

### **Objectives of a Bachelor of Science (B.Sc.) in Chemistry Program include:**

- Understand the fundamental principles, laws, concepts and formulas of Chemistry.
- Develop problem-solving skills of students.
- Gain practical experience by hands-on experience with instruments and develop laboratory skills.
- Learn about advanced Chemistry and its applications for higher studies.
- Learn to apply conceptual knowledge to practical work.
- Learn to interpret chemical and physical phenomena through experimental evidence.
- Learn to analyze and interpret data accurately through scientific reasoning and experimental hypothesis testing.

### **Program Outcomes:**

PO-1:- Students will gain fundamental knowledge of Chemistry which will help them for PG studies and research.

PO-2:- Students will be able to know good laboratory practices and lab safety.

PO-3:- Students will become proficient in analyzing the various observations and chemical phenomena presented to him during the course.

PO-4:- Students will be able to apply the fundamental knowledge to address the cross-cutting issues such as sustainable development.

PO-5:- Students will be able to solve various problems by identifying the essential parts of a problem, formulate strategy for solving the problem, applying appropriate techniques to arrive at a solution, test the precision and accuracy of the solution and interpret the results. PO-6:- Students will be able to communicate effectively i.e. being able to articulate, comprehend and write effective reports, make effective presentations and documentation and capable of expressing the subject through technical writing as well as through oral presentation.

### **Program Specific Outcomes:**

PSO-1:- Students will be able to explain fundamental concepts of Inorganic, Physical, Organic and Analytical Chemistry.

PSO-2. Students will be able to Identify chemical formulae and solve numerical problems.

PSO-3. Students will be able to use modern chemical tools, Models, Charts and Equipment.

PSO-4. Students will be able to prepare and qualify for competitive examinations

PSO-5. Students will understand good laboratory practices and safety.

PSO-6. Students will develop research-oriented skills.

### **Program Education Outcomes:**

PEO-1: Students after graduation (Graduates) will possess strong analytical, critical thinking, and problem-solving skills relevant to the field in chemistry and they will be prepared for careers in various sectors, including industry, research, and government, requiring a strong foundation in chemistry.

PEO-2: Graduates will be able to utilize their chemical knowledge and skills to address societal needs and challenges include areas like environmental sustainability, healthcare, energy solutions, and materials science.

PEO-3: Graduates will demonstrate a commitment to lifelong learning and professional development, and they will possess strong communication, teamwork, and leadership skills.

PEO-4: They will be able to apply their chemical knowledge and skills to solve problems and they will be prepared to adapt to the evolving landscape of the chemical sciences.

PEO-5: Graduates will be equipped to pursue further education, such as an M.Sc. or Ph.D., in chemistry or related disciplines and will be able to work effectively in multidisciplinary and interdisciplinary environments.

PEO-6 Graduates will be equipped to innovate and develop solutions that benefit society.

### **Course Outcomes**

#### **B.Sc. I (NEP-2.0) Semester I, PAPER-I**

##### **ICH-101- Inorganic Chemistry (Theory Credits-02, 30 hours)**

| Name of the topic                                           | Expected Course outcomes                                                                                                                                   |
|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Atomic Structure and Periodicity of Elements.            | To learn and understand basic knowledge of inorganic chemistry. To understand size, shape and electronic distribution in shells and sub-shells of an atom. |
| 2. P-block Elements.                                        | To learn and understand the properties and uses of the compounds of Boron, Carbon and Nitrogen from p-block elements.                                      |
| 3. Chemical Bonding and Molecular Structure: Ionic Bonding. | To learn different types of bonds and nature of bonding in inorganic compounds. Calculations of different energies associated with ionic bonding.          |
| 4. Acids and Bases.                                         | To Understand the role of acids and bases in chemistry. The study is useful in all chemical areas.                                                         |

#### **B.Sc. Part I (NEP-2.0) SEMESTER-I, PAPER-II**

##### **OCH-102- Organic Chemistry (Theory Credits: 02, 30 hours)**

| Name of the topic                    | Expected Course outcomes                                                                                                                                                                                                                                                 |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Fundamentals of Organic Chemistry | The students are expected to understand the fundamentals and basic principles involved in organic chemistry.                                                                                                                                                             |
| 2. Stereochemistry                   | Understanding the spatial arrangement of atoms of organic molecule and types of stereoisomers.                                                                                                                                                                           |
| 3. Aromaticity                       | Knowledge of general properties and fundamental reactions of aromatic compounds.                                                                                                                                                                                         |
| 4. Heterocyclic Compounds            | To understand the basic knowledge of heterocyclic compounds. To get knowledge of methods to preparation, physical and chemical properties of some heterocyclic compounds with five and six membered heterocycles containing N as the heteroatom ( Pyrrole and Pyridine). |

