

# **Chaudhary Bansi Lal University, Bhiwani**

(A State University established under Haryana Act No. 25 of 2014)



## **Examination Scheme and Syllabus For Postgraduate Programme**

**M.Sc. Chemistry**

**as per NEP 2020**

**Curriculum and Credit Framework for Postgraduate Programmes  
(Multiple Entry-Exit, Internship and Choice Based Credit System LOCF)**

**With effect from the Session 2025-26 (in phased manner)**

**DEPARTMENT OF CHEMISTRY  
FACULTY OF PHYSICAL SCIENCES  
Chaudhary Bansi Lal University, Prem Nagar– 127031  
BHIWANI  
HARYANA, INDIA**



# Chaudhary Bansi Lal University, Bhiwani

(A State University established under Haryana Act No. 25 of 2014)

| Summary of the Programme                       |                                                                                                                                                                                                                                                                       |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Name of Programme</b>                       | M.Sc. Chemistry                                                                                                                                                                                                                                                       |
| <b>Duration</b>                                | 2 Years (4 Semesters)                                                                                                                                                                                                                                                 |
| <b>Maximum Duration</b>                        | 4 Years                                                                                                                                                                                                                                                               |
| <b>Total Credits</b>                           | 100                                                                                                                                                                                                                                                                   |
| <b>Total Marks</b>                             | 2420                                                                                                                                                                                                                                                                  |
| <b>Passing Criteria</b>                        | The pass percentage will be 40% both for theory and practicum End-Term Examination. A student has to obtain minimum 40% marks in aggregate (sum of the Internal Assessment and End-Term Examination marks) and in End-Term Examination separately to qualify a course |
| <b>Medium of Instructions and Examinations</b> | English                                                                                                                                                                                                                                                               |
| <b>Minimum Attendance Requirement</b>          | 75% per course                                                                                                                                                                                                                                                        |
| <b>Internship</b>                              | 4-6 Weeks                                                                                                                                                                                                                                                             |
| <b>For Other Details</b>                       | See Ordinance for PG Programme                                                                                                                                                                                                                                        |

**PROGRAMME LEARNING OUTCOMES**

The graduate on completion of Master in Chemistry programme will be able to:

|              |                                                      |                                                                                                                                                                                                                          |
|--------------|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PLO 1</b> | <b>Development of Understanding about BASICS</b>     | Demonstrate advanced knowledge about chemistry with a critical understanding of the emerging developments and issues relating to the learners domain area.                                                               |
| <b>PLO 2</b> | <b>Critical thinking and analysis</b>                | Demonstrate advanced knowledge and understanding of principles, methods, and techniques applicable to the chosen field of study.                                                                                         |
| <b>PLO 3</b> | <b>Applications of Knowledge and Skills Acquired</b> | Demonstrate the capacity to extrapolate the acquired knowledge and skills to real-life situations and apply acquired competencies in new/unfamiliar contexts.                                                            |
| <b>PLO 4</b> | <b>Ability to Identity Real World Problems</b>       | Demonstrate the ability to apply the acquired conceptual, operational or technical knowledge and a range of cognitive and practical skills to identify and address problems related to the chosen field of learning.     |
| <b>PLO 5</b> | <b>Developing Research Aptitude</b>                  | Demonstrate and apply the advanced knowledge relating to research methods to carryout research and investigations to formulate evidence-based solutions to complex and unpredictable problems in the field of Chemistry. |
| <b>PLO 6</b> | <b>Data Analysis and Its Interpretation</b>          | Demonstrate the ability to communicate, in a well-structured manner the findings/ results of the research studies undertaken in the field of Chemistry.                                                                  |
| <b>PLO 7</b> | <b>Values and Ethics</b>                             | Pursue self-paced and self-directed learning to upgrade knowledge and skills, including research-related skills avoiding unethical practices.                                                                            |

**Chaudhary Bansi Lal University**  
**Scheme of Examination for Postgraduate Programme M.Sc. Chemistry**  
**as per NEP 2020 Curriculum and Credit Framework for Postgraduate Programmes**  
**(CBCS LOCF) with effect from the session 2025-26**  
**Semester I**

| Couse Code   | Course Type | Nomenclature of the Course                                                             | Course Level | Theory (T)/ Practical (P) | Credits | Total Credits | Contact Hours per Week<br>L: Lecture<br>P: Practical<br>T: Tutorial |   |   |       | Examination Scheme              |                      |                   | Examination Hours for Internal Examinations | Examination Hours for End Term Examinations |
|--------------|-------------|----------------------------------------------------------------------------------------|--------------|---------------------------|---------|---------------|---------------------------------------------------------------------|---|---|-------|---------------------------------|----------------------|-------------------|---------------------------------------------|---------------------------------------------|
|              |             |                                                                                        |              |                           |         | 24            | L                                                                   | T | P | Total | Internal Assessment Marks (170) | End Term Marks (410) | Total Marks (580) |                                             |                                             |
| 25PN-CHE-101 | CC          | Inorganic Chemistry-I                                                                  | 500-599      | Th                        | 4       |               | 4                                                                   | 0 | 0 | 4     | 30                              | 70                   | 100               | 1.5                                         | 3                                           |
| 25PN-CHE-102 | CC          | Physical Chemistry-I                                                                   | 500-599      | Th                        | 4       |               | 4                                                                   | 0 | 0 | 4     | 30                              | 70                   | 100               | 1.5                                         | 3                                           |
| 25PN-CHE-103 | CC          | Organic Chemistry-I                                                                    | 500-599      | Th                        | 4       |               | 4                                                                   | 0 | 0 | 4     | 30                              | 70                   | 100               | 1.5                                         | 3                                           |
| 25PN-CHE-104 | DEC         | Industrial Chemistry<br>or<br>Analytical Chemistry<br>or<br>Chemistry in Everyday Life | 500-599      | Th                        | 3       |               | 3                                                                   | 0 | 0 | 3     | 20                              | 50                   | 70                | 1.5                                         | 3                                           |
| 25PN-CHE-105 |             |                                                                                        | 500-599      |                           |         |               |                                                                     |   |   |       |                                 |                      |                   |                                             |                                             |
| 25PN-CHE-106 |             |                                                                                        | 500-599      |                           |         |               |                                                                     |   |   |       |                                 |                      |                   |                                             |                                             |
| 25PN-CHE-107 | PC          | Practical-I Inorganic Chemistry                                                        | 500-599      | P                         | 3       |               | 0                                                                   | 0 | 6 | 6     | 20                              | 50                   | 70                | 3                                           | 6                                           |

|              |    |                                                    |         |   |   |  |   |   |   |   |    |    |    |   |   |
|--------------|----|----------------------------------------------------|---------|---|---|--|---|---|---|---|----|----|----|---|---|
|              |    | Practical                                          |         |   |   |  |   |   |   |   |    |    |    |   |   |
| 25PN-CHE-108 | PC | Practical-II<br>Physical<br>Chemistry<br>Practical | 500-599 | P | 3 |  | 0 | 0 | 6 | 6 | 20 | 50 | 70 | 3 | 6 |
| 25PN-CHE-109 | PC | Practical-III<br>Organic<br>Chemistry<br>Practical | 500-599 | P | 3 |  | 0 | 0 | 6 | 6 | 20 | 50 | 70 | 3 | 6 |

**Note(s) and Abbreviations:** CC = Core Course, DEC = Discipline Elective Course, PC= Skill Enhancement Course; For discipline elective course, the student has to opt one course in the department/institute. All the PCcourse(s) are based on the theory papers.

