

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.

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 hetero atom (Pyrrole and Pyridine).

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 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
Fundamentals of Industrial Chemistry and IPR	a. Distinguish between classical and industrial chemistry 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. 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 Hours: 60

Course Outcomes:

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

- C01 Understand the concepts, principles, theories and practical applications of Chemistry
 C02 Understand the simple techniques of synthesis and analysis
 C03 Gain basic knowledge of instruments to be used for analysis.
 C04 Develop analytical skills

B. Sc. II, Semester IV		
BSU0325CEP207D01	CHCEP-401 Community Engagement Programme in Chemistry Paper-I	Credits: 2 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 III (CBCS) SEMESTER-V

B. Sc. Part - III (NEP- 1.0) SEMESTER-V

Paper No. DSE-E5, Chemistry Paper No.– IX (Inorganic

Chemistry) (Theory Credits: 02, 30 hours.)

Expected Learning Outcomes:

Name of the topic	Expected Learning Outcome
1. Acids bases and Non-aqueous solvents	Useful for the study of role of acids and bases in Chemistry. The study of non –aqueous solvents is important to learn all chemical properties of solutes and from the research Point of view.
2. Metal ligand bonding in transition metal complexes	Useful to understand geometry, stability and Nature of bonding between metal ion and ligand in complexes.
3. Metals, semiconductors and Superconductors	The topic deals with the synthesis and the applications of the semiconductors and Superconductors in electrical and electronic devices.
4. Organometallic compounds	The structure, method of preparation and the applications of organometallic compound in various fields are explained.
5. Catalysis	The classification, types, mechanism and applications of catalyst in industrial fields is explained.

B. Sc. Part III (NEP 1. 0) SEMESTER-V

Paper No. DSE-E6 Chemistry Paper No. X (Organic Chemistry)

(Theory Credits: 02, 30 hours.)

Expected Learning Outcomes:

Name of the Topic	Expected Learning Outcomes
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1. Introduction to Spectroscopy	Understanding of energy associated with electromagnetic radiation and its use in analytical technique.
2. UV-Vis Spectroscopy	Knowledge of chromophore, auxochrome and calculation of λ_{max} .
3. IR Spectroscopy	Knowledge of vibrational transitions, regions of IR spectrum, functional group recognition.
4. NMR Spectroscopy	Understanding of magnetic, non-magnetic nuclei, shielding-deshielding, chemical shift, splitting Pattern
5. Introduction to Mass spectroscopy. Combined Spectroscopic Problems based on UV-Vis, IR and NMR data.	Knowledge of molecular ion, fragmentation pattern and different types of ions produced. Student will predict the structure of organic compound with the help of provided spectral data.

B. Sc. Part III (NEP 1. 0) SEMESTER-V
Paper No. DSE-E7 Chemistry Paper No. XI (Physical Chemistry)
(Theory Credits: 02, 30 hours.)

Expected learning Outcomes:

Name of the Topics	Expected Learning Outcome
1. Elementary quantum mechanics	Learning and understanding quantum Chemistry, Heisenberg's uncertainty principle, concept of energy operators (Hamiltonian), learning of Schrodinger wave equation. Physical interpretation of the ψ and ψ^2 . Particle in a one dimensional box
2. Spectroscopy	Knowledge about spectroscopy, Electromagnetic spectrum, Energy level diagram, Study of rotational spectra of diatomic molecules: Rigid rotor model, Microwave oven, vibrational spectra of diatomic molecules, simple Harmonic oscillator model, Raman spectra: Concept of polarizability, pure rotational and pure Vibrational Raman spectra of diatomic molecules, related knowledge will be gained by the students.
3. Photochemistry	Learning and understanding photochemical laws, reactions and various photochemical phenomena.
4. Solution	Learning the various types of solutions, relations vapour pressure, temperature relations.
5. Electromotive force	Learning and understanding the knowledge of emf measurements, types of electrodes, different types of cells, various applications of emf measurements.

B. Sc. Part III (NEP 1. 0) SEMESTER-V
Paper No. DSE-E8 Chemistry Paper No. XII (Analytical Chemistry)
(Theory Credits: 02, 30 hours.)

EXPECTED LEARNING OUTCOMES:

Name of the topic	Expected Learning Outcome
1.Potentiometric Titrations	Understanding theory and applications of potentiometric titrations.
2.Colorimetry and Spectrophotometry	Understanding, working and applications of optical methods as an analytical tool.
3.Sugar Industry	Learning and understanding the whole process of manufacture of sugar and byproducts of sugar industry.
4.Manufacture of Industrial Heavy Chemicals	Learning and understanding of physico-chemical principles of production of ammonia, sulfuric acid, nitric acid and sodium carbonate along with its manufacturing plant.
5. Gas Chromatography and Quality Control	Understanding the basics of Gas Chromatography, Quality control practices in analytical industries / laboratories.