### **B. Sc. I (NEP-2.0) Semester II, Paper III PCH-201-Physical Chemistry**

**Credits: 02, 30 hours**

| Name of the Topic                 | Expected Course Outcomes                                                                                                                                                                |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Basic Mathematical Concepts    | Learning and coherent understanding of basic concepts and rules of logarithms, graphs, derivative and integrations.                                                                     |
| 2. Thermodynamics                 | Knowledge and coherent understanding of basic concepts in thermodynamics will be gained by the student.                                                                                 |
| 3. Chemical Kinetics              | Learning and understanding the knowledge about basic concepts in kinetics and first order, second order reactions with characteristics and suitable examples.                           |
| 4. Physical properties of liquids | Learning and coherent understanding of surface tension, viscosity and refractive index with suitable examples.                                                                          |
| 5. Electrochemistry               | Learning and coherent understanding of basic concepts in electrochemistry, conductors and conductivity cells, measurement of conductance with suitable examples and numerical problems. |

### **B. Sc. I Semester II, Paper IV ACH-202- Analytical Chemistry**

**(Theory Credits:02, Lectures-30 hours)**

**Expected learning Outcomes:**

| Name of the topic                               | Expected Course Outcome                                                                                                                               |
|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Introduction to Analytical Chemistry         | Learning various analytical procedures and importance also sampling, accuracy and precision                                                           |
| 2. Fundamentals of Industrial Chemistry and IPR | a. Distinguish between classical and industrial chemistry<br>b. Learning and Understanding basic concepts and concentration terms c. Knowledge of IPR |
| 3. Chromatography                               | Knowledge of chromatographic separation technique and terms involved in it. Learning paper chromatography and thin layer chromatography               |
| 4. Theory of titrimetric Analysis               | Knowledge of various type of titrations, neutralization curves, indicators used in various titrations                                                 |

### **B. Sc II Major Chemistry**

**B.Sc. Part II (NEP-2.0) Semester- III**

**PCH-301: Paper V (PHYSICAL CHEMISTRY)**

**(Credits: 02, 30 hours)**

**Expected Course Outcomes:**

| Name of the Topics        | Expected Course Outcomes                                                                                                                                                                                                |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Electrolytic Conductivity | Learning and coherent understanding of conductivity and transport number of the aqueous solutions with different applications. Experimental determination of transport number and numerical problems                    |
| Thermodynamics            | Knowledge and coherent understanding of basic concepts in thermodynamics and concept of Entropy will be gained by the student.                                                                                          |
| Chemical Kinetics         | Learning and understanding the knowledge about basic concepts in kinetics and third order reactions with characteristics, suitable examples and methods for determination of order of reactions and numerical problems. |

|                   |                                                                                                                                                                                                                                                                                          |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| States of Matter  | Learning and coherent understanding of behavior of gases, ideal gas as model system and its extension to real gases. The dependence of physical state on P, V and T. Liquid crystals are essential in all common and research devices, hence they are introduced with suitable examples. |
| Surface Chemistry | Learning and understanding of theoretical basis of adsorption phenomenon, dynamic nature of surface and its applications.                                                                                                                                                                |

**B. Sc. II Semester III, Paper VI ACH-302- Analytical Chemistry  
(Theory Credits:02, Lectures-30 hours)**

**Expected Course Outcomes:**

| Sr. No. | Name of Topic                     | Expected Course Outcomes                                                                                 |
|---------|-----------------------------------|----------------------------------------------------------------------------------------------------------|
| 1       | Gravimetric Analysis              | Learning and understanding of basic concepts in gravimetric analysis                                     |
| 2       | Colorimetry and Spectrophotometry | Understanding, working and applications of optical methods as an analytical tool.                        |
| 3       | Soap and Detergents               | Knowledge about the chemical nature and cleansing action of soap                                         |
| 4       | Chromatographic Techniques, IPR   | Learning and coherent understanding of column and ion exchange chromatography, copyrights and trademarks |
| 5       | Corrosion                         | Learning and understanding the knowledge about basic concepts in corrosion and mechanism of corrosion    |