| <b>Part A - Introduction</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------------|
| Name of Programme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | M.Sc. Chemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |               |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |               |
| Nomenclature of the Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Inorganic Chemistry-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |               |
| Sub-Nomenclature of the Course (if any)                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Basic Principles of Inorganic Chemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |               |
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 25PN-CHE-101                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |               |
| Course Type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | CC-1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |               |
| Level of the course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 500-599                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |               |
| Pre-requisite for the course (if any)                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Chemistry as a subject at UG level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |               |
| Course Learning Outcomes (CLOs)<br>After completing this course, the learner will be able to:                                                                                                                                                                                                                                                                                                                                                                                                              | <p>CLO 1: Understand the concept of metal-ligand bonding in transition metal complexes by exploring theories such as Crystal Field Theory (CFT), Ligand Field Theory (LFT), and Molecular Orbital (MO) theory.</p> <p>CLO 2: Explain the mechanisms of ligand substitution in octahedral transition metal complexes, and analyze the thermodynamic aspects of coordination complexes.</p> <p>CLO 3: Understand the reaction mechanisms of ligand substitution in square planar transition metal complexes, and gain knowledge of the redox chemistry involved in coordination complexes.</p> <p>CLO 4: Describe the structures and properties of isopoly and heteropoly acids and their salts, and explain the crystal structures of selected binary and ternary compounds.</p> |           |               |
| Credits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Theory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Practical | Total         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0         | 4             |
| Teaching Hours per Week                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0         | 4             |
| Internal Assessment Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0         | 30            |
| End Term Examination Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 70                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0         | 70            |
| Maximum Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0         | 100           |
| Examination Hours for End Term Examinations                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0         | 3             |
| Examination Hours for Internal Examinations                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0         | 1.5           |
| <b>Part B - Contents of the Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |               |
| <b>Instructions for Paper Setter:</b> The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of 7 parts covering entire syllabus and consists of 2 marks each. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks i.e. 14 marks. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |               |
| Unit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           | Contact Hours |
| I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Metal-Ligand Bonding:</b> 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,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           | 15            |

|                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                |
|----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
|                                                                                                                      | Jahn-Teller effect and its applications, ligand field theory, molecular orbital theory, M.O. diagrams of octahedral, tetrahedral and square planar complexes including both $\sigma$ and $\pi$ bonding, factors affecting $\Delta E$ .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |
| II                                                                                                                   | <b>Reaction Mechanism of Octahedral Transition Metal Complexes-I:</b> 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 <sub>2</sub> O 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 trischelate complexes, electrophilic attack on ligands. Thermodynamic aspects: Factors affecting stability of metal complexes, Irving–Williams series.                                         | 15                             |
| III                                                                                                                  | <b>Reaction Mechanism of Square-Planar Transition Metal Complexes-II:</b> 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.                                                                                                                                               | 15                             |
| IV                                                                                                                   | <b>Isopoly and Heteropoly Acids and Salts of Mo &amp; W:</b> Isopoly acids and isopoly-ions, preparation and structure of paramolybdate and octamolybdate, heteropoly acids(only classification into six groups), Keggin’s structure of 1:11 & 1:12–heteropoly acids and structure of 1:6 heteropoly acids and heteropoly blue.<br><b>Crystal Structures:</b> Structures of some binary and ternary crystalline solid such as fluorite, anti-fluorite, rutile, anti-rutile, cristobalite, layered lattices – CdI <sub>2</sub> , BiI <sub>3</sub> , ReO <sub>3</sub> , Mn <sub>2</sub> O <sub>3</sub> , NiAs, corundum, perovskite, Ilmenite, calcite, normal spinel & inverse spinel minerals, Well equation and tolerance factor. | 15                             |
| Total Contact Hours                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 60                             |
| Suggested Evaluation Methods                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                |
| Internal Assessment Marks: 30                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | End Term Examination Marks: 70 |
| ➤ Theory                                                                                                             | 30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ➤ Theory: 70                   |
| ● Class Participation:                                                                                               | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Written Examination            |
| ● Presentation/Assignment/Quiz/Class Test/ Seminar                                                                   | 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                |
| ● Mid-Term Examination                                                                                               | 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                |
| Part C - Learning Resources                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                |
| Recommended Books/e-resources/LMS:                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                |
| 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 Dr. R.K. Malik (Anu Books, Glasgo, U.K).

| <b>Part A - Introduction</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------------|
| Name of Programme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | M.Sc. Chemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |               |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |               |
| Nomenclature of the Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Physical Chemistry-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |               |
| Sub-Nomenclature of the Course (if any)                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | (Basic, Thermodynamics, Kinetics, Electrochemistry and Quantum Mechanics)                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |               |
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 25PN-CHE-102                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |               |
| Course Type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | CC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |               |
| Level of the course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 500-599                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |               |
| Pre-requisite for the course (if any)                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Chemistry as a subject at UG level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |               |
| Course Learning Outcomes (CLOs)<br>After completing this course, the learner will be able to:                                                                                                                                                                                                                                                                                                                                                                                                              | <p>CLO 1: Basic Postulates of quantum Mechanics &amp; Concept of Operators, Particle in a box problem</p> <p>CLO 2: Laws of thermodynamics &amp; phase equilibrium, Concept of Entropy and its calculation for various processes</p> <p>CLO 3: Rate law of different order reactions (zero, first &amp; second order) and consecutive, parallel, opposed &amp; chain reactions</p> <p>CLO 4: Explain Debye Huckle Theory of ion-ion interactions for the determination of activity and activity coefficients of electrolytic solution.</p> |           |               |
| Credits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Theory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Practical | Total         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0         | 4             |
| Teaching Hours per Week                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0         | 4             |
| Internal Assessment Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0         | 30            |
| End Term Examination Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 70                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0         | 70            |
| Maximum Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0         | 100           |
| Examination Hours for End Term Examinations                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0         | 3             |
| Examination Hours for Internal Examinations                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0         | 1.5           |
| <b>Part B - Contents of the Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |               |
| <b>Instructions for Paper Setter:</b> The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of 7 parts covering entire syllabus and consists of 2 marks each. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks i.e. 14 marks. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |               |
| Unit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           | Contact Hours |
| I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Quantum Mechanics</b><br>Introduction to Quantum Mechanics and its postulates, Quantum Mechanical operators, Eigen function and Eigen values, Hermitian operators, Angular momentum operators and their Commutation relation ( $L_x$ , $L_y$ , $L_z$ & $L^2$ ) ladder operators and its effect on angular momentum operator. Schrodinger wave equation for particle in one dimensional box; evaluation of average position,                                                                                                             |           | 15            |

