

Department of Chemistry

Programme Outcome

The students with the B.Sc (Honours) Chemistry degree should be able to understand and apply the following skills.

(i) Students will get a proper understanding of the basic theoretical concepts in Physical chemistry, Organic Chemistry, Inorganic Chemistry, Analytical Chemistry and all other related allied chemistry subjects.

(ii) Students will be able to understand the basic principle of equipments, instruments used in the chemistry laboratory.

(iii) The students will be able to understand the characterization and proper handling of chemicals.

(iv) The Students will be able to demonstrate the experimental techniques and methods for chemical analysis, synthesis and important data collection and their interpretation.

(v) The student will be capable of using of advanced instruments and related softwares for solving the chemical problems in fast, modern and better ways.

(vi) The course is also helpful for the students to develop critical thinking ability by way of solving problems/numerical using basic chemistry knowledge and concepts.

(vii) It is expected that the course curriculum will develop an inquisitive characteristics among the students through appropriate questions-answers, planning, analysing a chemical problem and reporting experimental investigation.

(viii) The course curriculum has been designed to provide a unique opportunity to act as team player by contributing in the laboratory.

(ix) The course curriculum has given an ample amount of scope to the students to develop computer knowledge in developing and carrying out data analysis, use of library search tools, and use of chemical simulation software and related computational work.

(x) The course curriculum is designed to develop a habit of learning continuously through use of advanced ICT technique and other available techniques/books/journals for personal academic growth as well as for increasing employability opportunity.

Course outcome

Semester 1

CEMA-CC-1-1-TH :

INORGANIC CHEMISTRY-1

Extra nuclear Structure of atom

It gives the idea about Schrödinger's wave equation, Pauli's Exclusion Principle, Hund's rules, Aufbau principle and leads to the extra-nuclear structure of atom.

Acid-Base reactions

It deals with elementary idea of acid-base chemistry leads to Arrhenius theory, Bronsted-Lowry theory, and Lewis theory.

Redox Reactions

It gives the idea about whether the reaction is oxidized or reduced and what factors influence on it.

ORGANIC CHEMISTRY-1A

Basics of Organic Chemistry

Bonding and Physical Properties

It gives the basic idea of structure, properties and reactivity of organic molecules and their relationship and an overview about Molecular Orbital Theory (MOT).

General Treatment of Reaction Mechanism I

It informs the students about the different reaction mechanism in organic chemistry.

CEMA-CC-1-1-P

INORGANIC CHEMISTRY: I (1)

Acid and Base Titrations: (DEMO ONLY) & Oxidation-Reduction Titrations:

It helps the students to develop the skill of basic manual of quantitative analyses of inorganic mixtures.

ORGANIC CHEMISTRY: O (1A) LAB

Separation of solid mixture

It helps to develop the hand-on skill to determine the nature of the organic compounds on the basis of solubility.

CEMA-CC-1-2-TH :

PHYSICAL CHEMISTRY-1

Kinetic Theory and Gaseous state

It gives the idea of ideal gas, its velocity and energy distribution, collision theory, real gas and the reason of deviation from ideal behavior.

Transport processes

This chapter helps to understand the different diffusion processes, viscosity of gases and liquid and its variation with temperature.

Chemical Kinetics

It introduces the idea of reaction rate, order, different types of reaction, temperature dependence of reaction rate, effect of catalyst.

ORGANIC CHEMISTRY-IB

Stereochemistry I

It gives the basic idea of spatial arrangements of the molecules, isomerism and the technique of resolution and racemisation.

General Treatment of Reaction Mechanism II

It gives elementary idea about reactive intermediates involving various reaction mechanisms.

CEMA-CC-1-2-P:

PHYSICAL CHEMISTRY: P (1) LAB

The practical classes help the students to understand about basics of handling of beaker, conical flask, burette, pipette and study the kinetics of H_2O_2 and ester, measure the viscosity and determine the solubility of sparingly soluble salt.

ORGANIC CHEMISTRY: O (1B) LAB

Determination of boiling point of liquid

It helps to develop laboratory training to use melting point and boiling apparatuses.

Semester 2

CEMA-CC-2-3-TH :

ORGANIC CHEMISTRY-2

Stereochemistry II

It provides an advanced idea on axial chirality, topicity, etc. and the conformational analysis of organic molecules.