**B. Sc. Part II Sem IV (NEP-2.0)**

**ICH-401 Paper-VII Inorganic Chemistry (Theory Credits: 02, 30 hours)**

**Expected Course Outcomes:**

| Name of the Topic                                          | Expected Course Outcomes                                                                                                   |
|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| 1. Co-ordination Chemistry                                 | Learning and understanding basic concepts about coordination complexes.                                                    |
| 2. Chemistry of elements of 3d Series elements             | Student will be capable of understanding the properties of 3d series elements.                                             |
| 3. Chemical Bonding and Molecular Structure. (VBT and MOT) | Students will understand the formation of molecules on the basis of concept of hybridization and molecular orbital theory. |
| 4. Inorganic Semi -micro Qualitative Analysis              | Students will learn the basic knowledge about the Qualitative analysis of inorganic compounds.                             |

**B. Sc. Part II Sem IV (NEP-2.0)****OCH-402 Paper-VIII Organic Chemistry (Theory Credits: 02, 30 hours)****Expected Course Outcomes:**

| Name of the topic                           | Expected Course Outcomes                                                                            |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------|
| 1. Carboxylic acids and their derivatives.  | To impart knowledge about the synthesis, reactivity and applications of carboxylic acids.           |
| 2. Amines and Diazonium Salts               | Knowledge about classification, preparation and applications of amines and diazonium salts.         |
| 3. Carbohydrates                            | Understanding the classification, configuration and structure of carbohydrates.                     |
| 4. Carbonyl Compounds Aldehydes and Ketones | Students will be capable of understanding the nomenclature and reactivity of aldehydes and ketones. |
| 5. Stereochemistry                          | Students will learn the basic knowledge of conformational analysis of some organic compounds.       |

**VOCATIONAL SKILL COURSES**

| B. Sc. II, Semester III, VSC Practical Paper-I |                                                                    |                         |
|------------------------------------------------|--------------------------------------------------------------------|-------------------------|
| BSU0325VSP207C01                               | PRCHVSC-301 Vocational Skill Course in Chemistry Practical Paper-I | Credits: 2<br>Hours: 60 |

**Course Outcomes:**

**After completion of the course, the students will be able to:**

- CO1 Understand the concepts, principles, theories and practical applications of Chemistry
- CO2 Understand the simple techniques of synthesis and analysis
- CO3 Gain basic knowledge of instruments to be used for analysis.
- CO4 Develop analytical skills

| B. Sc. II, Semester IV |           |                                                     |                         |
|------------------------|-----------|-----------------------------------------------------|-------------------------|
| BSU0325CEP207D01       | CHCEP-401 | Community Engagement Programme in Chemistry Paper-I | Credits: 2<br>Hours: 60 |

**INTRODUCTION:**

New generation of students are increasingly unaware of local rural and peri-urban realities surrounding their HEIs, as rapid urbanization has been occurring in India. A large percentage of Indian population continues to live and work in rural and peri-urban areas of the country. While various schemes and programs of community service have been undertaken by HEIs, there is no singular provision of a well- designed community engagement course that provides opportunities for immersion in rural realities. Such a course will enable students to learn about challenges faced by vulnerable households and develop an understanding of local wisdom and lifestyle in a respectful manner

#### **OBJECTIVES:**

- To promote a respect for rural culture, lifestyle, and wisdom among students.
- To learn about the present status of agricultural and development initiatives.
- Identify and address the root causes of distress and poverty among vulnerable households.
- Improve learning outcomes by applying classroom knowledge to real-world situations.

To achieve the objectives of the socio-economic development of New India, HEIs can play an important role through active community engagement. This approach will also contribute to improve the quality of both teaching and research in HEIs in India. India is a signatory to the global commitment for achieving Sustainable Development Goals (SDGs) by 2030. Achieving these 17 SDG goals requires generating locally appropriate solutions. Community engagement should not be limited to a few social science disciplines alone. It should be practiced across all disciplines and faculties of HEIs. These can take the forms of enumerations, surveys, awareness camps and campaigns, training, learning manuals/films, maps, study reports, public hearings, policy briefs, cleanliness and hygiene teachings, legal aid clinics, etc. For example, students of chemistry can conduct water and soil testing in local areas and share the results with the local community. Students of science and engineering can undertake research in partnership with the community on solid and liquid waste disposal. Therefore, students are being encouraged to foster social responsibility and community engagement in their teaching and research.