|                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                |
|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
|                                                    | average momentum and average energy, pictorial representation of the wave equation and energy for particle in one dimensional box, Derivation of uncertainty principle (x & p), Schrodinger wave equation for a particle in a three-dimensional box and the concept of degeneracy of energy levels.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                |
| II                                                 | <b>Thermodynamics</b><br>First & Second law of thermodynamics, Entropy changes in reversible and irreversible processes; variation of entropy with temperature, pressure and volume, criteria for the spontaneity of reaction; free energy functions and their significance, Gibbs-Duhem equation, variation of chemical potential with temperature and pressure, chemical potential for an ideal gas, thermodynamic functions of mixing (free energy, entropy, volume and enthalpy)<br>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.  | 15                             |
| III                                                | <b>Chemical Dynamics:</b><br>Brief description of integrated rate laws of zero, first and second order reactions with graphical representation, Lindemann - Hinshelwood mechanism of Unimolecular reactions. Rate law for opposing reactions (1st & 2nd order), Rate law for consecutive reactions, Kinetics of parallel reactions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 15                             |
| IV                                                 | <b>Electrochemistry:</b><br>Debye -Hückel theory of ion- ion interactions (ionic cloud, Poisson's equation, excess charge density, Linearization of Boltzmann equation, Linearized Poisson Boltzmann equation and its solution, excess charge density and potential as a function of distance from the central ion, Debye Hückel reciprocal length, ionic cloud and its contribution to the total potential), Debye-Hückel limiting law, activity coefficient and ion-ion interactions and its physical significance, mean ionic activity coefficient. Debye-Huckel Onsager theory for non-aqueous solutions, solvent effect on the mobility at infinite dilution, equivalent conductivity ( $\lambda_{eq}$ ) vs. Square root of concentration ( $c^{1/2}$ ) as a function of solvent, effect of ion association upon conductivity (Debye-Huckel-Bjerrum equation). | 15                             |
| Total Contact Hours                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 60                             |
| <b>Suggested Evaluation Methods</b>                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                |
| Internal Assessment Marks: 30                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | End Term Examination Marks: 70 |
| ➤ Theory                                           | 30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | ➤ Theory: 70                   |
| ● Class Participation:                             | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Written Examination            |
| ● Presentation/Assignment/Quiz/Class Test/ Seminar | 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                |
| ● Mid-Term Examination                             | 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                |

**Part C - Learning Resources**

**Recommended Books/e-resources/LMS:**

1. Atkins, P., Paula, Keeler, J. J., Atkins' Physical Chemistry Thermodynamics and Kinetics. Oxford University Press, 11th ed. (2017).
2. Rastogi, R. P. & Misra, R. R, An Introduction to Chemical Thermodynamics, Vikas Pub. 6th Revised ed. (6/e) (2000)
3. Glasstone, S., Thermodynamics for Chemists, Narahari Press (2007)
4. Laidler, K.J., Chemical Kinetics, McGraw Hill 2nd ed. (1965).
5. Levine, I. N., Quantum Chemistry, Pearson 7th ed. (2016).
6. Chandra, A.K., Introductory Quantum Chemistry, Tata Mc Graw Hill, 4th ed. (1998).
7. Prasad, R.K., Quantum Chemistry through Problems and solutions, New Age International (1997).
8. Castellan, G. W., Physical Chemistry, 3/E, Narosa Publishing House Pvt. Ltd. (2004).
9. Kapoor, K.L., A Textbook of Physical Chemistry Volume 2, Macmillan 3rd ed. (2004).
10. Kapoor, K.L., A Textbook of Physical Chemistry Volume 4, Tata Mc Graw Hill (2015).
11. Kapoor, K.L., A Textbook of Physical Chemistry Vol 5-Dynamics of chemical Reaction, Tata Mc Graw Hill (2014).
12. Bockris, J.O.M. & Reddy A.K.N., Modern electrochemistry Vol-1, 2nd ed. (1970).
13. Rogers, D. W., Concise Physical Chemistry, John Wiley & sons (2011).
14. Moudgil, H. K., Textbook of Physical Chemistry, PHI Learning Pvt. Ltd. 2nd ed. (2014).

| Part A - Introduction                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------------|
| Name of Programme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | M.Sc. Chemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |               |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |               |
| Nomenclature of the Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Organic Chemistry-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |               |
| Sub-Nomenclature of the Course (if any)                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Conceptual Organic Chemistry & Stereochemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |               |
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 25PN-CHE-103                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |               |
| Course Type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | CC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |               |
| Level of the course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 500-599                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |               |
| Pre-requisite for the course (if any)                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Chemistry as a subject at UG level                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |               |
| Course Learning Outcomes (CLOs)<br>After completing this course, the learner will be able to:                                                                                                                                                                                                                                                                                                                                                                                                              | CLO1: Understand the concepts delocalisation, conjugation and aromaticity and organic reaction mechanism<br>CLO2: Advanced knowledge of reaction intermediates, aliphatic nucleophilic and electrophilic substitution<br>CLO3: Basic knowledge of concepts of Stereochemistry, conformational analysis of acyclic and cyclic molecule. Optical activity in absence of chiral carbon, topicity of ligands and faces and their nomenclature<br>CO4: In-depth understanding of asymmetric synthesis            |           |               |
| Credits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Theory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Practical | Total         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0         | 4             |
| Teaching Hours per Week                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0         | 4             |
| Internal Assessment Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0         | 30            |
| End Term Examination Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 70                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0         | 70            |
| Maximum Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0         | 100           |
| Examination Hours for End Term Examinations                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0         | 3             |
| Examination Hours for Internal Examinations                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0         | 1.5           |
| Part B - Contents of the Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |               |
| <b>Instructions for Paper Setter:</b> The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of 7 parts covering entire syllabus and consists of 2 marks each. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks i.e. 14 marks. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |               |
| Unit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |           | Contact Hours |
| I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Nature of Bonding in Organic molecules:</b> Delocalized chemical bonding - conjugation, cross conjugation. Concept of aromaticity; Hückel's rule, energy level of $\pi$ -molecular orbitals, annulenes, antiaromaticity, homo-aromaticity.<br><b>Organic Reaction Mechanism:</b> Structure and Reactivity: Types of mechanisms, types of reactions, Relationship between thermodynamic stability and rates of reactions - kinetic versus thermodynamic control of product formation – Hammond postulate. |           | 15            |

|                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |
|----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
|                                                                                                                            | Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, guide lines for proposing reaction mechanism. The Hammett equation and linear free energy relationship, substituent and reaction constants.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |
| II                                                                                                                         | <b>Reactive Intermediates:</b> Generation, structure, stability and reactivity of reactive intermediates, carbocations, carbonanions, Free Radicals, Carbenes, Nitrenes.<br><b>Aliphatic Nucleophilic and Electrophilic Substitution:</b> The SN1, SN2, mixed SN1 and SN2, SNi and SET mechanisms. The neighbouring group mechanisms, neighbouring group participation by p and s bonds, anchimeric assistance. Classical and non-classical carbocations, phenonium ions, common carbocation rearrangements. Reactivity- effects of substrate structure, attacking nucleophile, leaving group and reaction medium. Ambident nucleophile, regioselectivity. Phase transfer catalysis; The SE1 mechanism, Bimolecular mechanisms- SE2 and SEi., Electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity. | 15                             |
| III                                                                                                                        | <b>Stereochemistry-I:</b> Introduction to molecular symmetry and chirality. D-L, R-S, E-Z and threo-erythro nomenclature, interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. Conformational analysis, enantiomerism and diastereomerism of simple acyclic, cyclic system (chair and boat configuration), fused and bridged bicyclic systems (decalins) and sugars. Conformation and reactivity some examples. Optical activity in the absence of chiral carbon (biphenyls, allenes, ansa compounds, cyclophanes, hemispiranes and spiranes); Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.                                                                                                                                                                                                                                             | 15                             |
| IV                                                                                                                         | <b>Stereochemistry-II:</b> Topicity of ligands and faces, their nomenclature and prostereoisomerism, stereogenecity, chirogenicity, pseudoasymmetry and prochiral centre. stereospecific and stereoselective reaction. Asymmetric synthesis: Enantiomer excess, % enantioselectivity, optical purity, % diastereomeric excess and % diastereoselectivity. Asymmetric synthesis (basic principle, auxiliary, substrate, reagent and catalyst controlled).                                                                                                                                                                                                                                                                                                                                                                                                                                    | 15                             |
| Total Contact Hours                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 60                             |
| Suggested Evaluation Methods                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |
| Internal Assessment Marks: 30                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | End Term Examination Marks: 70 |
| ➤ Theory                                                                                                                   | 30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ➤ Theory: 70                   |
| ● Class Participation:                                                                                                     | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Written Examination            |
| ● Presentation/Assignment/Quiz/Class Test/ Seminar                                                                         | 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                |
| ● Mid-Term Examination                                                                                                     | 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                |
| Part C - Learning Resources                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |
| Recommended Books/e-resources/LMS:                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |
| 1. March, J., <i>Advanced Organic Chemistry Reactions, Mechanism and Structure</i> , John Wiley 6 <sup>th</sup> ed.(2007). |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |
| 2. Carey, F. A. & Sundberg, R. J., <i>Advanced Organic Chemistry</i> , Plenum 5 <sup>th</sup> ed. (1977)                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |
| 3. Sykes, P., <i>A Guide Book to Mechanism in Organic Chemistry</i> , Pearson 6 <sup>th</sup> ed. (2003)                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |
| 4. Ingold, C. K., <i>Structure and Mechanism in Organic Chemistry</i> , Cornell University Press (1957)                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |

5. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Prentice –Hall 6<sup>th</sup> ed. (2001)
6. House, H. O., *Modern Synthetic Reactions*, Benjamin (1965)
7. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional 3<sup>rd</sup> ed. (1993)
8. Prakash, O. & Singh, S. P., *Reaction Mechanism in Organic Chemistry*, Trinity (2017)
9. Eliel, E. L. & Wilen, S. H., *Stereochemistry of Organic Compounds*, John Wiley (1994)
10. Nasipuri, D., *Stereochemistry of Organic Compounds*, New Age International 3<sup>rd</sup> ed. (2018)
11. Kalsi, P.S., *Stereochemistry of Organic Compounds*, New Age International 10<sup>th</sup> ed. (2019)
12. Carruthers, W. & Coldham, I., *Modern methods of Organic Synthesis*, Cambridge University Press 1<sup>st</sup> e. (2005)
13. Robinson, M.J. T., *Organic Stereochemistry*, Oxford University Press (2005)
14. Issacs, N. S., *Reactive Intermediates in Organic chemistry*, John Wiley (1974)

| Part A - Introduction                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------------|
| Name of Programme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | M.Sc. Chemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |               |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |               |
| Nomenclature of the Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Industrial Chemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |           |               |
| Sub-Nomenclature of the Course (if any)                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |               |
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 25PN-CHE-104                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |               |
| Course Type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | DEC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |               |
| Level of the course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 500-599                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |               |
| Pre-requisite for the course (if any)                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Chemistry as a subject at UG level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           |               |
| Course Learning Outcomes (CLOs)<br>After completing this course, the learner will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                    | <p>CLO 1: Introduce students to the fundamental principles and applications of chemistry in industrial processes.</p> <p>CLO 2: Familiarize students with key industrial chemical processes, raw materials, and products. Develop an understanding of process design, optimization, and scale-up considerations in chemical industries.</p> <p>CLO 3: Highlight the importance of safety, environmental protection, and quality control in industrial settings.</p> <p>CLO 4: Expose students to economic aspects and sustainable practices in the chemical industry.</p> |           |               |
| Credits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Theory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Practical | Total         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0         | 3             |
| Teaching Hours per Week                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0         | 3             |
| Internal Assessment Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0         | 20            |
| End Term Examination Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0         | 50            |
| Maximum Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 70                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0         | 70            |
| Examination Hours for End Term Examinations                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0         | 3             |
| Examination Hours for Internal Examinations                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0         | 1.5           |
| Part B - Contents of the Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |               |
| <b>Instructions for Paper Setter:</b> The examiner will set 7 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of 4 parts covering entire syllabus and consists of 2 marks each. The examinee will be required to attempt 4 questions, selecting one question from each unit and the compulsory question. All other questions will carry equal marks i.e. 14 marks. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |               |
| Unit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           | Contact Hours |
| I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Fundamentals &amp; Heavy Inorganic/Organic Chemicals</b><br><b>Introduction to Chemical Industry:</b> Scope and significance of chemical industries; types of chemical industries (heavy inorganic, organic, fine chemicals, specialty chemicals, petrochemicals, agrochemicals, pharmaceuticals).<br><b>Basic Concepts:</b> Raw materials, intermediates, finished products. Batch vs. continuous processes.<br><b>Unit Operations and Unit Processes:</b> Distinction and examples.<br><b>Material and Energy Balances:</b> Basic principles and their               |           | 15            |

|                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
|----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
|                                                                | <p>application in chemical processes (qualitative understanding).</p> <p><b>Industrial Catalysis:</b> Types of catalysts (homogeneous, heterogeneous, biocatalysts); features of industrial catalysts; examples of catalytic processes (Haber-Bosch, Contact process, Ziegler-Natta).</p> <p><b>Sulfuric Acid:</b> Production by Contact process; properties and uses.</p> <p><b>Chlor-Alkali Industry:</b> Manufacture of chlorine, caustic soda (NaOH), and soda ash (Na<sub>2</sub>CO<sub>3</sub>); diaphragm cell and membrane cell processes; uses.</p> <p><b>Nitrogenous Fertilizers:</b> Ammonia synthesis (Haber-Bosch); urea manufacture; ammonium sulfate.</p> <p><b>Phosphatic Fertilizers:</b> Superphosphate; triple superphosphate.</p>                                                                                                                                                                                                                                                     |                                |
| II                                                             | <p><b>Major Organic Products &amp; Specialty Chemicals</b></p> <p><b>Industrial Gases:</b> Oxygen, nitrogen, hydrogen, argon (production and uses).</p> <p><b>Petroleum Refining:</b> Crude oil composition; distillation, cracking, reforming; major fractions and their uses. Overview of primary petrochemicals derived from naphtha and natural gas; examples and their downstream products.</p> <p><b>Dyes and Pigments:</b> Classification of dyes based on structure and application (e.g., azo dyes, triphenylmethane dyes, vat dyes); synthesis of selected dyes; pigments vs. dyes.</p> <p><b>Oils, Fats, and Soaps:</b> Sources, refining, hydrogenation of oils; saponification; detergents (types and manufacture).</p> <p><b>Sugar Industry:</b> Manufacture of sugar; by-products (molasses, bagasse).</p> <p><b>Pulp and Paper Industry:</b> Raw materials; pulping processes; paper making.</p> <p><b>Explosives:</b> Classification; examples (TNT, nitroglycerin); safety aspects.</p> | 15                             |
| III                                                            | <p><b>Industrial Practices, Environmental Aspects &amp; Safety:</b></p> <p><b>Pharmaceutical Industry:</b> Overview of drug discovery and development process; APIs (Active Pharmaceutical Ingredients) and formulations; Good Manufacturing Practices (GMP); quality control.</p> <p><b>Water Treatment:</b> Industrial water requirements; treatment methods (coagulation, sedimentation, filtration, disinfection, ion exchange, reverse osmosis).</p> <p><b>Industrial Pollution and Waste Management:</b> Types of industrial wastes (solid, liquid, gaseous); treatment and disposal methods; Effluent Treatment Plants (ETP); Zero Liquid Discharge (ZLD) concept.</p> <p><b>Safety in Chemical Industry:</b> Hazards, safety measures, Material Safety Data Sheets (MSDS).</p>                                                                                                                                                                                                                    | 15                             |
| Total Contact Hours                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 45                             |
| Suggested Evaluation Methods                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| Internal Assessment Marks: 20                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | End Term Examination Marks: 50 |
| ➤ Theory                                                       | 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | ➤ Theory: 50                   |
| ● Class Participation:                                         | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Written Examination            |
| ● Presentation/Assignment/Quiz/Class Test/ Seminar             | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                |
| ● Mid-Term Examination                                         | 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                |
| Part C - Learning Resources                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| Recommended Books/e-resources/LMS:                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| 1. Industrial Chemistry by B.K. Sharma, Goel Publishing House. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |

