ferrate (III).
4. Preparation of $Ni(dmg)_2$.
5. Perform ring test for NO_3^- ion.

Unit–II (Physical)
1. Study the elevation in boiling point on adding some concentrations of electrolyte and non-electrolyte to a specific volume of water. 2. Determine the molecular weight of a non-volatile solute by Rast method. 3. Determine the solubility of benzoic acid at various temperatures and determine ΔH of the dissolution process. 4. Prepare the arsenious sulphide sol and compare the precipitating power of mono-, bi- and tri-valent anions. 5. Study kinetics of hydrolysis of ester in the presence of acid.
Unit–III (Organic)
1. Two-step organic synthesis and checking purity of samples prepared: (i) Acetanilide from acetophenone *via* acetophenone oxime. (ii) *p*-Nitroaniline from acetanilide *via p*-nitroacetanilide. (iii) Methyl orange from sulphanilic acid *via* diazotized sulphanilic acid. (iv) 2,4-Dinitrophenylhydrazine from chlorobenzene *via* 1-chloro-2,4-dinitrobenzene. (v) Anthranilic acid from phthalic anhydride *via* phthalimide. (vi) *m*-Nitroaniline from nitrobenzene *via m*-dinitrobenzene
Viva-Voce **(06 Marks)**
Note Book **(05 Marks)**
Books Recommended/References:
1. B.Sc. Chemistry Practical by S. Goyal. 2. Advanced Physical Chemistry, Practical Handbook by G. Raj. 3. Basic Concepts: Physical Chemistry Experiments by N. Seedher. 4. Advanced Practical Organic Chemistry by N. K. Vishnoi. 5. Comprehensive Practical Organic Chemistry: Qualitative Analysis by V. K. Ahluwalia and S. Dhingra.

B.Sc. 4th (4 Year UG Hons. with Research in Chemistry)

Semester — VIII (Session: 2027- 28)

(Option –II)

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – X**	**Nomenclature**	**General Spectroscopy**
Name of the Course	**Discipline Specific Course**	**Course Code**	**27CHEH408DS01**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**04**	**External Marks**	**70**
Duration of Examination	**03 Hrs.**	**Internal Marks**	**30**
Syllabus Objectives: The course is designed to provide students with a comprehensive understanding of advanced topics in spectroscopy which include developing a strong theoretical foundation, enhancing practical skills in spectroscopic techniques and fostering the ability to apply these methods to solve complex problems in the structural			

elucidation of organic and inorganic compounds. The ultimate goal is to prepare students for advanced research and applications in the diverse and dynamic field of spectroscopy.

Note: Examiner will set nine questions, and the candidates must attempt five questions. Out of nine questions, one question will be compulsory, containing seven short answer type questions covering the entire syllabus. Further, the examiner will set two questions from each unit, and the candidates must attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Learn about point symmetry groups for various molecules.
CLO2: Explore different regions of the electromagnetic spectrum.
CLO3: Analyse vibrational and vibrational-rotational spectra of polyatomic molecules.
CLO4: Understand the role of UV, IR, and NMR in determining molecular structures.
CLO5: Know about order of reactions by NMR spectroscopy.
CLO6: Apply NMR techniques in the characterization of inorganic compounds.

Unit–I

Symmetry and Group Theory in Chemistry

Symmetry elements and symmetry operation, point group and its properties, group multiplication table, Schonflies symbol, representation of groups by matrices (representation for C_n, C_{nv}, C_{nh}, C_s, D_{nh} etc. groups to be worked out explicitly). Point groups of following molecules: H_2O, NH_3, CH_4, SF_6, $CHCl_3$, BF_3, C_6H_6, C_5H_5, NSF_3, C_2H_2, HCl, HCN, CO_2 etc. Irreducible representation of groups. The Great Orthogonality theorem (without proof) and its importance. Character tables and its applications in spectroscopy.

Unit–II

Introduction to spectroscopy

Electromagnetic radiations, interaction of electromagnetic radiation with matter, regions of the spectrum, width and intensity of spectral transitions. Resolving power, transition probability.

