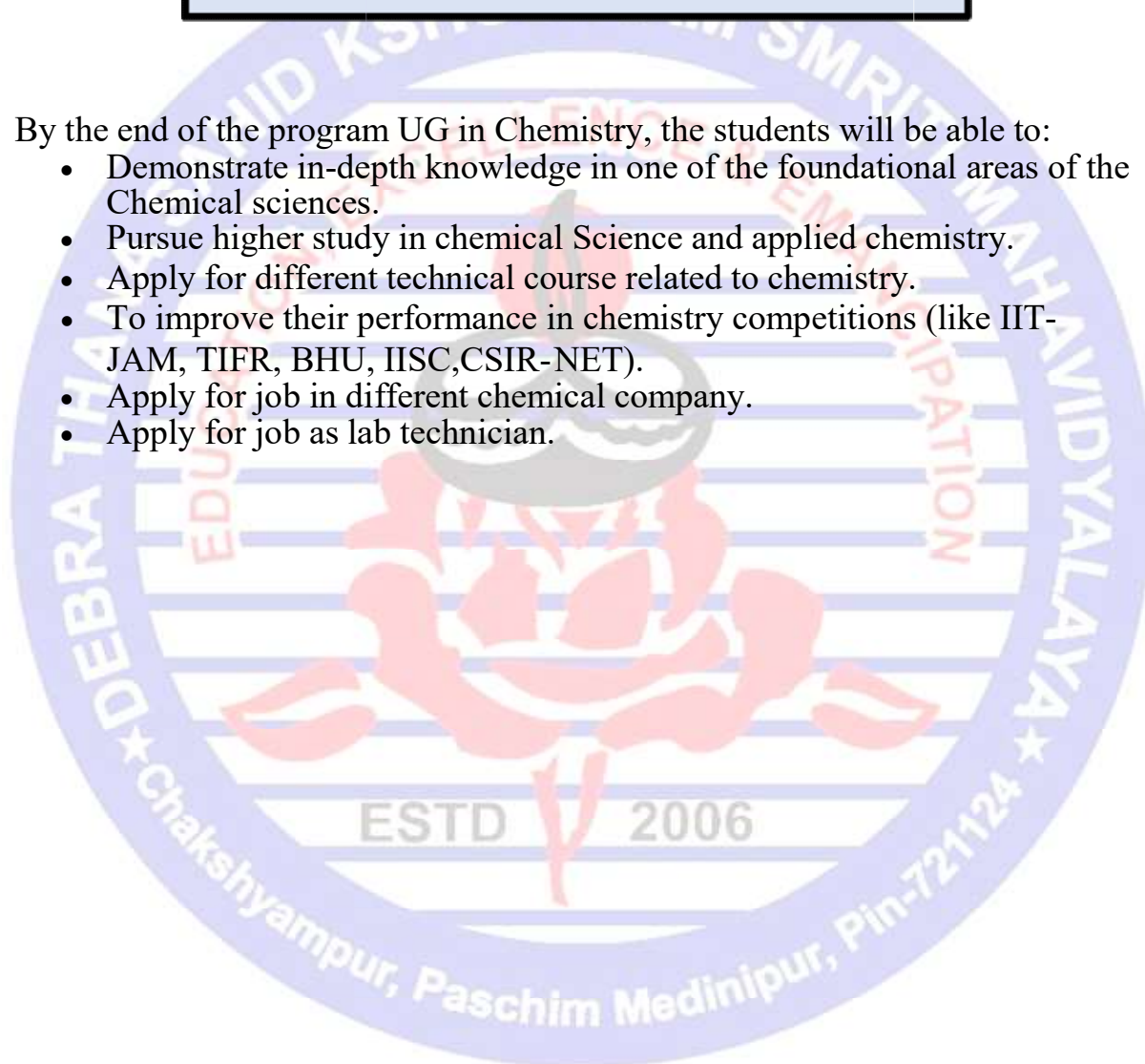


B.SC Honours in Chemistry

Programme Specific Outcome (PSO)

By the end of the program UG in Chemistry, the students will be able to:

- Demonstrate in-depth knowledge in one of the foundational areas of the Chemical sciences.
- Pursue higher study in chemical Science and applied chemistry.
- Apply for different technical course related to chemistry.
- To improve their performance in chemistry competitions (like IIT-JAM, TIFR, BHU, IISC, CSIR-NET).
- Apply for job in different chemical company.
- Apply for job as lab technician.