2. Industrial Chemistry by E. Stocchi, Ellis Horwood Series in Chemical Engineering.
3. Industrial Organic Chemistry by K. Weissermel and H.-J. Arpe, Wiley-VCH.
4. Ullmann's Encyclopedia of Industrial Chemistry (Online Resource/Reference).
5. Shreve's Chemical Process Industries by G.T. Austin, McGraw-Hill.
6. Principles of Green Chemistry by M. Lancaster, Royal Society of Chemistry.
7. NPTEL courses on Chemical Engineering and Industrial Chemistry.
8. Journals: Industrial & Engineering Chemistry Research, Chemical Engineering Science.
9. Websites of major chemical companies and regulatory bodies (e.g., EPA, OSHA for safety guidelines).

| <b>Part A - Introduction</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------------|
| Name of Programme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | M.Sc. Chemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |               |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |               |
| Nomenclature of the Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Analytical Chemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |               |
| Sub-Nomenclature of the Course (if any)                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |               |
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 25PN-CHE-105                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |               |
| Course Type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | DEC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |               |
| Level of the course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 500-599                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |               |
| Pre-requisite for the course (if any)                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Chemistry as a subject at UG level                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |               |
| Course Learning Outcomes (CLOs)<br>After completing this course, the learner will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                    | <p>CLO 1: Analyze and interpret experimental data using appropriate statistical tools and error analysis.</p> <p>CLO 2: Understand and apply fundamental concepts of classical and instrumental analytical techniques to solve real-world chemical problems.</p> <p>CLO 3: Understand to Operate basic analytical instruments and perform routine chemical analyses with precision and scientific rigor.</p>                                                                                          |           |               |
| Credits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Theory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Practical | Total         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 0         | 3             |
| Teaching Hours per Week                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 0         | 3             |
| Internal Assessment Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 0         | 20            |
| End Term Examination Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 0         | 50            |
| Maximum Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 70                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 0         | 70            |
| Examination Hours for End Term Examinations                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 0         | 3             |
| Examination Hours for Internal Examinations                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 0         | 1.5           |
| <b>Part B - Contents of the Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |               |
| <b>Instructions for Paper Setter:</b> The examiner will set 7 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of 4 parts covering entire syllabus and consists of 2 marks each. The examinee will be required to attempt 4 questions, selecting one question from each unit and the compulsory question. All other questions will carry equal marks i.e. 14 marks. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |               |
| Unit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           | Contact Hours |
| I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Introduction to Analytical Chemistry and Data Analysis: Role and Importance of Analytical Chemistry in various fields (pharmaceutical, environmental, food, clinical, etc.); Types of Analysis: Qualitative and Quantitative; Errors in Chemical Analysis; Confidence limits, standard deviation, variance; Statistical treatment of analytical data- t-test, F-test, and Q-test; Calibration methods and regression analysis; Systematic and random errors; Accuracy, precision, significant figures |           | 15            |
| II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Classical (Wet) Analytical Methods: Gravimetric Analysis Principle, types of precipitates, co-precipitation and post-precipitation, Steps in gravimetric analysis with examples; Volumetric Analysis -Acid-base titrations, redox titrations, complexometric titrations; Indicators and                                                                                                                                                                                                               |           | 15            |

|                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                        |                                |
|--------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
|                                                                                                              | end-point detection; Calculations involving normality, molarity, and titration curves                                                                                                                                                                                                                                                                                                  |                                |
| III                                                                                                          | Electroanalytical and Separation Techniques: Electroanalytical Methods: Conductometry, Potentiometry, and Voltammetry (basic concepts and applications); Separation Techniques: Solvent extraction: Principles and applications, Chromatography: Principles, types (Paper, Thin-layer, Column, Gas, HPLC – basic overview); Electrophoresis – principle and types (brief introduction) | 15                             |
| Total Contact Hours                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                        | 45                             |
| Suggested Evaluation Methods                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                        |                                |
| Internal Assessment Marks: 20                                                                                |                                                                                                                                                                                                                                                                                                                                                                                        | End Term Examination Marks: 50 |
| ➤ Theory                                                                                                     | 20                                                                                                                                                                                                                                                                                                                                                                                     | ➤ Theory: 50                   |
| ● Class Participation:                                                                                       | 5                                                                                                                                                                                                                                                                                                                                                                                      | Written Examination            |
| ● Presentation/Assignment/Quiz/Class Test/ Seminar                                                           | 5                                                                                                                                                                                                                                                                                                                                                                                      |                                |
| ● Mid-Term Examination                                                                                       | 10                                                                                                                                                                                                                                                                                                                                                                                     |                                |
| Part C - Learning Resources                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                        |                                |
| Recommended Books/e-resources/LMS:                                                                           |                                                                                                                                                                                                                                                                                                                                                                                        |                                |
| 1. Fundamentals of Analytical Chemistry by D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch                   |                                                                                                                                                                                                                                                                                                                                                                                        |                                |
| 2. Quantitative Chemical Analysis by Daniel C. Harris                                                        |                                                                                                                                                                                                                                                                                                                                                                                        |                                |
| 3. Analytical Chemistry by Gary D. Christian                                                                 |                                                                                                                                                                                                                                                                                                                                                                                        |                                |
| 4. Basic Concepts of Analytical Chemistry by S.M. Khopkar                                                    |                                                                                                                                                                                                                                                                                                                                                                                        |                                |
| 5. Vogel’s Textbook of Quantitative Chemical Analysis by J. Mendham, R.C. Denney, J.D. Barnes, M.J.K. Thomas |                                                                                                                                                                                                                                                                                                                                                                                        |                                |
| 6. Analytical Chemistry Handbook by J.A. Dean                                                                |                                                                                                                                                                                                                                                                                                                                                                                        |                                |