Rotational spectra: Rotational spectra of diatomic molecules (rigid rotator), spectrum of non-rigid rotator, effect of isotopic substitutions, rotational spectra of linear and symmetric top polyatomic molecules.

Vibrational and Vibrational-Rotational Spectra: Vibrating diatomic molecule (simple harmonic vibrator), anharmonicity, diatomic vibrating rotator, interaction of rotations and vibrations, vibrational spectra of polyatomic molecules, analysis by infrared technique.

Electronics Spectra: Electronic spectra of diatomic molecules, vibrational course structure and rotational fine structure of electronic band. Frank-Condon principle (intensity of vibrational-electronic band, dissociation energy), Fortrat diagram.

Unit–III

Ultraviolet and Visible Spectroscopy

Principle, electronic energy levels and transitions, chromophores and auxochromes, bathochromic and hypsochromic shift, hypochromic and hyperchromic effect.

Infrared Spectroscopy: Principle, functional group and fingerprint regions, absorption of infrared radiation and molecular vibrations (stretching and bending), fundamental vibrations and overtones.

NMR Spectroscopy: Spin active nuclei, chemical shift, shielding and deshielding, internal standards, spin-spin coupling, equivalent and non-equivalent protons, effect of changing solvents and hydrogen bonding on chemical shifts, anisotropic effect.

Applications of UV, IR, and NMR spectra in the structural elucidation of organic compounds.

Unit–IV

Electronic Absorption Spectroscopy

Energy levels in diatomic molecules, introduction to electronic transition, assignment of transitions, selection rules for EAS, p-d intermixing.

Nuclear Magnetic Resonance: Quantum concept of NMR, larmor frequency, coupling constant, applications of spin-spin coupling in structure determination of inorganic compounds, population excess and types of relaxation, standard references for inorganic compounds, calculation of rates from NMR-

spectrum, determination of order by NMR, double resonance technique for inorganic compounds like B_2H_6, $Al(BH_4)_3$ etc. Characterization of metal hydrides complexes (counting signals), inorganic applications of NMR like ^{1}H NMR, ^{11}B NMR, ^{19}F NMR, ^{31}P NMR (dynamic and frozen spectra), fluxional behaviour of inorganic molecules.

Finger print regions of IR spectroscopy, Hooke's law & its applications for determination of stretching frequency. Application of infrared spectroscopy in the determination of inorganic compounds: Determination of coordination site, identification of cis-and trans isomers, structure elucidation of covalent molecules, H-bonding etc.

Books Recommended/References:

1. Chemical Applications of Group Theory by F. A. Cotton.
2. Physical Methods in Inorganic Chemistry by R. S. Drago.
3. Infrared Spectra of Inorganic and Coordination Compound by K. Nakamoto.
4. Fundamentals of Molecules Spectroscopy by C. N. Banwel.
5. Introduction to Magnetic Resonance Spectroscopy ESR, NMR, NQR by D. N. Sathyanarayana.
6. Physical Chemistry by P.W. Atkins and J. Paula.
7. Introduction to Spectroscopy by D. L. Pavia, G. M. Lampman, G. S. Kriz and J. R. Vyvyan.
8. Organic Spectroscopy: Principles and Applications by J. Mohan.
9. Spectroscopy (Vol. 2) by R. K. Malik.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – XI**	**Nomenclature**	**Research Methodology**
Name of the Course	**Discipline Specific Course**	**Course Code**	**27CHEH408DS02**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**04**	**External Marks**	**70**
Duration of Examination	**03 Hrs.**	**Internal Marks**	**30**

Syllabus Objectives: This course aims to provide a comprehensive understanding of research fundamentals, including various types and methods. It focuses on effective data collection, documentation and ethical conduct in scientific research. Students will learn about literature review, laboratory procedures, publication processes and ethical considerations, equipping them with essential skills for conducting responsible and impactful research in diverse fields.