General Treatment of Reaction Mechanism III

Idea of reaction thermodynamics, reactivity vs selectivity, acid-base equilibria and tautomerism. Basic concept of reaction kinetics includes kinetic isotope effect and KCP vs TCP.

Substitution and Elimination Reactions:

Detailed reflexion on nucleophilic substitution (SN1, SN2) along with NGP and SNⁱ and Stereochemical and regiochemical outcome of elimination (E1, E2, E1CB) reactions.

CEMA-CC-2-3-P:

Organic Preparations

The basic skill of organic synthesis through the preparation methodology.

CEMA-CC-2-4-TH :

INORGANIC CHEMISTRY-2

Chemical Bonding-I

The chapter educates the students about the nature of different bondings of atoms in a molecule such as ionic bond, covalent; hybridization, valence bond theory, VSEPR, dipole moment.

Chemical Bonding-II

This chapter gives the idea about molecular orbital theory, bond order, bond length, magnetic property, structure and reactivity of the molecules and discusses about the metallic bond and weak chemical forces such as hydrogen bond.

Radioactivity

It informs the students about nuclear structure of atoms, Nuclear forces Nuclear models, nuclear reactions, natural and artificial radioactivity, transmutation of elements, fission, fusion and spallation and their applications.

CEMA-CC-2-4-P:

The students learn about iodo/iodimetric titration and to estimate metal content in some selective alloys

Semester 3**CEMA-CC-3-5-TH :****PHYSICAL CHEMISTRY-2****Chemical Thermodynamics I**

It deals with first law of thermodynamics, concept of work, heat, internal energy, enthalpy, state and path function, isothermal and adiabatic processes, laws of thermochemistry and its applications.

Chemical Thermodynamics II

It gives the knowledge of second law of thermodynamics, Carnot engine, entropy, free energy, Maxwell's relations and Joule-Thompson experiment, partial molar quantities, chemical potential and fugacity.

Applications of Thermodynamics – I

It gives the information about various conditions of thermodynamic equilibrium, variation of rate constant with temperature and pressure.

Electrochemistry

It gives the knowledge of ion conductance, transport number, various factors influencing the conductance, ionic equilibrium of electrolytes, buffer solution and also gives the concept of construction and reaction of electrochemical cell and EMF.

CEMA-CC-3-5-P:

The students learns to use the conductometer, potentiometer etc and determine the strength of acids, base, Mohr's salt, rate constant of saponification and solubility of AgCl and heat of neutralization of a strong acid by a strong base.

CEMA-CC-3-6-TH :

INORGANIC CHEMISTRY-3

Chemical periodicity

The students get the knowledge of modern IUPAC Periodic table, effective nuclear charge, lanthanide contraction, ionization potential, electron affinity and electronegativity, group trends and periodic trends.

Chemistry of s and p Block Elements

It explains about the different trends of properties of s and p block Elements and their different compounds.

Noble Gases:

It discusses about the chemistry of noble gases and their compounds, application of VBT, MOT and VSEPR theory in explaining structure and bonding.

Inorganic Polymers

It gives a preliminary idea about the different types of inorganic polymers and comparison with organic polymers.

Coordination Chemistry-I

It informs the students about coordinate bonding, double and complex salts, Werner's theory, ligands, chelates, isomerism.

CEMA-CC-3-6-P:

The students learn to estimate 1. Zn(II), 2. Zn(II) in a Zn(II) and Cu(II) mixture, 3. Ca(II) and Mg(II) in a mixture, 4. hardness of water, 5. Al(III) in Fe(III) and Al(III) in a mixture using complexometric titration

CEMA-CC-3-7-TH :

ORGANIC CHEMISTRY-3

Chemistry of alkenes and alkynes

Detailed idea about electrophilic addition of organic molecules with stereochemistry.

Aromatic Substitution

Preparation of different aromatic compounds using the idea of substitution reaction.

Carbonyl and Related Compounds

Detailed idea about nucleophilic addition and 1,2- addition vs 1,4 -addition by using of organometallics compounds.

CEMA-CC-3-7-P:

The students learn the application of organic reaction and some tricks for qualitative and quantitative analysis of some organic compounds used in daily life.