| Part A - Introduction                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------------|
| Name of Programme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | M.Sc. Chemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |               |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |               |
| Nomenclature of the Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Chemistry in Everyday Life                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |               |
| Sub-Nomenclature of the Course (if any)                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |               |
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 25PN-CHE-106                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |               |
| Course Type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | DEC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |               |
| Level of the course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 500-599                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |               |
| Pre-requisite for the course (if any)                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Chemistry as a subject at UG level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           |               |
| Course Learning Outcomes (CLOs)<br>After completing this course, the learner will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                    | <p>CLO 1: Explain the fundamental chemical principles governing the properties and applications of common everyday products and materials.</p> <p>CLO 2: Analyze the chemical composition and impact of food, pharmaceuticals, and personal care items on human health.</p> <p>CLO 3: Evaluate the role of chemistry in understanding and addressing environmental challenges and promoting sustainable practices.</p> <p>CLO 4: Discuss the societal implications of chemical advancements and critically assess chemically-related information in various contexts.</p> |           |               |
| Credits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Theory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Practical | Total         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0         | 3             |
| Teaching Hours per Week                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0         | 3             |
| Internal Assessment Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0         | 20            |
| End Term Examination Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0         | 50            |
| Maximum Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 70                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0         | 70            |
| Examination Hours for End Term Examinations                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0         | 3             |
| Examination Hours for Internal Examinations                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0         | 1.5           |
| Part B - Contents of the Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |               |
| <b>Instructions for Paper Setter:</b> The examiner will set 7 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of 4 parts covering entire syllabus and consists of 2 marks each. The examinee will be required to attempt 4 questions, selecting one question from each unit and the compulsory question. All other questions will carry equal marks i.e. 14 marks. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |               |
| Unit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           | Contact Hours |
| I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Household &amp; Personal Care Chemistry:</b> Soaps, detergents, cleaning agents (bleaches, disinfectants); Cosmetics (moisturizers, sunscreens, hair products); Toothpaste; Mechanisms of action and safety.<br><b>Polymeric Materials:</b> Types of polymers (thermoplastics, thermosets, elastomers); Common plastics (PVC, PET, nylon, Teflon), their properties, applications, and recycling; Bioplastics.<br><b>Surface &amp; Structural Materials:</b> Paints, coatings, and adhesives                                                                           |           | 15            |

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|                                                                                                                                                                               | (components, film formation, bonding); Textiles (natural vs. synthetic fibers) and the chemistry of dyes; Ceramics and glass (composition, properties, applications).<br><b>Energy &amp; Storage:</b> Basic electrochemistry; Common battery types (alkaline, lithium-ion); Fuel cells and their chemical principles.                                                                                                                                                                                                                                                                                                                                                                     |                                |
| II                                                                                                                                                                            | <b>Food Chemistry:</b> Macronutrients (carbohydrates, proteins, lipids – structure, digestion, chemical changes); Micronutrients (vitamins, minerals – chemical roles); Food additives (preservatives, colorants, flavors, sweeteners); Chemical aspects of food processing (Maillard reaction, fermentation) and preservation; Chemistry of taste and aroma.<br><b>Pharmaceuticals &amp; Toxicology:</b> Principles of drug action (receptor binding, enzyme inhibition); Common drug classes (analgesics, antibiotics, antacids) and their chemical structures; Drug discovery overview; Classes of poisons, toxins, and their mechanisms of toxicity; Principles of antidotal therapy. | 15                             |
| III                                                                                                                                                                           | <b>Environmental Chemistry:</b> Air pollution (sources, smog, acid rain, ozone depletion); Soil pollution (pesticides, herbicides); Principles of green chemistry and sustainable practices.<br><b>Chemistry of Art &amp; Conservation:</b> Chemical composition of historical pigments and binders; Application of analytical techniques for art authentication and degradation studies; Chemical principles in art conservation and restoration.                                                                                                                                                                                                                                        | 15                             |
| Total Contact Hours                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 45                             |
| Suggested Evaluation Methods                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| Internal Assessment Marks: 20                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | End Term Examination Marks: 50 |
| ➤ Theory                                                                                                                                                                      | 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | ➤ Theory: 50                   |
| ● Class Participation:                                                                                                                                                        | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Written Examination            |
| ● Presentation/Assignment/Quiz/Class Test/ Seminar                                                                                                                            | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                |
| ● Mid-Term Examination                                                                                                                                                        | 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                |
| Part C - Learning Resources                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| Recommended Books/e-resources/LMS:                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| 1. McMurry, John, Castellion, Mary, and Ballantine, David. Chemistry in Your Life. Pearson. (Provides a broad overview and good starting point.)                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| 2. Atkins, Peter, Jones, Loretta, and Laverman, Leroy. Chemical Principles: The Quest for Insight. W. H. Freeman. (For foundational chemical principles.)                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| 3. Snyder, Carl H. The Extraordinary Chemistry of Ordinary Things. Wiley. (Excellent for everyday applications.)                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| 4. Flick, Ernest W. Industrial Solvents Handbook. Noyes Publications. (For cleaning agents, paints, adhesives).                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| 5. Brydson, J.A. Plastics Materials. Butterworth-Heinemann. (For polymeric materials).                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| 6. Winter, Ruth. A Consumer's Dictionary of Cosmetic Ingredients. Three Rivers Press. (For personal care products).                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| 7. Belitz, Hans-Dieter, Grosch, Werner, and Schieberle, Peter. Food Chemistry. Springer. (A comprehensive text on food chemistry).                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| 8. Patrick, Graham L. An Introduction to Medicinal Chemistry. Oxford University Press. (For pharmaceuticals and drug action).                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| 9. Timbrell, John A. Principles of Biochemical Toxicology. CRC Press. (For toxicology).                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
| 10. Sawyer, Clair N., McCarty, Perry L., and Parkin, Gene F. Chemistry for Environmental Engineering and Science. McGraw-Hill Education. (For water chemistry and treatment). |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |

11. Manahan, Stanley E. Environmental Chemistry. CRC Press. (A standard textbook for environmental chemistry).
12. Bell, Suzanne. Forensic Chemistry. Pearson. (For forensic chemistry applications).
13. Eastaugh, Nicholas, Walsh, Valentine, Chaplin, Tracey, and Siddall, Ruth. The Pigment Compendium: A Dictionary of Historical Pigments. Butterworth-Heinemann. (For chemistry of art).
14. Erhardt, David, and Mecklenburg, Marion F. (Eds.). Materials Issues in Art and Archaeology. Materials Research Society. (For art conservation).