Note: Examiner will set nine questions, and the candidates must attempt five questions. Out of nine questions, one question will be compulsory, containing seven short answer type questions covering the entire syllabus. Further, the examiner will set two questions from each unit, and the candidates must attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Understand different types of research.
CLO2: Understand research methods and methodology.
CLO3: Understand data collection and maintaining laboratory record.
CLO4: Understand different research areas of chemistry.
CLO5: Understand the various instruments to characterize the research.
CLO6: Understand publication of research.

Unit–I

Basic concepts of research

Research-definition and types of research (Descriptive vs analytical, applied vs fundamental, quantitative vs. qualitative, conceptual vs empirical). Research methods vs methodology.

Literature-review and its consolidation, library research, field research; laboratory research.

Unit–II

Data collection and documentation of observations

Maintaining a laboratory record, tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.

Unit–III

Basic knowledge of publication house, journals and instrumentation

Introduction, research publications, access to different publication house and journals associated with it, research articles. Code of conduct - while entering in the lab, while working with the chemicals, while disposal of chemicals, storage and disposal of chemical wastes – aqueous wastes, organic wastes and radioactive wastes, human contribution to reduce hazardous wastes. characterization of samples, instruments used for characterization.

Unit–IV

Ethics with respect to science and research

Scientific misconducts – Falsification, fabrication and plagiarism (FFP),

Redundant publications – Duplicate and overlapping publications, selective reporting and misrepresentation of data

Publication ethics – Definition, introduction and importance

Publication misconduct – Definition, concept, problems that lead to unethical behaviour, Conflicts of interest, violation of publication ethics authorship and contributorship.

Books Recommended/References:

1. Conducting Research Literature Reviews by A. Fink.
2. Research Methods: A Process of Inquiry by M. Graziano, A. M. Anthony and M. L. Raulin.
3. Research Methods: the concise knowledge base by W. M. K. Trochim.
4. Practical Research: Planning and Design by P. D. Leedy and J. E. Ormrod.
5. An introduction to Research Methodology by L. Garg, R. Karadia, F. Agarwal and U. K. Agarwal.
6. How to Write and Publish a Scientific Paper by R. A. Day.
7. Research Methodology: Methods and Techniques by C. R. Kothari.

Student has to opt either a Skill Enhancement Course or a Minor Course

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**SEC Paper – VI**	**Nomenclature**	**Inorganic Chemistry Practical – II**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**27CHE408SE01**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**08**	**External Marks**	**70**
Duration of Examination	**08 Hrs.**	**Internal Marks**	**30**

Syllabus Objectives: The course on quantitative inorganic analysis is designed to equip students with comprehensive knowledge and practical skills in separating and determining metal ions through various analytical methods. Additionally, students will delve into the principles and applications of cerimetry for determining Ferrous, Oxalate, and Nitrite ions. The course emphasizes hands-on experience in laboratory settings, ensuring proficiency in analytical

techniques. Overall, the course aims to foster a deep understanding of inorganic analytical methods, enhance problem-solving skills, and promote awareness of sustainable practices in chemical analysis.

***Note: Examiner will set two experiments for practical examinations*.**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Separate and determine binary mixtures of metal ions using gravimetric and volumetric methods.
CLO2: Determine strengths of ferrous and oxalate using cerimetry.
CLO3: Determine the strengths of nitrite ions using cerimetry (also by indirect method).
CLO4: Synthesize some metal acetyl acetonato complexes employing green methods.

List of Experiments

1. Quantitative Inorganic Analysis (25 Marks)

a) Separation and determination of two metal ions *via* volumetric and gravimetric methods

(i) Silver-Copper
(ii) Copper-Nickel
(iii) Copper-Zinc
(iv) Nickel-Zinc
(v) Copper-Iron

2. (a) Determination by Cerimetry (25 Marks)

(i) Ferrous
(ii) Oxalate
(iii) Nitrite

(b) Green methods of preparation of the following

(i) Bis(acetylacetonato) zinc (II)
(iii) Bis(acetylacetonato) chromium (II)

Viva-Voce (10 Marks)