## LEARNING OUTCOMES:

After completing this course, students will be able to

1. Gain an understanding of rural life, Indian culture, and social realities.
2. Develop empathy and bonds of mutuality with the local community.
3. Appreciate the significant contributions of local communities to Indian society and economy.
4. Learn to Value local knowledge and wisdom.
5. Gain valuable skills such as communication, leadership, teamwork and problem solving etc.
6. Identify opportunities to contribute to the community's socioeconomic improvement.

### B.Sc. Part II Minor (NEP-2.0)

#### Semester- III

#### PCHMN-301: Paper V APPLIED PHYSICAL CHEMISTRY

(Credits: 02, 30 hours)

| Name of the Topics   | Expected Learning Outcome                                                                                                                                                                                                                |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Colloidal State   | Learning and understanding the knowledge of Colloidal State, understanding of colloidal system, different types of colloidal system, preparation, properties, stability of different colloidal system, General applications of colloids. |
| 2. Entropy           | Knowledge and coherent understanding of basic concepts in thermodynamics and Entropy as state function will be gained by the student.                                                                                                    |
| 3. Surface Phenomena | Learning and understanding of theoretical basis of adsorption phenomenon, dynamic nature of surface and its applications.                                                                                                                |
| 4. Chemical Kinetics | Learning and understanding the knowledge about basic concepts in reaction kinetics and third order reaction with characteristics, suitable examples, and methods for determination of order of reactions .                               |

### B.Sc. Part II (NEP-2.0) Semester- III

#### ACHMN-302: Paper VI APPLIED ANALYTICAL CHEMISTRY

(Credits: 02, 30 hours)

| Sr. No. | Name of Topic                           | Expected Course Outcomes                                                        |
|---------|-----------------------------------------|---------------------------------------------------------------------------------|
| 1       | Cleansing Agents : Soaps and Detergents | Knowledge about the chemical nature and cleansing action of soap and detergents |

|   |                                        |                                                                                  |
|---|----------------------------------------|----------------------------------------------------------------------------------|
| 2 | Optical methods of analysis            | Understanding, working and applications of optical methods as an analytical tool |
| 3 | Electroplating                         | Learning and understanding the knowledge about basic concepts in Electroplating  |
| 4 | Column and Ion Exchange Chromatography | Learning and coherent understanding of column, ion exchange chromatography       |

**B.Sc. Part II (NEP-2.0) Semester– IV**

**ICHMN-401: Paper VII FUNDAMENTALS OF INORGANIC CHEMISTRY**

**(Credits: 02, 30 hours)**

**Expected Course Outcomes:**

| Sr. No. | Name of the Topics                      | Expected Course Outcomes                                                                                                                                                  |
|---------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | Chemistry of Lanthanide Elements        | Learning and understanding unique properties such as electronic configuration, stability of Oxidation states, colour, and separation of lanthanides and its applications. |
| 2       | Crystal Structure and Defects in Solids | Knowledge about Crystal structure and defects in Ionic solids will be gained by the students.                                                                             |
| 3       | Chemistry of Non-Aqueous Solvents       | Learning and understanding classification and physical properties of non-aqueous solvents                                                                                 |
| 4       | Catalysis                               | Learning and understanding classification and physical properties of catalysis and its industrial applications.                                                           |

**B.Sc. Part II (NEP-2.0) Semester– IV**

**OCHMN-402: Paper VIII APPLIED ORGANIC CHEMISTRY**

**(Credits: 02, 30 hours) Expected Learning Outcomes:**

| Name of Topic | Expected Learning Outcomes                                                                                                                                                                                                                                                                                                          |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Biomolecules  | <ul style="list-style-type: none"> <li>• Understanding the sources, classification, structure and functions of major biomolecules: Amino Acids, Peptides, and Proteins.</li> <li>• Students should also be able to understand biological processes like metabolism, energy transformation, and the functions of enzymes.</li> </ul> |

|                                  |                                                                                                                                                                                                                                                                                                           |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Chemistry of Carbohydrates       | Learning and understanding of classification, Configuration, and structures of carbohydrates.                                                                                                                                                                                                             |
| Synthetic Dyes                   | Students will get knowledge about classification, preparation, structure, and applications of synthetic dyes.                                                                                                                                                                                             |
| Organic Chemistry in Agriculture | <ul style="list-style-type: none"> <li>• Understanding the chemistry of fertilizers and pesticides for sustainable agriculture.</li> <li>• Students get knowledge about chemical structures and the mechanism of action of various fertilizers and pesticides, with their environmental impact</li> </ul> |