Course Outcome (CO)

CHEMHCC-01: Bonding and Physical properties, General Treatment of Reaction Mechanism I, Stereochemistry I and Organic Chemistry I Lab.

Outcomes:

Bonding and Physical properties:

- Students will know about the Valance Bond Theory.
- Students can grow their concept about electronic displacement.
- Students will know about the Molecular Orbital Theory and how to draw the MO picture of different types of organic molecule.
- Students will know about the Aromaticity.

General Treatment of Reaction Mechanism I:

- Student will gather knowledge about the comparative study of physical properties of the molecules.
- Students will know about Mechanistic classification and Reactive Intermediates.

Stereochemistry I:

- Students will know about the basic concept of stereochemistry

Organic Chemistry I Lab:

- Students will learn how to separate a binary Mixture of pure compound.
- Students will learn how to determine the boiling point of liquid.
- Students will also learn about the Identification of pure Organic Compound.

CHEMHCC-02: Kinetic Theory Of Gaseous State, Chemical Thermodynamics, Chemical Kinetics and Physical Chemistry I Lab.

Outcomes:

Kinetic Theory Of Gaseous State:

- Students will know about the basic of Kinetic Theory of Gaseous State.
- Students will learn about Maxwell's distribution of speed and energy.
- Students will know about Real gas and Viral equation.

Chemical Thermodynamics:

- Students will learn about Zeroth and 1st Law of Thermodynamics.
- Students will learn about Thermochemistry.
- Students can able to derive Thermodynamic relations.

Chemical Kinetics:

- Students will know how to calculate the order, Molecularity and rate of different chemical reaction.
- Students can correlate the temperature with reaction rate.
- Students will learn about the Homogeneous catalysis.

Physical Chemistry I Lab:

- Students can determine the pH of unknown solution (buffer), by color matching method.
- Students can determine the heat of neutralization of a strong acid by a strong base.
- Students can determine the Study of kinetics of acid-catalyzed hydrolysis of methyl acetate.
- Students can determine the kinetics of decomposition of H_2O_2 .
- Students can determine the heat of solution of oxalic acid from solubility measurement.

CHEMHCC-03: Extra nuclear Structure of atom, Chemical periodicity, Acid-Base reactions, Redox Reactions and precipitation reactions and Inorganic Chemistry I Lab.

Outcomes:

Extra nuclear Structure of atom:

- Students will know about the different theories of structure of atom and their application.
- Students will know how to write the electronic configuration of atoms and ions.

Chemical periodicity:

- Students will learn about Modern IUPAC Periodic table.
- Students will learn about periodicity in chemical and physical properties.

Acid-Base reactions:

- Students will learn about the different definition of acids and bases.
- Students will learn relative strength of acids.
- Students also learn about pH, buffer, Acid-base neutralisation curves, indicator, choice of indicators etc.

Redox Reactions and precipitation:

- Students can solve Ion-electron method of balancing equation of redox reaction.
- Students will learn Elementary idea on standard redox potentials with sign conventions, redox titration.
- Students also learn about Solubility product principle and common ion effect and their applications to the precipitation and separation of common metallic ions.

Inorganic Chemistry I Lab:

- Students can do Acid and Base Titrations.
- Students can do Oxidation-Reduction Titrimetric analysis.

CHEMHCC-04: Stereochemistry II, General Treatment of Reaction Mechanism II, Substitution and Elimination Reactions and Organic Chemistry II Lab.

Outcomes:

Stereochemistry II:

- Students will know how Chirality arising out of stereoaxis.
- Students will know the Concept of prostereoisomerism.
- Students can do the conformation analysis of different organic compounds.

General Treatment of Reaction Mechanism II:

- Students will learn the Concept of organic acids and bases.
- Students will learn the Reaction thermodynamics.
- Students will learn about Tautomerism.

Substitution and Elimination Reactions:

- Students can know about Free-radical substitution reaction.
- Students can know about Nucleophilic substitution reactions.
- Students can know about Elimination reactions.