Note Book (10 Marks)

Books Recommended/References:

1. A Text Book of Quantitative Inorganic Analysis by A.I. Vogel.
2. Applied Analytical Chemistry by O. P. Vermani.
3. Vogel's Quantitative Chemical Analysis by J. Mendham.
4. Vogel's Qualitative Inorganic Analysis by G. Svehla.
5. Practical Inorganic Chemistry by Marr and Rockett.
6. Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and S. R. Crouch.
7. Quantitative Chemical Analysis by D. C. Harris.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**SEC Paper – VI**		**Physical Chemistry Practical – II**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**27CHE408SE02**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**08**	**External Marks**	**70**
Duration of Examination	**08 Hrs.**	**Internal Marks**	**30**

Syllabus Objectives: The course on experimental techniques in physical chemistry aims to provide students with a thorough understanding of various experimental methods used in the study of physical chemistry principles. The objectives include developing hands-on experimental skills in physical chemistry techniques and enhancing the understanding of fundamental principles governing physical and chemical processes. This course aims to prepare

students for advanced studies or careers in physical chemistry, research and industrial applications by combining theoretical knowledge with practical skills in experimental techniques.

***Note: Examiner will set two experiments for practical examinations*.**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Know the concept of viscosity and determine the viscosity of various liquids.
CLO2: Study the conductometric and pH metric titration for determination of normality and strength of acids.
CLO3: Study the potentiometric titration and determine strength and thermodynamic properties of given acids.
CLO4: Determine the partition coefficient of a solute between two immiscible solvents using distribution law.
CLO5: Study the kinetics of hydrolysis of ethyl or methyl acetate and calculation of thermodynamic parameters.
CLO6: Develop the ability to compile interpreted information in the form of lab record.

List of Experiments

1. Viscosity **(25 Marks)**

(i) Study the variation of viscosity with concentration for a glycerol/amyl alcohol solution using Ostwald viscometer and thereafter determine the concentration of unknown solution of glycerol and amyl alcohol.
(ii) Determination of molar mass of a polymer by using viscometer.
(iii) Determine the temperature coefficient of given liquid.

2. Conductometry

(iv) Study the equivalent conductance versus square root of concentration relationship of a strong electrolyte (KCl or NaCl) and weak electrolyte (acetic acid).
(v) Determine the strength of NaOH and NH_4OH in a given mixture by titrating it against HCl.
(vi) Estimate conductometrically the quantities of HCl and NH_4Cl in their mixture.

3. pH-metry

(i) Titration of a mixture of (HCl + CH_3COOH) against NaOH pH-metrically and comment on the shape of the curve.

4. Potentiometry **(25 Marks)**

(iv) Determine the strength of acetic acid by titrating it against NaOH potentiometrically. Also calculate dissociation constant of acid using quinhydrone electrode.
(v) Study the effect of ionic strength on mean activity coefficient of HCl in a given solution.
(vi) Determine the standard free energy change and equilibrium constant for the reaction.
$Cu + 2Ag^+ \rightarrow Cu^{2+} + 2Ag$

5. Distribution Law

(iii) Study the complex formation of cuprammonium ion or study the complex formation between copper sulphate and ammonia solution.
(iv) Determination of equilibrium constant for $I_2 + I^- = I^-_3$

6. Chemical Kinetics

(ii) Determination of the rate constant and activation energy for hydrolysis of ethyl or methyl acetate.
(iii) Determination of the temperature coefficient for hydrolysis of ethyl or methyl acetate and calculation of thermodynamic parameters.

