COURSE & PROGRAM OUTCOMES
OF
CHEMISTRY HONOURS (B.SC.)
UNDER CBCS

The CBCS Course curriculum of the discipline of Chemistry is well designed and very promising. The core course would help to improve the subject knowledge of the students and increase their confidence level in the field of both academia and industry. Generic electives make amalgamation among various interdisciplinary courses to fulfil the vision and mission of designing the course. The introduction of Skill Enhancement Courses (SEC) would help to gain more powerful knowledge not only in their core Chemistry subject but also in interconnected multidisciplinary subjects both theoretically and practically. The insertion of Discipline Specific Courses (DSE) has brought an opportunity in front of students to grow knowledge on various useful materials which are naturally and industrially important and also helps them to familiar and expert in handling different chemistry based software after proper training. In brief the student graduated with this type of curriculum would be able to disseminate subject knowledge along with necessary skills to be adequate their capabilities for academia, entrepreneurship and industry.

After careful analysis of the course, the department of Chemistry has pointed out the following outcomes of the course.

Course Outcomes

Semester	Course Code	Course Outcomes
SEM-I	**Course Code: CC-01 Course Title: Organic Chemistry-I (Theo)**	**CO-1:** Mechanistic approach of different organic reactions and reaction Intermediates. **CO-2:** Understanding of the Stereochemistry of organic molecules **CO-3:** Students will have knowledge about bonding and physical properties as well as Valence Bond Theory and MO Theory.

	Course Code: CC-02 Course Title: Physical Chemistry-I	**CO-1:** To understand the basic concept of kinetic theory of gases and know how to solve numerical problems related to that topic. **CO-2:** To learn the variation of speed of the gas molecules and theoretical treatment of this by Maxwell distribution formula, to determine various physical parameters such as pressure, kinetic energy, root mean square velocity, kinetic energy distribution etc. **CO-3:** To understand the theoretical basis of Equipartition principle and its limitation. **CO-4:** Students will get knowledge about the deviation of real gas from ideal behaviour, formulation of different equation of states(Vander Waals equation, Dieterici equation, Barthelot equation) to explain the behaviour of real gases under different condition and also their limitations. **CO-5:** To learn in detail about the various Thermodynamic terms and thermodynamic functions and parameters, laws of thermodynamics, and the related terms; to get idea about thermo-chemistry and thermodynamic relationships and system of variable compositions. **CO-7:** To understand the application of thermodynamic principles for a system performing mechanical work and determination of change in internal energy, enthalpy, entropy, Gibbs free energy and Helmholtz free energy etc. CO-8:Get practical experience on determination of enthalpy of various physical and chemical process. CO-9: To understand rate laws, rate equations of different types of reactions, determine rate constant values, order of reactions, effect of temperature and other factors on reaction rate, homogenous catalysis, catalytic effect on reaction rate, equations related to chemical catalysis.
	CC-1 Organic chemistry(Prac.)	**CO-1:** To understand experimentally how to determine the boiling points of organic liquid compounds. CO-2: To learn the separation based on solubility. CO-3:Identification of a pure organic compound by chemical tesr(s).
	CC-2 Physical chemistry(Prac.)	CO-1: pH of unknown solution (buffer), by color matching method CO-2:the reaction rate constant of hydrolysis of ethylacetate in the presence of an equal quantity of sodium hydroxide CO-3:Study of kinetics of acid-catalyzed hydrolysis of methyl acetate CO-4:Study of kinetics of decomposition of H_2O_2 by KI CO-5:Determination of solubility product of PbI_2 by titremetric method
SEM-2	**Course Code: CC-03**	CO-1: Give an elementary idea of acids and bases and various theories of acid bases.

	Course Title: Inorganic Chemistry-I	CO-2: Gather an in-depth knowledge about atomic structure. CO-3: To study in detail about modern periodic table, physical and chemical properties of the elements along a group or period, factors influences those properties, relativistic effects and inert pair effect. CO-4: Understand the concepts of a redox reaction. CO-5: Explain various phenomenon of redox reactions using Nernst Equation.
	Course Code: CC-04 Course Title: Organic Chemistry-II	**CO-1:** To understand stereochemistry of chiral compounds arises due to presence of stereo-axis; concept of prostereoisomerism and concept of conformations of stereo isomers. **CO-2:** To learn reaction kinetics, reaction thermodynamics and tautomerism of organic compounds. **CO-3:** To know the concept, types, reaction mechanism and examples of elimination, free-radical and nucleohilic substitution reactions. CO-4:Understand Basic concept oforganic acids and bases.
	Course Code: CC-03 Course Title: Inorganic Chemistry-I (Prac)	CO-1:From this course students will able to estimate: ➢ Fe(II) using standardized KMnO4 solution oxalic acid and sodium oxalate in a given mixture ➢ Fe(II) and Fe(III) in a given mixture using $K_2Cr_2O_7$ solution ➢ Fe(III) and Mn(II) in a mixture using standardized $KMnO_4$ solution ➢ Fe(III) and Cu(II) in a mixture using $K_2Cr_2O_7$ ➢ Fe(III) and Cr(III) in a mixture using $K_2Cr_2O_7$
	Course Code: CC-04 Course Title: Organic Chemistry-II (Prac)	CO-1: To learn experimentally how to synthesize of some organic compounds in the laboratory and calculate the yield.
SEM-3	**Course Code: CC-05 Course Title: Physical Chemistry-II**	CO-1: To learn in detail about Fick's Law, Conductance and Transport number, Viscosity, Principles of Hittorf's and Moving-boundary method Wien effect, Debye-Falkenhagen effect, Walden's rule. CO-2: To gain vast knowledge on Partial Properties, Chemical Potential, Chemical Equilibrium -to derive reaction, isotherm; equilibrium constants based on different standard states; dependence of equilibrium constants on temperature and pressure, derivation of van't Hoff reaction isotherm and reaction isochore, effect of various parameters governing the equilibrium position of a chemical reaction, Le Chatelier principle and its thermodynamic derivation. CO-3:To study in detail about Distribution Law and Chemical Potential of pure and mixtures of ideal substances. Distribution Law and Chemical Potential of pure and mixtures of ideal substances.