| Part A - Introduction                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |                         |
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| Name of Programme                                                                                                                                                                                                  | M.Sc. Chemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |                         |
| Semester                                                                                                                                                                                                           | I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |                         |
| Nomenclature of the Course                                                                                                                                                                                         | Practical-I Inorganic Chemistry Practical                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |                         |
| Sub-Nomenclature of the Course (if any)                                                                                                                                                                            | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |                         |
| Course Code                                                                                                                                                                                                        | 24PN-CHE-107                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |                         |
| Course Type                                                                                                                                                                                                        | P.C.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                         |
| Level of the course                                                                                                                                                                                                | 500-599                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |                         |
| Pre-requisite for the course (if any)                                                                                                                                                                              | Chemistry as a subject at UG level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                         |
| Course Learning Outcomes (CLOs)<br>After completing this course, the learner will be able to:                                                                                                                      | <p>CLO 1: Perform iodometric, iodimetric, and potassium iodate titrations to estimate substances such as Cu(II), <math>K_2Cr_2O_7</math>, iodide, and hydrazine.</p> <p>CLO 2: Apply potassium bromate titrations and the oxine method to determine metals like aluminium, magnesium, cobalt, and zinc</p> <p>CLO 3: Conduct EDTA titrations—including direct, back titrations, and those involving masking/demasking agents—for the analysis of metal ions and water hardness.</p> <p>CLO 4: Synthesize selected metal acetylacetonato complexes using environmentally friendly (green chemistry) methods.</p> |           |                         |
| Credits                                                                                                                                                                                                            | Theory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Practical | Total                   |
|                                                                                                                                                                                                                    | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 3         | 3                       |
| Teaching Hours per Week                                                                                                                                                                                            | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 6         | 6                       |
| Internal Assessment Marks                                                                                                                                                                                          | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 20        | 20                      |
| End Term Examination Marks                                                                                                                                                                                         | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 50        | 50                      |
| Maximum Marks                                                                                                                                                                                                      | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 70        | 70                      |
| Examination Hours for End Term Examinations                                                                                                                                                                        | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 6         | 6                       |
| Examination Hours for Internal Examinations                                                                                                                                                                        | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 3         | 3                       |
| Part B - Contents of the Course                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |                         |
| <b>Instructions for Paper Setter for End Term Examination:</b> The examiner will ask 2 experiments to demonstrate from the list of experiments. Separate experiments can be designed by examiner for each student. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |                         |
| Unit                                                                                                                                                                                                               | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           | Contact Hours           |
|                                                                                                                                                                                                                    | <b>1. Volumetric Analysis:</b><br>a) Iodo/Iodimetric Titrations : Estimation of Cu (II) , $K_2Cr_2O_7$ using sodium thiosulphate solution iodometrically.<br>b) Potassium Iodate Titrations: Determination of iodide, hydrazine.<br>c) Potassium Bromate Titrations: Determination of aluminium, magnesium, cobalt and zinc (by Oxine method).<br>d) EDTA Titrations: Determination of magnesium, calcium, barium, nickel, copper; Back titration; Titration of mixtures using masking and demasking agents; Determination of                                                                                   |           | <b>6 Hours per Week</b> |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |    |                                |           |
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| hardness of water.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |    |                                |           |
| <b>2. Green methods of preparation of the following:</b><br>a) Bis(acetylacetonato)copper(II)<br>b) Tris(acetylacetonato)iron(III)<br>c) Tris(acetylacetonato)manganese(III)<br><b>d) Silver nanoparticles by plant extract and characterization using UV-Visible spectrophotometer</b><br><b>Note:</b> Any experiments can be introduced/ omitted in the practical class on the basis of availability of instruments/ chemicals/ glasswares and other facilities in the laboratory. |    |                                |           |
| Total Contact Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |    |                                | <b>90</b> |
| <b>Suggested Evaluation Methods</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                  |    |                                |           |
| Internal Assessment Marks: 20                                                                                                                                                                                                                                                                                                                                                                                                                                                        |    | End Term Examination Marks: 50 |           |
| ➤ Practical                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 20 | ➤ Practical                    | 50        |
| ● Class Participation                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 5  | ● Demonstration                | 15+15     |
| ● Demonstration                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 5  | ● Laboratory Record            | 10        |
| ● Laboratory Record                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 10 | ● Viva-Voce                    | 10        |
| <b>Part C - Learning Resources</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                   |    |                                |           |
| Recommended Books/e-resources/LMS:<br>1. A Text Book of Quantitative Inorganic Analysis by A.I.Vogel.<br>2. Applied Analytical Chemistry by O.P.Vermani.<br>3. Vogel's Quantitative Chemical Analysis by J. Mendham.<br>4. Vogel's Qualitative Inorganic Analysis by G. Svehla.<br>5. Practical Inorganic Chemistry by Marr and Rockett.<br>6. Synthesis and characterization of inorganic compounds by W. L. Jolly.<br>7. Instrumental Methods of Analysis by B. K. Sharma.         |    |                                |           |

| <b>Part A - Introduction</b>                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         |       |
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| Name of Programme                                                                                                                                                                                                  | M.Sc. Chemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         |       |
| Semester                                                                                                                                                                                                           | I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                         |       |
| Nomenclature of the Course                                                                                                                                                                                         | Practical-II Physical Chemistry Practical                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                         |       |
| Sub-Nomenclature of the Course (if any)                                                                                                                                                                            | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                         |       |
| Course Code                                                                                                                                                                                                        | 25PNCHE-108                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                         |       |
| Course Type                                                                                                                                                                                                        | P.C.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                         |       |
| Level of the course                                                                                                                                                                                                | 500-599                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                         |       |
| Pre-requisite for the course (if any)                                                                                                                                                                              | Chemistry as a subject at UG level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                         |       |
| Course Learning Outcomes (CLOs)<br>After completing this course, the learner will be able to:                                                                                                                      | <p>CLO 1: Handling of instruments like pH meter and conductivity meter along with electrodes with basic experiments.</p> <p>CLO 2: Realization of the concept of Viscosity using Ostwald's Viscometer.</p> <p>CLO 3: To understand the basic concept of photometry with the help of instrument colorimeter.</p> <p>CLO 4: Understanding the laboratory etiquettes to perform experiment, analyse the data and compilation of experimental information in the practical notebook.</p>                                                                                |                         |       |
| Credits                                                                                                                                                                                                            | Theory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Practical               | Total |
|                                                                                                                                                                                                                    | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 3                       | 3     |
| Teaching Hours per Week                                                                                                                                                                                            | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 6                       | 6     |
| Internal Assessment Marks                                                                                                                                                                                          | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 20                      | 20    |
| End Term Examination Marks                                                                                                                                                                                         | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 50                      | 50    |
| Maximum Marks                                                                                                                                                                                                      | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 70                      | 70    |
| Examination Hours for End Term Examinations                                                                                                                                                                        | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 6                       | 6     |
| Examination Hours for Internal Examinations                                                                                                                                                                        | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 3                       | 3     |
| <b>Part B - Contents of the Course</b>                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         |       |
| <b>Instructions for Paper Setter for End Term Examination:</b> The examiner will ask 2 experiments to demonstrate from the list of experiments. Separate experiments can be designed by examiner for each student. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         |       |
| Unit                                                                                                                                                                                                               | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Contact Hours           |       |
| I                                                                                                                                                                                                                  | <p><b>pH metry</b></p> <ol style="list-style-type: none"> <li>1. Calibrate the pH meter and hence prepare basic buffer solution and acidic buffer solution with different pH values.</li> <li>2. Determine the strength of strong acid by titration with standardized strong base.</li> <li>3. Determine the strength of weak acid by titration with standardized strong base.</li> <li>4. Determine the strength of dibasic acid by titration with standardized strong base.</li> <li>5. Determine the strength of mixture of acids (strong &amp; weak)</li> </ol> | <b>6 Hours per Week</b> |       |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |    |                                |       |
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| by titration with standardized strong base.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |    |                                |       |
| Note: Comment on the shape and nature of the curve extensively.                                                                                                                                                                                                                                                                                                                                                                                                                                                              |    |                                |       |
| <b>Conductometry</b><br>1. Determine the cell constant of the conductivity cell and hence calibrate the instrument.<br>2. Study the variation of conductivity with concentration for strong electrolyte & weak electrolyte.<br>3. Determine the strength of strong acid by titration with standardized strong base.<br>4. Determine the strength of weak acid by titration with standardized strong base.<br>5. Determine the strength of given mixture of acids (strong & weak) by titration with standardized strong base. |    |                                |       |
| Note: Comment on the shape of the graph extensively.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |    |                                |       |
| <b>Viscometry</b><br>1. Determination of absolute & relative viscosity of organic solvents using Ostwald's viscometer.<br>2. Determination of the percentage composition of a liquid mixture by viscosity measurement.                                                                                                                                                                                                                                                                                                       |    |                                |       |
| <b>Colorimeter</b><br>1. Verification of Lambert Beer's Law.<br>2. Determination of concentration of $\text{KMnO}_4$ & $\text{K}_2\text{Cr}_2\text{O}_7$ colorimetrically.                                                                                                                                                                                                                                                                                                                                                   |    |                                |       |
| <b>Note:</b> Any experiments can be introduced/ omitted in the practical class on the basis of availability of instruments/ chemicals/ glasswares and other facilities in the laboratory.                                                                                                                                                                                                                                                                                                                                    |    |                                |       |
| Total Contact Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |    | <b>90</b>                      |       |
| <b>Suggested Evaluation Methods</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |    |                                |       |
| Internal Assessment Marks: 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |    | End Term Examination Marks: 50 |       |
| ➤ Practical                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 20 | ➤ Practical                    | 50    |
| ● Class Participation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 5  | ● Demonstration                | 15+15 |
| ● Demonstration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 5  | ● Laboratory Record            | 10    |
| ● Laboratory Record                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 10 | ● Viva-Voce                    | 10    |
| <b>Part C - Learning Resources</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |    |                                |       |
| Recommended Books/e-resources/LMS:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |    |                                |       |
| 1. James, A.M. & Prichard, F.E., Practical Physical Chemistry, Longman 3rd ed. (1974).                                                                                                                                                                                                                                                                                                                                                                                                                                       |    |                                |       |
| 2. Lavitt, B.P., Findley's Practical Physical Chemistry, Longman 9th ed. (1973).                                                                                                                                                                                                                                                                                                                                                                                                                                             |    |                                |       |
| 3. Das, R.C. & Behera, B., Experimental Physical Chemistry, Tata McGraw Hill (1983).                                                                                                                                                                                                                                                                                                                                                                                                                                         |    |                                |       |
| 4. Shoemaker, D.P., Gerland, C. W., Experiments in Physical Chemistry, Tata McGraw Hill 8th ed. (2009)                                                                                                                                                                                                                                                                                                                                                                                                                       |    |                                |       |
| 5. Jahagirdhar, D.V., Experiments in Physical Chemistry, Himalaya Publishing Housing                                                                                                                                                                                                                                                                                                                                                                                                                                         |    |                                |       |