Organic Chemistry II Lab:

- Students can prepare some common organic compounds by applying basic organic chemistry reaction.

CHEMHCC-05: Transport processes, Applications of Thermodynamics – I, Foundation of Quantum Mechanics and Physical Chemistry II Lab.

Outcomes:

Transport processes:

- Students will learn about Fick's law.
- Students will learn about Viscosity.
- Students will learn about Conductance and transport number.

Applications of Thermodynamics – I:

- Students will know about Partial properties and Chemical potential.
- Students will clarify the concept of Chemical Equilibrium.
- Students will know how chemical potential and other properties of ideal substances- pure and mixtures are related.

Foundation of Quantum Mechanics:

- Students will know the Beginning of Quantum Mechanics.
- Students will gather the concept of Wave function and Operators.
- Students can solve the problem of Particle in a box and Simple Harmonic Oscillator.

Physical Chemistry II Lab:

- Students can study the viscosity of unknown liquid (glycerol, sugar) with respect to water.
- Students can determine the partition coefficient for the distribution of I₂ between water and CCl₄.
- Students can determine the K_{eq} for KI + I₂ = KI₃, using partition coefficient between water and CCl₄.
- Students can study the Conductometric titration of an acid (strong, weak/ monobasic, dibasic) against base strong.
- Students can study the saponification reaction conductometrically
- Students can verify the Ostwald's dilution law and can determine K_a of weak acid.

CHEMCC-06: Chemical Bonding-I, Chemical Bonding-II,

Radioactivity and Inorganic Chemistry II Lab. Outcomes:

Chemical Bonding-I:

- Students build deep concept about Ionic Bonding and Covalent Bonding.

Chemical Bonding-II:

- Students will learn Molecular orbital concept of bonding and know how to draw the MO diagram of different Inorganic compound.
- Students will learn the qualitative idea of valence bond and band theories, Semiconductors, insulators and defects in solids.
- Students will know about the Weak Chemical Forces.

Radioactivity:

- Students will learn about the various type nuclear reactions.
- Students also learn the Principles of determination of age of rocks and minerals, radiocarbon dating, hazards of radiation and safety measures.

Inorganic Chemistry II Lab:

- Iodo / Iodimetric Titrations concept have been discussed in this topic.
- Students also learn How to Estimate the metal content in some selective samples.

CHEMHCC-07: Chemistry of alkenes and alkynes, Aromatic Substitution, Carbonyl and Related Compounds, Organometallics and Organic Chemistry III Lab.

Outcomes:

Chemistry of alkenes and alkynes:

- Students will gather knowledge about the addition reaction to C=C and to C≡C.

Aromatic Substitution:

- Students will acquire some basic concept of electrophilic aromatic substitution.
- Students will acquire some basic concept of Nucleophilic aromatic substitution.

Carbonyl and Related Compounds:

- Students will grow their concept on addition reaction to carbonyl compounds.
- Elementary ideas of Green Chemistry also discussed in this particular section.

Organometallics:

- Organo lithium, organo magnesium, organo copper based chemistry are discussed here.

Organic Chemistry III Lab:

- Students can handle the Qualitative Analysis of Single Solid Organic Compounds.

CHEMHCC-08:

Application of Thermodynamics – II, Electrical Properties of molecules, Quantum Chemistry and Physical Chemistry III Lab.

Outcomes:

Application of Thermodynamics – II:

- Students will know about the Colligative properties.
- Students will know about Phase rule.

Electrical Properties of molecules:

- Students will know about Ionic equilibria.
- Students will know about Electromotive Force.
- Student can solve the problem related to Dipole moment and polarizability.

Quantum Chemistry:

- Angular momentum related problems are discussed in this particular section.
- Students can solve quantum mechanical problem related to hydrogen

atom and hydrogen-like ions.

Physical Chemistry III Lab: students will gather knowledge about the following practical

- Determination of solubility of sparingly soluble salt in water, in electrolyte with commonions and in neutral electrolyte (using common indicator).
- Potentiometric titration of Mohr's salt solution against standard $K_2Cr_2O_7$ solution
- Determination of K_{sp} for $AgCl$ by potentiometric titration of $AgNO_3$ solution against standard KCl solution
- Effect of ionic strength on the rate of Persulphate – Iodide reaction.
- Study of phenol-water phase diagram.
- pH-metric titration of acid (mono- and di-basic) against strong base.