### **B. Sc. III Chemistry** **Major Mandatory (Theory)**

#### **PCH-501 Paper-IX Physical Chemistry (2 Credits, 30 hours)**

##### **Course Outcomes:**

CO1: Students will Learn and understand quantum Chemistry, Heisenberg's uncertainty principle, the concept of energy operators (Hamiltonian), and the Schrödinger wave equation.

CO2: Students will gain knowledge about rotational, vibrational and Raman spectroscopy

CO3: Students will Learn and understand photochemical laws, reactions and various photochemical phenomena.

CO4: Students will gain knowledge of emf measurements, types of electrodes, different types of cells, and various applications of emf measurements.

#### **ICH-502, Paper No.– X, Inorganic Chemistry (2 Credits, 30 Hours)**

**COURSE OUTCOMES (COs):** Students will be able to

**CO-1:** Learn the properties, geometry, stability and nature of bonding between metal ion and ligand in complexes using Crystal Field Theory and Molecular Orbital Theory.

**CO-2:** Understand the preparation and applications of the semiconductors and Superconductors in electrical and electronic devices

**CO-3:** Study the structure, method of preparation and Applications of Organometallic compounds

**CO-4:** Study the synthesis, Classification, types, mechanism, and catalytic applications of different catalysts in industrial fields.

#### **Major Elective (Theory)**

##### **OCHA-503 Organic Chemistry-A Organic Chemistry (2 Credits, 30 Hours)**

##### **Course Outcomes (COs):**

Students will be able to explain the

**CO1.** Fundamental principles of UV-Visible spectroscopy, including electronic transitions, spectral shifts, and the Beer-Lambert Law. Additionally, they will gain the

skills to calculate the absorption maximum using the Woodward-Fieser rules and to understand its role in structural elucidation and chemical analysis.

**CO2.** Use of IR spectroscopy and Hooke's Law to calculate vibrational frequencies and identify vibrational modes in organic molecules. By examining selection rules, electronic effects, and key absorption bands, develop skills to differentiate functional-group and fingerprint regions, aiding in the elucidation of molecular structures and the identification of chemical compounds.

**CO3.** Use of retrosynthetic analysis, disconnections, and synthons to deconstruct complex organic molecules. Develop proficiency in designing efficient synthetic pathways for target molecules by integrating knowledge of reaction mechanisms and reagents.

**CO4.** To describe the preparation and strategic use of key oxidizing and reducing reagents in organic transformations. They will explain the mechanisms and synthetic utility of name reactions, enabling them to predict products and design pathways for complex molecular synthesis.

### ***OCHB-503 Organic Chemistry-B (2 Credits, 30 Hours)***

**Course Outcomes (COs):** Students will be able to explain the

**CO1:** Fundamental principles of UV-Visible spectroscopy, including electronic transitions, spectral shifts, and the Beer-Lambert Law. Additionally, they will gain the skills to calculate the absorption maximum using Woodward-Fieser rules and the role in structural elucidation and chemical analysis

**CO2:** Apply the principles of IR Spectroscopy and Hooke's Law to calculate vibrational frequencies and identify fundamental modes of vibration in organic molecules. By analyzing selection rules, electronic effects, and characteristic absorption bands, they will develop the skills to differentiate between functional group and fingerprint regions to elucidate molecular structures and identify various chemical compounds.

**CO3:** To classify and describe the occurrence, isolation, and general properties of terpenoids and alkaloids, and apply the isoprene rule to understand their structural frameworks. Furthermore, they will gain proficiency in using analytical evidence and chemical syntheses to determine the structures of natural products such as Citral and Nicotine.

**CO4:** To classify pesticides and fertilizers by chemical class and explain their mechanisms of action, including contact and systemic modes of action. They will also master integrated pest management (IPM) strategies and the chemical synthesis of key agrochemicals such as Carbaryl and Glyphosate via specific routes, including the Curtius rearrangement.