Viva-Voce **(10 Marks)**

Note Book **(10 Marks)**

Books Recommended/References:

1. Practical Physical Chemistry by A. M. James and F. E. Prichard.
2. Findley's Practical Physical Chemistry by B. P. Lavitt.
3. Practical Physical Chemistry by S. R. Palit and S. K. De.
4. Experimental Physical Chemistry by R. C. Das and B. Behera.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**SEC Paper – VI**	**Nomenclature**	**Organic Chemistry Practical – II**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**27CHE408SE03**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**08**	**External Marks**	**70**
Duration of Examination	**08 Hrs.**	**Internal Marks**	**30**

Syllabus Objectives: The organic synthesis and purity analysis course aims to provide students with a complete understanding of organic synthesis techniques and the methods for assessing the purity of synthesized compounds. The course aims to prepare students for advanced work in organic chemistry, research or industrial applications by combining theoretical knowledge with practical skills in organic synthesis and analytical techniques.

***Note: Examiner will set two experiments for practical examinations*.**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Handle organic chemicals in a safe and competent manner.
CLO2: Perform the standard techniques used in practical organic chemistry.
CLO3: Carry out multistep synthesis of organic compounds following a prescribed procedure.
CLO4: Apply the basic chemical concepts to understand the mechanism of chemical reactions.
CLO5: Characterize and purify the synthesized compounds.

List of Experiments

1. Simple organic preparations and checking the purity of samples prepared: (20 Marks)

(i) Chalcone from benzaldehyde and acetophenone.
(ii) Phenyl-azo-β-naphthol dye from aniline.
(iii) Adipic acid from cyclohexene.
(iv) 2-Butoxynaphthalene from 2-naphthol and 1-iodobutane.
(v) 3,4-Dihydropyrimidin-2(1H)-ones from aldehyde, β-ketoester and urea (Biginelli reaction).
(vi) Benzilic acid from benzil.

2. Two-step organic synthesis and checking purity of samples prepared: (30 Marks)

(i) Acetanilide from acetophenone *via* acetophenone oxime.
(ii) *p*-Nitroaniline from acetanilide *via p*-nitroacetanilide.
(iii) Methyl orange from sulphanilic acid *via* diazotized sulphanilic acid.
(iv) 2,4-Dinitrophenylhydrazine from chlorobenzene *via* 1-chloro-2,4-dinitrobenzene.
(v) Anthranilic acid from phthalic anhydride *via* phthalimide.
(vi) *m*-Nitroaniline from nitrobenzene *via m*-dinitrobenzene

Viva-Voce (10 Marks)

Note Book (10 Marks)

Books Recommended/References:

1. Experiments and Techniques in Organic Chemistry by D. J. Pasto, C. R. Johnson and M. J. Miller.
2. Macroscale and Microscale Organic Experiments by K. L. Williamson and D. C. Heath.
3. Systematic Qualitative Organic Analysis by H. Middleton.
4. A Handbook of Organic Analysis-Qualitative and Quantitative by H. Clark.
5. Vogel's Textbook of Practical Organic Chemistry by A. I. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hanaford and P. W. G. Smith.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – VIII**	**Nomenclature**	**Chemistry of Acid-Base, Dyes, Bio-inorganics, Photochemistry, and Carbohydrates**
Name of the Course	**Minor Course**	**Course Code**	**27CHE408MV01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Syllabus objectives: The objective of this course is to deliver information about bioinorganic and acid-base chemistry. The student learns the importance of inorganic chemical species, specially metals in biological systems through discussions on metal-containing enzymes such as the sodium-potassium pump. This course also aims to provide students with a comprehensive understanding of the principles and applications of photochemistry. Students will gain a comprehensive understanding of the chemistry and applications of disaccharides, polysaccharides and dyes.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Understand the concept of acid-base reactions in aqueous solvents.
CLO2: Define and explain terms such as absorption, fluorescence, phosphorescence and intersystem crossing.
CLO3: Describe the Jablonski diagram and its significance in photochemistry.
CLO4: Identify common disaccharides and polysaccharides.
CLO5: Classify dyes based on their chemical structure and applications.

Unit–I

Acids and Bases

Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.

Unit–II

Bioinorganic Chemistry

Metal ions present in biological system, classification based on action (essential, non-essential, trace, toxic), Na/K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity. Metalloporphyrins with special reference to hemoglobin and myoglobin. Biological role of Na^{+}, K^{+}, Ca^{+2}, Mg^{+2}, Fe^{+2} ions.