		CO-4: Preliminary idea and foundations of Quantum Mechanics.
	Course Code: CC-06 Course Title: Inorganic Chemistry-II (Theo)	CO-1: To learn about the basic concepts and types of chemical bonding, VSEPR theory, Bent's rules, hybridization and dipole moment of molecules. CO-2. Concepts of weak bonds like Hydrogen Bond, van der Waals bond etc. CO-3. Understanding the concepts of Molecular Orbital Theory. CO-4. Metallic bonding and concepts of semi-conductors. CO-5:To understand about the concept of radioactivity and radioactive compounds, nuclear reactions, artificial radioactivity, radio carbon dating, hazards of radiation and safety measures. CO-6:The students will gained knowledge About the versatile applications of radiochemistry in different fields like in determination of age of an ancient species, reaction mechanism through isotope labeling, in medicinal chemistry etc.
	Course Code: CC-07 Course Title: Organic Chemistry-III (Theo)	**CO-1:**To study the properties and reactions of carbonyl compounds and corresponding reaction mechanisms. **CO-2:**To learn preparations, reactions and corresponding reaction mechanisms of organometallic compounds. **CO-3:** To understand about different types of electrophilic and nucleophilic aromatic substitution reactions, reaction intermediates and their mechanisms. CO-4: To learn in detail about the addition to C=C/ C≡C mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity .
	Course Code: SEC-1 Course Title: Basic Analytical Chemistry	**CO1:** Learn about analytical chemistry, sampling, accuracy and precision, sources of errors in analytical measurements. **CO2:** Understand about the analysis of soil, cosmetics, water and food products. **CO3:** Get a basic idea about chromatography and ion-exchange phenomenon.
	Course Code: CC-05 Course Title: Physical Chemistry-II (Prac)	CO-1:Students will learn to measure the viscosity of unknown solution / liquid. CO-2: Students will learn how to determine: the partition coefficient for the distribution of I_2 between water and CCl_4, K_{eq} for $KI+I_2 = KI_3$ using partition coefficient between water and CCl4. CO-3: To learn experimentally how to do the and conductometric titration of an acid (strong, weak/ monobasic, dibasic) against strong base and also

		Study the saponification reaction conductometrically. CO-4: Students will learn to Verify the Ostwald's dilution law and determination of K_a of weak acid.
	Course Code: CC-06 **Course Title: Inorganic Chemistry-II (Prac)**	CO-1: Students should be able to estimate: Cu(II),VitaminC, arsenite by iodimetric method. CO-2: Students can also learn how to estimate Cu in brass, Cr and Mn in steel.
	Course Code: CC-07 **Course Title: Organic Chemistry-III (Prac)**	CO-1: Students will learn to systematic qualitative analysis of organic compounds for the detection of elements with two functional groups, determination of melting point of the compound, identification of the compound and preparation of derivative and determination of its melting point.
SEM-4	**Course Code: CC-08** **Course Title: Physical Chemistry-III (Theo)**	**CO-1:** Helps to understand about the applications of Thermodynamics in Colligative Properties and Phase Equilibrium. **CO-2:** To gain vast knowledge on electrochemistry and also get an idea about activity and activity coefficient of various ionic species present in the solution; variation of activity coefficient with ionic strength. CO-3:To give an elementary idea about Debye- Huckel limiting law and its application and limitation. CO-4:To learn about various electrode processes; different types of electrodes; derivation of Nernst equation using laws of Thermodynamics; derivation of expression of EMF of an electrode and EMF of a cell using Nernst equation about the betterment of the materials. CO-5:To gain knowledge Concentration cells with and without transference, liquid junction potential. CO-6:To understand the application of potentiometric titration as analytical techniques and solving numerical problems related to this topic. **CO-7:** To study the fundamentals of Quantum Mechanics.
	Course Code: CC-09 **Course Title: Inorganic Chemistry-III (Theo)**	CO-1: To study the chemistry of s and p block elements including noble gases and their compounds in detail. CO-2:To learn about ➢ Chief modes of occurrence of metals based on standard electrode potentials. ➢ Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. ➢ Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining. **CO-3:** To learn about inorganic polymers in detail.