### **Major Mandatory (Practical)**

#### **PRCH-504 Practical Paper in Physical Chemistry-V(a) (2 Credits, 60 Hours)**

Course Outcomes: After Completion of course students will be able to

**CO1:** Learn the concept of reaction kinetics

**CO2:** Learn and understand the concept of Viscosity and its measurement using the Ostwald viscometer

**CO3:** Gain hands-on experience with a potentiometer, conductometer, pH meter, and refractometer instruments.

**CO4:** Understand the distribution law and concept of partition coefficient

### **PRCH-505 Practical Paper in Inorganic Chemistry-V(b) (2 Credits, 60 Hours)**

**CO1:** Gain the practical skills to perform quantitative analysis

**CO2:** Perform quantitative analysis of ore and alloy and to determine the percentage of metal and ore using gravimetric analysis method.

**CO3:** Synthesize and to determine the percentage purity of inorganic compounds and complexes through standard preparation techniques.

**CO4:** Apply ion exchange chromatography method for separation and estimation of metal ions and inorganic species in complex mixtures.

### **Major Elective (Practical)**

**Course Outcomes (COs):** Students will be able

1. To conduct qualitative and quantitative analyses of organic compounds and gain proficiency in techniques such as separating binary mixtures, estimating compounds from samples, and synthesizing organic derivatives.
2. To separate binary organic mixtures into individual components by utilizing differences in solubility and chemical nature (acidic, phenolic, basic, or neutral). Develop skills to identify each component through qualitative analysis, including detection of elements and functional groups and determination of physical constants.
3. To quantify organic compounds using titrimetric methods to measure specific functional groups or compounds. This will help develop skills in calculating and interpreting the purity of organic samples for accurate laboratory analysis.
4. To conduct organic synthesis and purification techniques for specific compounds, while mastering essential lab operations like refluxing, filtration, and recrystallization. Additionally, students will learn to calculate percentage yields and verify product purity through physical constants like melting points.

### **Major Mandatory (Theory)**

### **PCH-601 Paper-XI Physical Chemistry (2 Credits, 30 hours)**

#### **Course Outcomes:**

CO1: Students will Learn and understand the phase rule, including one-component, two-component, and three-component systems phase diagrams, with suitable examples.

CO2: Students will gain knowledge about Gibbs free energy, Helmholtz energy, Criteria for thermodynamic equilibrium and spontaneity and partial molar quantities

CO3: Students will Learn and understand Laws of crystallography and the determination of crystal structure by Bragg's method.

CO4: Students will gain knowledge of potentiometric techniques

**COURSE OUTCOMES :** Student will be able to

**CO-1:** Learn and focused on the mechanism of the reactions involved in Inorganic complexes of transition metals.

**CO-2:** Understand the thermodynamic and kinetic aspects of Metal complexes

**CO-3:** Study the characteristics properties of Actinides and generation of nuclear power with the help of nuclear reactions. Also studied role of Radio isotopes in medicinal, industrial and Archaeology fields.

**CO-4:** Study the Role of various metals and non metals useful for our Health.

### **Major Elective (Theory) Paper-II**

#### **OCHC-603 Organic Chemistry-C (2 Credits, 30 Hours)**

**Course Outcomes (COs):** Students will be able to explain the

1. The fundamental principles of PMR spectroscopy, including nuclear shielding, deshielding, and the role of TMS as a reference standard. They will develop proficiency in interpreting chemical shifts and spin-spin splitting ( $n+1$  rule) to solve complex structural problems and determine the molecular frameworks of organic compounds.
2. The fundamental principles of Mass Spectrometry and the formation of various ions by analyzing specific fragmentation patterns, including the McLafferty rearrangement and the Nitrogen rule. They will also develop the skills to interpret mass spectra for the structural identification of organic molecules, such as alkanes, alkenes, and carbonyl compounds, in diverse analytical applications.
3. To describe the mechanisms and stereochemistry of electrophilic addition reactions to carbon-carbon double and triple bonds, including specialized transformations such as hydroboration-oxidation. They will also be able to predict reaction products by applying rules such as Markovnikov and Anti-Markovnikov addition, while accounting for carbocation rearrangements and stereochemical outcomes.
4. To classify medicinal agents, define the essential qualities of an ideal drug, and explain the therapeutic applications of specific compounds such as Benzocaine and Chloramphenicol. They will also master the chemical synthesis of key drugs, including Isoniazid and Ethambutol, and evaluate the physiological mechanisms of action of sulfonamide drugs in treating infections.