Unit–III

Photochemistry

Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus - Drapper law, Stark-Einstein law (law of photochemical equivalence) Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions-energy transfer processes (simple examples).

Unit–IV
Disaccharides and polysaccharides An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination. **Synthetic Dyes** Colour and constitution (electronic concept). Classification of dyes. Chemistry and synthesis of Methyl orange, Congo red, Malachite green, Crystal violet, Phenolphthalein, Fluorescein, Alizarin and Indigo.
Books Recommended/References:
7. Modern Inorganic Chemistry by R. D. Madan. 8. Organometallic and Bioinorganic Chemistry by A. Kumar. 9. Fundamental of Photochemistry by K. K. Rohtagi and Mukherjee. 10. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania. 11. Organic Chemistry by R. T. Morrison and R. N. Boyd. 12. Basic Organic Chemistry by R. Chandra, S. Singh and A. Singh.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	
Paper No.	**Paper – VIII**	**Nomenclature**	**Minor Chemistry Practical – VIII**
Name of the Course	**Minor Course**	**Course Code**	**27CHE408MV01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**04**	**External Marks**	**35**
Duration of Examination	**04 Hrs.**	**Internal Marks**	**15**

Syllabus Objectives: The objective of this course is to furnish students with fundamental knowledge in preparation of some inorganic compounds. Students will be able to demonstrate a comprehensive understanding of colligative properties and Rast method for determining molecular weight and kinetics of acid hydrolysis of ester. It further develops a clear understanding of the synthesis and purification of organic compounds.

***Note: Examiner will set two experiments for practical examinations*.** **(12×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Learn preparation of some inorganic compounds.

CLO2: Explore the concept of colligative properties and their role in determining the boiling point elevation of solutions.

CLO3: Understand the principles and procedures of the Rast method for determining molecular weight.

CLO4: Understand the hydrolysis of esters, particularly the acid-catalyzed mechanism and the role of catalysts in chemical reactions.

CLO5: Learn and employ synthesis and purification of some organic compounds.

List of Experiments

Unit–I (Inorganic)

1. Preparation of cuprous chloride.
2. Preparation of prussian blue from iron fillings.
3. Preparation of Potassium tri (oxalato) ferrate (III).
4. Preparation of $Ni(dmg)_2$.
5. Perform ring test for NO_3^- ion.

Unit–II (Physical)

1. Study the elevation in boiling point on adding some concentrations of electrolyte and non-electrolyte to a specific volume of water.
2. Determine the molecular weight of a non-volatile solute by Rast method.
3. Determine the solubility of benzoic acid at various temperatures and determine ΔH of the dissolution process.
4. Prepare the arsenious sulphide sol and compare the precipitating power of mono-, bi- and tri-valent anions.
5. Study kinetics of hydrolysis of ester in the presence of acid.

Unit–III (Organic)

1. Two-step organic synthesis and checking purity of samples prepared:

(i) Acetanilide from acetophenone *via* acetophenone oxime.

(ii) *p*-Nitroaniline from acetanilide *via p*-nitroacetanilide.

(iii) Methyl orange from sulphanilic acid *via* diazotized sulphanilic acid.

(iv) 2,4-Dinitrophenylhydrazine from chlorobenzene *via* 1-chloro-2,4-dinitrobenzene.

(v) Anthranilic acid from phthalic anhydride *via* phthalimide.

(vi) *m*-Nitroaniline from nitrobenzene *via m*-dinitrobenzene

Viva-Voce **(06 Marks)**

Note Book **(05 Marks)**

Books Recommended/References:

1. B.Sc. Chemistry Practical by S. Goyal.
2. Advanced Physical Chemistry, Practical Handbook by G. Raj.
3. Basic Concepts: Physical Chemistry Experiments by N. Seedher.
4. Advanced Practical Organic Chemistry by N. K. Vishnoi.
5. Comprehensive Practical Organic Chemistry: Qualitative Analysis by V. K. Ahluwalia and S. Dhingra.