CHEMHCC-09:

General Principles of Metallurgy, Chemistry of s and p Block Elements, Noble Gases, Inorganic Polymers, Coordination Chemistry-I and Inorganic Chemistry III Lab.

Outcomes:

General Principles of Metallurgy:

- Students will gather knowledge about the Chief modes of occurrence of metals based on standard electrode potentials.
- Students will gather knowledge about the Methods of purification of metals.

Chemistry of s and p Block Elements:

Students will learn about the relative stability of different oxidation stat

- Students will learn about the structural properties about the important inorganic compound.

Noble Gases:

- Students will know about the Occurrence and uses of Nobel Gases.
- Students will know about Molecular shapes of noble gas compounds (VSEPR theory).

Inorganic Polymers:

- Students will learn about the types of inorganic polymers.
- Students will learn synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes.

Coordination Chemistry-I:

- Werner's theory of coordination complexes is taught in this particular topic.

- IUPAC nomenclature of coordination complexes is also taught here.
- Students learn some basic concept of co-ordination chemistry.

Inorganic Chemistry III Lab:

- Students will acquire knowledge about Complexometric titration.
- Students will learn Inorganic preparations of some complex compound.

CHEMHCC-10:

Nitrogen compounds, Rearrangements, the Logic of Organic Synthesis, Organic Spectroscopy and Organic Chemistry IV Lab.

Outcomes:

Nitrogen compounds:

- Students are taught how to synthesise Amines.
- Students can acquire knowledge about some specific reactions of Amines.
- Students are taught how to synthesise Nitro compounds (aliphatic and aromatic).
- Students can acquire knowledge about some specific reactions of Nitro compounds (aliphatic and aromatic).
- Students will grow their concept about the preparation and reaction of Alkyl nitrile and isonitrile.
- Students will grow their concept about Diazonium salts and their related compounds.

Rearrangements:

- Rearrangement to electron-deficient carbon, nitrogen and oxygen are taught in this particular topic.
- Students are taught about Aromatic rearrangements.

The Logic of Organic Synthesis:

- Students will learn about Retrosynthetic analysis.
- Students will learn about strategy of ring synthesis.
- Students will learn about Asymmetric synthesis.

Organic Spectroscopy:

- Students will acquire knowledge about UV Spectroscopy, IR Spectroscopy, NMR Spectroscopy.
- Applications of IR, UV and NMR spectroscopy for identification of simple organic molecules are discussed broadly in this particular topic.

Organic Chemistry IV Lab: The following practical are discussed separately in this particular topic

- Estimation of glycine by Sørensen's formal method.

- Estimation of glucose by titration using Fehling's solution.
- Estimation of sucrose by titration using Fehling's solution.
- Estimation of vitamin-C (reduced).
- Estimation of aromatic amine (aniline) by bromination (Bromate-Bromide) method.
- Estimation of phenol by bromination (Bromate-Bromide) method.
- Estimation of formaldehyde (Formalin).
- Estimation of acetic acid in commercial vinegar.
- Estimation of urea (hypobromite method).
- Estimation of saponification value of oil/fat/ester.

CHEMHCC-11:

Coordination Chemistry-II, Chemistry of d- and f- block elements and Inorganic Chemistry IV Lab.

Outcomes:

Coordination Chemistry-II:

- Students will learn about VB description and its limitations.
- Students will learn about Elementary Crystal Field Theory.
- Students will learn about Magnetism and Colour of coordination compounds.

Chemistry of d- and f- block elements:

- Students are familiar about Transition Elements.
- Students are familiar about Lanthanoids and Actinoids.

Inorganic Chemistry IV Lab:

- Students will learn Principles involved in chromatographic separations, basically Paper chromatographic separation of metal ions are discussed.
- Students will learn Principles involved in Gravimetric analysis.
- Students will learn Principles involved in Spectrophotometric analysis.

CHEMHCC-12:

Carbocycles and Heterocycles, Cyclic Stereochemistry, Pericyclic reactions, Carbohydrates, Biomolecules and Organic Chemistry V Lab.