Semester 4

CEMA-CC-4-8-TH :

ORGANIC CHEMISTRY-4

Nitrogen compounds

Detailed idea about preparations and applications of nitrogenous organic compounds.

Rearrangements

Rearrangements of organic compounds in presence different reagents.

The Logic of Organic Synthesis

Synthesis of organic compounds used in daily life with the knowledge of organic reactions and mechanism.

Organic Spectroscopy

Idea about analysis of different organic compounds using different spectroscopic methods.

CEMA-CC-4-8-P:

Qualitative Analysis of Single Solid Organic Compounds

Detection of functional groups and preparation of derivatives using the knowledge of organic reaction.

CEMA-CC-4-9-TH :

PHYSICAL CHEMISTRY 3

Application of Thermodynamics – II

Colligative properties

The students learn about ideal solution, colligative property, Raoult's law and Henry's law and their applications.

Phase Equilibrium:

The students come to know about phase, component and degrees of freedom; Phase rule and its derivations, phase diagram for water, CO₂, sulphur. It also gives knowledge of Duhem-Margules Equation, Konowaloff's rule; positive and negative deviations from ideal behavior,

azeotropic solution and eutectic mixture.

Foundation of Quantum Mechanics

This chapter introduces the students to the basics of quantum mechanics, black body radiation, wave particle duality theory, Heisenberg's Uncertainty principle, Schrodinger time-independent equation and well behaved functions, concept of operators and setting up of Schrodinger equation for one-dimensional box and its solution.

Crystal Structure

It gives the idea of structure and properties of different types of crystals, Bragg's law, coefficient of thermal expansion and Dulong –Petit's law.

CEMA-CC-4-9-P :

This unit enables the students to learn the use of pH-meter, polarimeter and study the inversion of cane sugar, phase diagram of phenol – water system, partition coefficient and pH-metric titration.

CEMA-CC-4-10-TH

INORGANIC CHEMISTRY-4

Coordination Chemistry-II

It informs the students about VBT description, Crystal Field Theory and MO concept and origins of magnetism and colour in coordinated compounds.

Chemistry of d- and f- block elements

It helps the students to understand the electronic configuration and different properties of d- and f- block elements and their compounds and introduces about the reaction mechanisms of coordination compounds.

CEMA-CC-4-10-P:

It teaches the students to prepare different coordination compounds and to measure $10Dq$ and to determine λ_{max} of $[Mn(acac)_3]$ and $[Fe(acac)_3]$ complexes by spectrophotometric method.

Semester 5

CEMA-CC-5-11-TH :

PHYSICAL CHEMISTRY - 4

Quantum Chemistry II

It helps the students to understand quantitative treatment of simple harmonic oscillator, construction of Schrodinger equation of in spherical polar coordinate of hydrogen and hydrogen like ions and Born-Oppenheimer approximation.

Statistical Thermodynamics

It helps the students to conceptualize the idea of statistical thermodynamics, macrostates, microstates, thermodynamic probability, Boltzmann distribution, partition function, third law of thermodynamics and adiabatic demagnetization.

Numerical Analysis

In this the students learn about different numerical methods for finding the roots of equations.

CEMA-CC-5-11-P :

In this unit the students are taught to use computer programming for finding root of equation, numerical differentiation and numerical integration.

CEMA-CC-5-12-TH :

ORGANIC CHEMISTRY - 5

Carbocycles and Heterocycles

It provides knowledge about the detection and transformation of carbohydrates and their uses.

Cyclic Stereochemistry

Idea about the preparation and different reactions of heterocyclic compounds.

Pericyclic reactions

General idea about pericyclic reactions, stereochemistry of cyclic organic compounds and their reactions.

Biomolecules

Basic idea about preparations and applications of bio-molecules.

CEMA-CC-5-12-P:

A. Chromatographic Separations

Qualitative and quantitative separations and purifications of organic compounds using the knowledge of different extent of affinity of various organic compounds with a particular

solvent.

B. Spectroscopic Analysis of Organic Compounds

Qualitative analysis of organic compounds using IR and NMR spectroscopy.

Semester 6

CEMA-CC-6-13-TH:

INORGANIC CHEMISTRY-5

Theoretical Principles in Qualitative Analysis

It helps the students to understand the theory of qualitative analysis of various inorganic salts.