#### **OCHD-603 Organic Chemistry-D (2 Credits, 30 Hours)**

**Course Outcomes (COs):** Students will be able to explain the

**CO1:** To explain the fundamental principles of PMR spectroscopy, including nuclear shielding, deshielding, and the role of TMS as a reference standard. They will develop proficiency in interpreting chemical shifts and spin-spin splitting ( $n+1$  rule) to solve complex structural problems and determine the molecular frameworks of organic compounds.

**CO2:** To explain the fundamental principles of Mass Spectrometry and the formation of various ions by analyzing specific fragmentation patterns, including the McLafferty rearrangement and the Nitrogen rule. They will also develop the skills to interpret mass spectra for the structural identification of organic molecules, such as alkanes, alkenes, and carbonyl compounds, in diverse analytical applications.

**CO3:** To classify polymers based on their origin and structure while explaining mechanisms of addition and Ziegler-Natta polymerization. Furthermore, they will gain proficiency in describing the synthesis and applications of commercial resins and conducting organic polymers, such as polyaniline and polypyrrole, for

modern industrial and electronic applications.

**CO4:** To describe the industrial manufacturing process of cane sugar, covering key stages from juice extraction and clarification to crystallization and centrifugation. Additionally, they will identify the economic value of sugar industry by-products and explain the biochemical process of producing ethyl alcohol from molasses through fermentation.

### **Major Mandatory (Practical)**

#### **PRCH-604 Practical Paper in Physical Chemistry-VI(a) (2 Credits, 60 Hours)**

Course Outcomes: After Completion of course, students will be able to

**CO1.** Learn the concept of activation energy, and effect of salt on rate of reaction **CO2.** Understand the adsorption isotherms.

**CO3.** Gain hands-on experience with a potentiometer, conductometer, pH meter experiments.

**CO4.** Learn the Beer-Lambert law, concept of dissociation constant

#### **PRCH-605 Practical Paper in Inorganic Chemistry-VI(b) (2 Credits, 60 Hours)**

**CO1:** Gain knowledge regarding practical applications of chemistry in daily life **CO2:** Perform quantitative analysis of ore and alloy and to determine the percentage of metal and ore using gravimetric analysis method.

**CO3:** Synthesize and to determine the percentage purity of inorganic compounds and complexes through standard preparation techniques.

**CO4:** Apply ion exchange chromatography method for separation and estimation of metal ions and inorganic species in complex mixtures

### **Major Elective (Practical)**

**Course Outcomes (COs):** Students will be able

- 1.** To conduct qualitative and quantitative analyses of organic compounds and gain proficiency in techniques such as separating binary mixtures, estimating compounds from samples, and synthesizing organic derivatives.
- 2.** To separate binary organic mixtures into individual components by utilizing differences in solubility and chemical nature (acidic, phenolic, basic, or neutral). Develop skills to identify each component through qualitative analysis, including detection of elements and functional groups and determination of physical constants.
- 3.** To quantify organic compounds using titrimetric methods to measure specific functional groups or compounds. This will help develop skills in calculating and interpreting the purity of organic samples for accurate laboratory analysis.
- 4.** To conduct organic synthesis and purification techniques for specific compounds, while mastering essential lab operations like refluxing, filtration, and recrystallization. Additionally, students will learn to calculate percentage yields

and verify product purity through physical constants like melting points.

#### VOCATIONAL SKILL COURSES

| B. Sc. III, Semester V, VSC Practical Paper-II |                                                                     |                         |
|------------------------------------------------|---------------------------------------------------------------------|-------------------------|
| BSU0325VSP307E                                 | PRCHVSC-508 Vocational Skill Course in Chemistry Practical Paper-II | Credits: 2<br>Hours: 60 |

##### Course Outcomes:

**After completion of the course, the students will be able to:**

- CO1 Students will understand the concepts, principles, theories and practical applications of Chemistry
- CO2 Students will develop synthesis and analysis skills
- CO3 Students will gain knowledge of instruments like conductometer, refractometer etc.
- CO4 Students will develop analytical skills.