Outcomes:

Carbocycles and Heterocycles:

- Synthesis of Polynuclear hydrocarbons and their derivatives are discussed here.
- Reactions (with mechanism) of naphthalene, anthracene, phenanthrene and their derivatives are also discussed here.

- Synthesis of Heterocyclic compounds (5- and 6-membered) and their important chemical reactions are discussed here.

Cyclic Stereochemistry:

- Students will gather knowledge about I strain and conformation analysis of cyclohexane.
- Students will gather knowledge about elimination and substitution reaction in cyclohexane derivatives.

Pericyclic reactions:

- Students will learn the Mechanism, stereochemistry and regioselectivity in case of Electrocyclic reactions, Cycloaddition reactions, Sigmatropic reactions.

Carbohydrates:

- Structure of Monosaccharides, Disaccharides and Polysaccharides are taught in this particular section.
- Reactions of Monosaccharides, Disaccharides and Polysaccharides are also discussed here.

Biomolecules:

- Students will learn about the synthesis and chemical reaction of Amino Acid.
- Students will learn how to form peptide linkage.
- Details structural study of nucleic acid is also learn by the student in this section.

Organic Chemistry V Lab:

- Students will acquire knowledge of Chromatographic Separations.

Students will acquire knowledge of Spectroscopic Analysis of Organic Compounds

CHEMHCC-13:

Bioinorganic Chemistry, Organometallic Chemistry, Catalysis by Organometallic Compounds, Reaction Kinetics and Mechanism and Inorganic Chemistry V Lab.

Outcomes:

Bioinorganic Chemistry:

- Basic chemical reactions in the biological systems and the role of metal ions (specially Na^+ , K^+ , Mg^{2+} , Ca^{2+} , Fe^{3+} , Fe^{2+} , Cu^{2+} , and Zn^{2+}) are taught to the students.
- Metal ion transport across biological membrane Na^+ / K^+ - ion pump, Dioxygen molecule in life are also learn.

Organometallic Chemistry:

- Definition and classification of organometallic compounds on the basis of bond type are discussed here.

- Reactions of organometallic complexes: substitution, oxidative addition, reductive elimination and insertion reactions are also learn by the students.

Catalysis by Organometallic Compounds: students will learn Study of the following industrial processes

- Alkene hydrogenation (Wilkinson's Catalyst)
- Hydroformylation
- Wacker Process
- Synthetic gasoline (Fischer Tropsch reaction)
- Ziegler-Natta catalysis for olefin polymerization.

Reaction Kinetics and Mechanism:

- Students will learn about the Substitution reactions in square planar complexes, Trans- effect and its application in complex synthesis.
- Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes are also known to the students.

Inorganic Chemistry V Lab:

- Students will learn about the Qualitative semimicro analysis of Inorganic compounds.

CHEMHCC-14:

Molecular Spectroscopy, Photochemistry, Surface phenomenon and Physical Chemistry IV Lab.

Outcomes:

Molecular Spectroscopy:

- Students will gather knowledge about Rotation spectroscopy, Vibrational spectroscopy, Raman spectroscopy, Nuclear Magnetic Resonance (NMR) spectroscopy and Electron Spin Resonance (ESR) spectroscopy.

Photochemistry:

- Students will learn about Lambert-Beer's law.
- Students will learn about Photochemical Processes.
- Students will learn about Rate of Photochemical processes.

Surface phenomenon:

- Surface tension and energy are discussed here.
- Students will learn about Adsorption.
- Students will learn about Colloids.

Physical Chemistry IV Lab: students will gather knowledge about the following practical

- Determination of surface tension of a liquid using Stalagmometer.
 - Determination of CMC from surface tension measurements.
 - Verification of Beer and Lambert's Law for KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ solution.
 - Study of kinetics of $\text{K}_2\text{S}_2\text{O}_8 + \text{KI}$ reaction, spectrophotometrically .
5. Determination of pH of unknown buffer, spectrophotometrically

CHEMHDS-01:

Crystal Structure, Statistical Thermodynamics, Special selected topics, Advanced Physical Chemistry Lab.

Outcomes:

Crystal Structure:

- Student will learn about Bravais Lattice and Laws of Crystallography.
- Students understand Crystal planes.
- Students can solve the crystal structure.