Bioinorganic Chemistry

It tells the metal ions in biological system, its toxicity; hemoglobin, myoglobin, hemocyanine and hemerythrin etc.

Organometallic Chemistry

It gives the idea of organometallic compounds and its color, magnetic property, spectra and reactions.

Catalysis by Organometallic Compounds

It gives the knowledge of different reactions catalyzed by organometallic compounds.

CEMA-CC-6-13-P:

Here the students learn to qualitatively estimate different inorganic radicals in mixture of salts.

CEMA-CC-6-14-TH:

PHYSICAL CHEMISTRY-5

Molecular Spectroscopy

It enables the students to study the theory and applications of rotation, vibrational, electronic and Raman spectroscopy.

Photochemistry and Theory of reaction rate

It helps to understand laws of photochemistry, quantum yield, efficiency, low and high quantum efficiency, kinetics of photochemical reactions, energy transfer in photochemical reactions (photosensitization and quenching), fluorescence, phosphorescence, chemiluminescence, discussion of electronic spectra and photochemistry.

Surface tension and energy

This chapter deals with surface tension, surface energy, work of cohesion and adhesion, angle of contact, capillary rise and temperature dependence of surface tension.

Adsorption

It gives the idea about Physical and chemical adsorption, Freundlich and Langmuir adsorption isotherms; BET isotherm and Gibbs adsorption.

Colloids

It gives the knowledge about Lyophobic and lyophilic sols, origin of charge and stability of colloids, Schultz-Hardy rule, Zeta potential, Tyndall effect and Micelle formation.

Dipole moment and polarizability

This chapter deals with polarizability of atoms and molecules, molar polarisation for polar and non-polar molecules; Clausius-Mosotti equation and Debye equation.

CEMA-CC-6-14-P

The classes enables the students to learn how to use stalagmometer, spectrophotometer and determine surface tension, indicator constant, pH of an unknown buffer, verification of Beer and Lambert's Law, study of kinetics of $K_2S_2O_8 + KI$ reaction etc.

Discipline Specific Courses (DSE)

DSE-A

DSE A-1: MOLECULAR MODELLING AND DRUG (Semester 5)

Introduction to Molecular Modelling:

It introduces the students about molecular modeling.

Force Fields:

It provides the idea of force field Models for the Simulation of Liquid Water.

Energy Minimization and Computer Simulation:

It introduces the students about computer simulation.

Molecular Dynamics & Monte Carlo Simulation

The students learn about Molecular Dynamics Simulation Methods, Metropolis method and Monte Carlo simulation of molecules.

Structure Prediction and Drug Design:

It gives an introduction to comparative Modeling, sequence alignment, constructing and evaluating a comparative model.

PRACTICAL - DSE A-1: MOLECULAR MODELLING & DRUG DESIGN

The students learn the basics of computer simulation of molecular modeling and drug design in lab.

DSE-A-2: APPLICATIONS OF COMPUTERS IN CHEMISTRY (Semester 5)

Computer Programming Basics (FORTRAN):

It gives the basic knowledge of Fortran programming.

Introduction to Spreadsheet Software (MS Excel):

The students are introduced to Microsoft Excel.

Statistical Analysis:

It gives the details of Gaussian Distribution and Errors in Measurement and their effect on data sets and descriptive Statistics using Excel, Statistical Significance Testing, the T test and the F test.

PRACTICALS DSE-A-2: APPLICATIONS OF COMPUTERS IN CHEMISTRY

It helps the students to apply different computer programs in chemistry experiments.

DSE-A-3: GREEN CHEMISTRY AND CHEMISTRY OF NATURAL PRODUCTS (Semester 6)

(i) Basic idea about sustainable development.

(ii) Use of indigenous material to synthesize organic compounds in a viable, sustainable or green pathway without using any hazardous chemicals or solvents.

(iii) An overview on alkaloid and terpene compounds used in daily life.

PRACTICALS-DSE-A-3: GREEN CHEMISTRY

Practical uses of different types of reaction to synthesize different organic compounds used in daily life

DSE-A4: ANALYTICAL METHODS IN CHEMISTRY (Semester 6)

Optical methods of analysis:

The students learn about different optical methods of analysis such as UV-Vis, Infrared spectroscopy, Flame Atomic Absorption and Emission Spectrometry

Thermal methods of analysis:

It gives the information about the theory and instrumentation of thermogravimetry.