B. Sc. Part III (NEP 1. 0) SEMESTER-VI
Paper No. DSE-F5 Chemistry Paper No. XIII (Inorganic Chemistry)
(Theory Credits: 02, 30 hours.)

EXPECTED LEARNING OUTCOME:

Name of the topic	Expected Learning Outcome
1. Coordination Chemistry	The topic focused on the mechanism of the reactions involved in inorganic complexes of transition metals. The students can understand the thermodynamic and kinetic aspects of Metal complexes.
2. Nuclear Chemistry	The generation of nuclear power with the help of nuclear reactions is highlighted. Role of Radio isotopes in medicinal, industrial and Archaeology fields is explained.
3. Chemistry of f-block Elements	The characteristics properties and separation of lanthanides and Actinides are discussed. Synthesis and IUPAC Nomenclature of trans -uranic elements (TU) explained.

4. Iron and Steel	The techniques involve in ore dressing and extraction of cast iron from its ore are discussed.
5. Bio-inorganic Chemistry	Role of various metals and non metals in our Health are discussed.

B.Sc. Part III (NEP 1. 0) SEMESTER-VI
Paper No. DSE-F6 Chemistry Paper No. XIV (Organic Chemistry)
(Theory Credits: 02, 30 hours.)

Expected learning Outcomes:

Name of the Topic	Expected Learning Outcome
1. Reagents and Reactions in Organic Synthesis	Knowledge of reagents used in organic transformations and various reactions used in organic synthesis.
2. Retrosynthesis	Knowing basic terms used in retrosynthetic analysis, retrosynthesis of some organic compounds.
3. Electrophilic addition to $>C=C<$ and $-C\equiv C-$ bond	Student will learn addition reaction across $>C=C<$ bond w.r.t. hydrohalogenation, hydration hydroxylation, ozonolysis and addition of halogen, halogen acid, hydrogen, water, etc. across $-C\equiv C-$ bond.
4. Natural Products	Knowledge of terpenoids and alkaloids w.r.t. occurrence, isolation, characteristics and classification. Analytical and synthetic evidences of Citral and Nicotine.
5. Pharmaceuticals	Understanding classification of drugs, Qualities of ideal drug. Synthesis and uses of some representative drugs and Drug action of sulpha drugs.

B.Sc. Part III (NEP 1. 0) SEMESTER-VI
Paper No. DSE-F7 Chemistry Paper No. XV Physical Chemistry)
(Theory Credits: 02, 30 hours.)

EXPECTED LEARNING OUTCOMES:

Name of the Topics	Expected Learning Outcome
1. Phase equilibria	Learning and understanding of phase rule, learning of One component, Two component and Three component systems phase diagrams with suitable examples.
2. Thermodynamics	Knowledge about basic concept of Thermodynamics, free energy, Gibbs-Helmholtz equation and its applications, problem related with it.

3. Solid state chemistry	Learning and understanding Space lattice, lattice sites, Lattice planes, Unit cell. Laws of crystallography, Weiss indices and Miller indices, Cubic lattices and types of cubic lattice, planes or faces of a simple cubic system, Diffraction of Xrays, Derivation of Bragg's equation. Determination of crystal structure by Bragg's method. crystal structure of NaCl and KCl on the basis of Bragg's equation..
4. Chemical kinetics	Learning of kinetics, Simultaneous reactions such as i)opposing reaction ii)side reaction iii)consecutive reactions: iv) chain reaction v) explosive reaction
5. 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.

B.Sc. Part III (NEP 1. 0) SEMESTER-VI
Paper No. DSE-F8 Chemistry Paper No. XVI (Analytical Chemistry)
(Theory Credits: 02, 30 hours.)

Expected learning Outcomes:

Name of the topic	Expected Learning Outcome
1.Soap and Detergents	Knowledge about the chemical nature and cleansing action of soap
2.Synthetic polymers	Understanding and learning the classification, synthesis and applications of various polymers.
3.Flame Photometry	Knowledge of instrumental analysis of alkali and alkaline earth elements.
4. Soil and Fertilizer Analysis	Knowledge of analysis of soil essential parameters and nutrients, Understanding the fertilizers used in regular farming
5.Nanotechnology	Understanding and learning of nanotechnology including classification, optical properties, synthesis routes, characterization techniques and applications of nano-materials.

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 know

- 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