#### VOCATIONAL SKILL COURSES

| B. Sc. III, Semester VI, VSC Practical Paper-III |                                                                      |                         |
|--------------------------------------------------|----------------------------------------------------------------------|-------------------------|
| BSU0325VSP307F                                   | PRCHVSC-607 Vocational Skill Course in Chemistry Practical Paper-III | Credits: 2<br>Hours: 60 |

##### Course Outcomes:

**After completion of the course, the students will be able to:**

- CO1 Students will learn the concept of optical rotation.
- CO2 Students will learn different types of conductometric titrations.
- CO3 Students will learn the use of computer techniques to solve the problems in chemistry.
- CO4 Students will learn preparation skills.

#### Indian Knowledge System (IKS) in Chemistry

| Sr. No. | Semester | Course Code    | Title of Paper                                              |
|---------|----------|----------------|-------------------------------------------------------------|
| 1       | VI       | BSU0325IKL307F | CHIKS-609 Ancient Indian Chemistry<br>(2 credits, 30 Hours) |

##### Course Outcomes:

Upon completion of the course, student will be able to

- 1) Know the Indian Knowledge System and its significance in the protection of traditional knowledge.
- 2) Understand the need of the Indian Knowledge System and significance of the ancient Indian Chemistry.
- 3) Organize the contributions made by the ancient Indians in the field of Science and related concepts.
- 4) Know the contribution of Indians chemists in the development of chemistry.
- 5) Outline the chemistry heritage of ancient India.

| B. Sc. III, Semester VI<br>SKILL ENHANCEMENT COURSE in CHEMISTRY |                                            |                         |
|------------------------------------------------------------------|--------------------------------------------|-------------------------|
| BSU0325SEP307F                                                   | CHSEC-608 Practical Skill in Chemistry-III | Credits: 2<br>Hours: 60 |

**Course Outcomes:**

**After completion of the course, the students will be able to:**

CO1: analyses water and soil samples

CO2: gain knowledge of methods to detect adulterations in food. CO3: understand applications of separation techniques in analysis. CO4: gain knowledge of instruments.

**Open Elective in Chemistry**

| Sr. No. | Semester | Course Code    | Title of Paper                                                                       |
|---------|----------|----------------|--------------------------------------------------------------------------------------|
| 1       | V        | BSU0325OEP307E | CHOEPR-507 Exploring Fundamental Chemistry Experiments Paper-V (2 credits, 60 Hours) |

**Exploring Fundamental Chemistry Experiments**

**Course Outcomes:**

***On completion of the course, the students will be able to:***

CO1: Gain the knowledge of preparation and standardization of solutions.

CO2: Gain knowledge of separation techniques.

CO3: Gain knowledge of the basic instruments.

CO4: Gain knowledge of indicators and titration technique.

**B. Sc. Chemistry Practical component:**

The aim of the practical component of the course is to provide students with the skills that will be needed in their future practical work. Instruction is provided regarding the presentation of practical reports, awareness of health and safety procedures, practical skills in the laboratory (and the theory on which they are based).

### **B. Sc. I Chemistry practicals**

Student is able to

- follow and understand general laboratory practical guidelines, including safety
- the use of an analytical balance for mass measurement
- how to maintain a detailed scientific notebook
- use of graduated cylinders, graduated pipettes, thermometers and volumetric pipettes .
- set up glassware and apparatus to conduct experiments.
- Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.

### **B. Sc. II Chemistry practicals**

Student is able to

- how to communicate the results of scientific work in oral, written and electronic formats
- how to critically evaluate data collected to determine the identity, purity, and yield of products
- understanding of the distinction between qualitative and quantitative chemical analysis
- to interpret data from an experiment, including the construction of appropriate graphs and the evaluation of errors.

### **B. Sc. III Chemistry practicals**

Student is able to

- use modern instrumentation and classical techniques, to design experiments, and to properly record the results of their experiment.
- the application of statistical methods for the evaluation of laboratory data
- Calibration and use of pH metry, conductometric , potentiometric, calorimetry technique.
- how to design and perform experiments to determine the rate, order, and activation energy of chemical reactions by varying concentrations and/or temperature
- the preparation of buffer solutions at a required pH, given a choice of solutions of acid/conjugate base pairs
- how to perform common laboratory techniques, including reflux, distillation, steam distillation, recrystallization, vacuum filtration, aqueous extraction, thin layer chromatography, column chromatography
- how to predict the outcome and mechanism of some simple organic reactions, using a basic understanding of the relative reactivity of functional groups