Electroanalytical methods:

It provides the information of electroanalytical methods of analysis such as pH-metry, conductometry, potentiometry.

Separation techniques:

This chapter deals with different separation techniques such as solvent extraction, chromatography etc.

PRACTICALS-DSE-A-4: ANALYTICAL METHODS IN CHEMISTRY

In the practical classes the students learn how to apply different analytical techniques in chemistry.

DSE-B

DSE-B-1: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE (Semester 5)

To study classification, composition and properties of glasses, ceramics, cements, fertilizers, Surface Coatings, Batteries, Alloys, Catalysis, Chemical explosives and also studies manufacture and processing of them.

PRACTICALS- DSE B-1: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

- (i) Student can be able to develop the skill by the experimental observation
- (ii) Estimation of element/group in a fertilizer
- (iii) Electrolysis metallic coatings on ceramic and plastic material
- (iv) Determination of composition of ore and analysis of alloy or synthetic samples and cement
- (v) Preparation of pigment.

DSE B-2: NOVEL INORGANIC SOLIDS (Semester 5)

- (i) It gives the information about solid electrolytes, inorganic pigments, molecular material and fullerenes.
- (ii) Elementary idea on nanomaterials: overview of nanostructures and classification. Preparation of metallic nanoparticles, carbon nanotubes and inorganic nanowires.
- (iii) Learn to composition, mechanical and fabricating characteristics and applications of various types of composite materials, cast irons, plain carbon and metals & their alloys.
- (iv) To study introduction, classification, properties, raw materials, manufacturing and applications: Conducting polymers, Ceramic & Refractory

PRACTICAL – DSEB-2: NOVEL INORGANIC SOLIDS

- (i) Synthesis of hydrogel, silver and gold metal nanoparticle.

(ii) Determination of TDS and cation exchange method

DSE-B-3: POLYMER CHEMISTRY (Semester 6)

- (i) Summarizes historical evolution of polymers.
- (ii) Evaluate the structure of polymers and interprets stereochemistry of polymers.
- (iii) Categorizes polymerization reactions with respect to mechanisms and distinguishes differences of these reactions.
- (iv) Explain polymer production processes

PRACTICALS – DSE- B-3: POLYMER CHEMISTRY

It helps to develop the hand-on skill to synthesis polymers and to determine their different characters.

DSE B-4: Dissertation (Semester 6)

A student has to carry out research /review on a topic as assigned by the teachers.

SKILL ENHANCEMENT COURSES

SEC-A (SEMESTER 3)

SEC 1 – Mathematics and Statistics for Chemists

- (i) It gives the basic idea of functions, limits, derivative, physical significance, basic rules of differentiation, error function, Gamma function, exact and inexact differential, Taylor and McLaurin series, Fourier series and Fourier Transform, Laplace transform, partial differentiation, rules of integration, definite and indefinite integrals.
- (ii) The students learn about Separation of variables, homogeneous, exact, linear equations, equations of second order, series solution method.
- (iii) This chapter enables the students to know about permutations, combinations and theory of probability.
- (iv) It introduces the students about vectors, dot, cross and triple products, introduction to matrix algebra, addition and multiplication of matrices, inverse, adjoint and transpose of matrices, unit and diagonal matrices.
- (v) This chapter deals with sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.
- (vi) It helps the students to learn descriptive statistics. choosing and using statistical tests, chemometrics, Analysis of variance, correlation and regression, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, general polynomial fitting,

linearizing transformations, exponential function fit.

SEC 2 – ANALYTICAL CLINICAL BIOCHEMISTRY:

- (i) Basic idea about different biochemical components, their metabolism, isolation and characterization.
- (ii) An overview about the components of blood and urine.
- (iii) Different diseases related to blood and urine.

SEC-B (SEMESTER 4)

SEC 3 – PHARMACEUTICALS CHEMISTRY:

- (i) History of drugs and their discovery.
- (ii) Basic idea about different types of drugs and their uses in different diseases with special importance on antibiotics.
- (iii) Synthesis of some common drugs and their therapeutic effects.

SEC-4 PESTICIDE CHEMISTRY:

- (i) Basic idea about pesticides and their classification.
- (ii) Synthesis of some common pesticides, their uses, doses and effects on human.