- (1994).
6. Khosla, B.D., Garg, V. & Gulati, A. Senior Practical Physical Chemistry, R. Chand 4th ed. (1985).
7. Yadav, J.B., Advanced Practical Physical Chemistry, Goel Publishing House 16th ed. (2006).

| <b>Part A - Introduction</b>                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------------------|
| Name of Programme                                                                                                                                                                                                  | M.Sc. Chemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                         |
| Semester                                                                                                                                                                                                           | I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |                         |
| Nomenclature of the Course                                                                                                                                                                                         | Practical III – Organic Chemistry Practical                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |                         |
| Sub-Nomenclature of the Course (if any)                                                                                                                                                                            | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |                         |
| Course Code                                                                                                                                                                                                        | 24PN-CHE-109                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                         |
| Course Type                                                                                                                                                                                                        | P.C.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |           |                         |
| Level of the course                                                                                                                                                                                                | 500-599                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                         |
| Pre-requisite for the course (if any)                                                                                                                                                                              | Chemistry as a subject at UG level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           |                         |
| Course Learning Outcomes (CLOs)<br>After completing this course, the learner will be able to:                                                                                                                      | CLO 1: Safe laboratory conduct and good practices<br>CLO 2: Purification techniques for solids such as crystallization, sublimation and chromatography<br>CLO 3: Purification techniques for liquids such as distillation and chromatography Determination of melting and boiling point of organic compounds<br>CLO 4: Preparation of organic compounds                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                         |
| Credits                                                                                                                                                                                                            | Theory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Practical | Total                   |
|                                                                                                                                                                                                                    | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 3         | 3                       |
| Teaching Hours per Week                                                                                                                                                                                            | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 6         | 6                       |
| Internal Assessment Marks                                                                                                                                                                                          | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 20        | 20                      |
| End Term Examination Marks                                                                                                                                                                                         | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 50        | 50                      |
| Maximum Marks                                                                                                                                                                                                      | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 70        | 70                      |
| Examination Hours for End Term Examinations                                                                                                                                                                        | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 6         | 6                       |
| Examination Hours for Internal Examinations                                                                                                                                                                        | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 3         | 3                       |
| <b>Part B - Contents of the Course</b>                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                         |
| <b>Instructions for Paper Setter for End Term Examination:</b> The examiner will ask 2 experiments to demonstrate from the list of experiments. Separate experiments can be designed by examiner for each student. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                         |
| Unit                                                                                                                                                                                                               | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           | Contact Hours           |
| I                                                                                                                                                                                                                  | 1. <b>General experimental techniques:</b> <ul style="list-style-type: none"> <li>Common laboratory glasswares</li> <li>Purification of organic solids               <ul style="list-style-type: none"> <li>Purification of organic compounds by sublimation</li> <li>Recrystallization of benzoic acid from water</li> </ul> </li> <li>Purification of organic liquids by simple distillation.</li> <li>Determination of melting point of solid organic compounds.</li> <li>Determination of boiling point of liquid organic compounds.</li> <li>Separation of organic compounds by paper, TLC, column chromatography.</li> </ul> 2. <b>Organic Synthesis:</b> Preparation of following organic compounds: <ul style="list-style-type: none"> <li>Preparation of benzanilide from aniline.</li> <li>Preparation of p-bromoacetanilide from acetanilide.</li> <li>Preparation of tribromoaniline from aniline.</li> </ul> |           | <b>6 Hours per Week</b> |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |    |                                |           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|--------------------------------|-----------|
| <ul style="list-style-type: none"> <li>• Preparation of p-nitroacetanilide from Acetanilide.</li> <li>• Preparation of benzene-azo-<math>\beta</math>-naphthol by diazotization.</li> <li>• Preparation of adduct of anthracene and maleic anhydride by Diels-Alder reaction. Any other reaction as per requirement</li> </ul> <p><b>Note:</b> Any experiments can be introduced/ omitted in the practical class on the basis of availability of instruments/ chemicals/ glasswares and other facilities in the laboratory.</p>                                                                                                                                                                                                                                                  |    |                                |           |
| Total Contact Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |    |                                | <b>90</b> |
| <b>Suggested Evaluation Methods</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |    |                                |           |
| Internal Assessment Marks: 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |    | End Term Examination Marks: 50 |           |
| ➤ Practical                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 20 | ➤ Practical                    | 50        |
| • Class Participation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 5  | • Demonstration                | 15+15     |
| • Demonstration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 5  | • Laboratory Record            | 10        |
| • Laboratory Record                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 10 | • Viva-Voce                    | 10        |
| <b>Part C - Learning Resources</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |    |                                |           |
| Recommended Books/e-resources/LMS:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |    |                                |           |
| <ol style="list-style-type: none"> <li>1. Clarke, H.T. &amp; revised by Haynee, B. Edward Arnold, <i>A Hand book of Organic Analysis -Qualitativeand Quantitative</i>, London (1975).</li> <li>2. Furhen, B.S., <i>Vogel's Text Book of Practical Organic Chemistry</i>, Longman.</li> <li>3. Middleton, H., <i>Systematic Qualitative Organic Analysis</i>, Edward Arnold (Publishers) Limited, London(1959).</li> <li>4. Vogel, A. I., <i>Elementary Practical Organic Chemistry</i>, EX CBS Publishers and Distriibutors (1957).</li> <li>5. Louis, F., Fieser, D.C., <i>Experiments in Organic Chemistry</i>, Heath and Company Boston (1955)</li> <li>6. Vishnoi, N.K., <i>Advanced Practical Organic Chemistry</i>, Vikas Publishing 3<sup>rd</sup> ed. (2009).</li> </ol> |    |                                |           |