Statistical Thermodynamics:

- Students acquire knowledge of Configuration.
- Students can understand Boltzmann distribution.
- Students can understand Partition function.

Special selected topics:

- Students learn a clear concept of Specific heat of solid.
- Students learn a clear concept of 3rd law.
- Students learn a clear concept of adiabatic demagnetization.
- Students learn a clear concept Polymers.

Advanced Physical Chemistry Lab: Computer Programming based on numerical methods for the following are learn by the students.

- Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid).
- Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).
- Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values.
- Matrix operations (Application of Gauss-Siedel method in colourimetry).
- Simple exercises using molecular visualization software.

CHEMHDS-02:

Qualitative and quantitative aspects of analysis, Optical methods of analysis, Thermal methods of analysis, Electroanalytical methods, Separation techniques, Analytical Methods of Chemistry Lab.

Outcomes:

Qualitative and quantitative aspects of analysis:

- Students can understand what is meaning by Sampling.
- Students can evaluate analytical data.

Optical methods of analysis:

- Students can acquire knowledge about the origin of spectra.
- Students will learn the basic principles of instrumentation of UV-Visible Spectrometry.
- Students will learn the basic principles of instrumentation of Infrared Spectrometry.
- Students will learn the basic principles of instrumentation of Flame Atomic Absorption and Emission Spectrometry.
- Students will learn the basic principles of quantitative analysis.

Thermal methods of analysis:

- Theory of thermogravimetry (TG), basic principle of instrumentation is taught in this particular section.
- Students will learn the Techniques for quantitative estimation of Ca and Mg from their mixture.

Electroanalytical methods:

- Students will learn the basic principle of pH metric titrations.
- Students will learn the basic principle of potentiometric titrations.
- Students will learn the basic principle of conductometric titrations.

Separation techniques:

- Students will acquire knowledge of Solvent extraction technique.
- Students will learn qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.
- Students will understand the role of computers in instrumental methods of analysis. **Analytical Methods of Chemistry Lab:** Students will learn the following practicals in this particular course.
- Chromatography Separation techniques.
- Solvent Extractions techniques.
- Spectrophotometric analysis.

CHEMHDS-03:

Inorganic Materials of Industrial Importance

Outcomes:

- Students will learn about Silicate Industries.
- Students will learn the Manufacture of the nitrogen based fertilizers.
- Students will learn about Surface Coatings.
- Students will learn about Batteries.
- Students will learn about Alloys.
- Students will learn about Catalysis.
- Students will learn about

Chemical explosives. The following practical are also learn by the student.

- Determination of free acidity in ammonium sulphate fertilizer.
- Estimation of Calcium in Calcium ammonium nitrate fertilizer.
- Estimation of phosphoric acid in superphosphate fertilizer.
- Electroless metallic coatings on ceramic and plastic material.
- Determination of composition of dolomite (by complexometric titration).
- Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
- Analysis of Cement.
- Preparation of pigment (zinc oxide).

CHEMHDS-04:

Polymer Chemistry

Outcomes:

- Students will acquire knowledge about the introduction and history of polymeric materials.
- Students will acquire knowledge about the functionality and its importance of polymer.
- Students will acquire knowledge about the Kinetics of Polymerization.
- Students will acquire knowledge about the Crystallization and crystallinity.
- Students will acquire knowledge about the Nature and structure of polymers.
- Students will acquire knowledge about the Determination of molecular weight of polymers.
- Students will acquire knowledge about the Polymer Solution.
- Students will acquire knowledge about the Properties of Polymer.
- Students will learn about the synthesis of polymer.
- Students will learn about the Polymer characterization.
- Students can understand how to analyse polymer.

CHEMHSE-01:

Pharmaceuticals Chemistry

Outcomes:

- Students will learn about drug discovery.
- Students will learn about design and development of drug.
- Students will learn about Basic retrosynthetic approach of drug.
- Student will learn about Fermentation.
- Student will learn how to prepare Aspirin.
- Student will learn how to prepare magnesium bisilicate (Antacid).

CHEMHSE-02:

Basic Analytical Chemistry

Outcomes:

- Students can analyse soil.
- Students can analyse water.
- Students can analyse food products.
- Students can analyse cosmetics.