		CO-4: To know the meaning of various terms involved in co-ordination chemistry, Werner's theory for complex formation, IUPAC nomenclature of coordination Complexes, structural and stereoisomerism of coordination complexes.
	Course Code: CC-10 Course Title: Organic Chemistry-IV (Theo)	**CO-1:** To understand in detail about the synthesis, separation, properties, identification, chemical reactions and their corresponding mechanism of nitrogen containing compounds. CO-2: To gain vast knowledge about different kinds of rearrangement reactions. CO-3:To learn in details about UV-Visible, IR and NMR spectroscopy and applications of IR, UV and NMR spectroscopy for identification of simple organic molecules. **CO-4:** Helps to know the logic of organic synthesis
	Course Code: SEC-2 Course Title: Pharmaceuticals Chemistry	**CO-1:** Helps to understand about the drug discovery, design and development of representative drugs of the following classes: Antipyretic, Analgesics, Antiinflammatory, Anti-bacterial, Antifungal, Antiviral, Antibiotics, Anti-laprosy, Central Nervous System agents, HIV-AIDS related drugs. **CO-2:** To know about aerobic and anaerobic fermentation, importance of Vitamins and Amino acids, synthesis of Penicillin, Cephalosporin, Chloromycetin, Streptomycin and their role as an antibiotic.
	Course Code: CC-08 Course Title: Physical Chemistry-III (Prac)	**CO-1:**To know experimentally how to study phase diagram of a Phenol-Water system, Determine the solubility of sparingly soluble salt in water, in electrolyte with common ions and in neutral electrolyte (using common indicator), Perform the Potentiometric titration of Mohr's salt solution against standard $K_2Cr_2O_7$ solution, Determine the Ksp for AgCl by potentiometric titration of AgNO3 solution against standard KCl solution, Study the Effect of ionic strength on the rate of Persulphate – Iodide reaction. kinetic study of inversion of cane sugar, determination of partition co-efficient
	Course Code: CC-09 Course Title: Inorganic Chemistry-III (Prac)	CO-1: To learn experimentally quantitative estimation Zn(II), Zn(II) in a Zn(II) and Cu(II) mixture, Ca(II) and Mg(II) in a mixture by Complexometric titration. CO-2:To Know experimentally determine the total hardness of water. CO-3:To learn about the preparation of following compounds [Cu(CH3CN)4]PF6/ClO4 Potassium dioxalatodiaquachromate(III) Tetraamminecarbonatocobalt (III) ion Potassium tris(oxalate)ferrate(III) Tris-(ethylenediamine) nickel(II) chloride. [Mn(acac)3] and Fe(acac)3]

	Course Code: CC-10 Course Title: Organic Chemistry-IV (Prac)	CO-1:To learn experimentally to estimate: ➢ glucose by titration using Fehling's solution ➢ vitamin-C (reduced) ➢ aromatic amine (aniline) by bromination (Bromate-Bromide) method ➢ phenol by bromination (Bromate-Bromide) method ➢ formaldehyde (Formalin) ➢ acetic acid in commercial vinegar ➢ urea (hypobromite method) ➢ saponification value of oil/fat/ester.
SEM-5	**Course Code: CC-11 Course Title: Inorganic Chemistry-IV (Theo)**	**CO-1:** To know details of Co-ordination chemistry in the light Of VBT, CFT, LFT. CO-2. Understanding of the colour and spectra of co-ordination Compounds and their magnetic properties. CO-3: To give an elementary idea about Racah parameter; Selection rules for electronic spectral transitions; spectrochemical series of ligands; charge transfer spectra. CO-4. Detailed study of d- and f- transition elements. CO-5. Detailed study of Lanthanides and Actinides.
	Course Code: CC-12 Course Title: Organic Chemistry-V (Theo)	CO-1. Detailed study of Carbocycles and Heterocyles. CO-2. Helps to understand about stereochemistry of cyclic compounds. CO-3. To learn in detail about Pericyclic reactions. CO-4. Thorough study of Carbohydrates. CO-5. To know details about amino acids, peptides and nucleic acids. CO-6: To get an idea on terpenoids and alkaloids and also determination of structure of α-Terpenol and ephedrine.
	Course Code: DSE-1 Course Title: Advanced Physical Chemistry (Theo)	CO-1. Helps to understand about the specific heat of solids, Einstein and Debye theory related to it. CO-2: To learn in detail about Laws of Crystallography;x-ray diffraction as a technique to explore the atomic/molecular-level structure of a crystalline solid, Bragg's law and crystal planes; Miller indices, Idea about Bravais lattices and detailed discussion about cubic crystal system. CO-2. Understanding the concepts of Statistical Thermodynamics. CO-3. Understanding of the 3rd Law of Thermodynamics. CO-4. Deeper insight of Quantum Mechanics.
	Course Code: DSE-2 Course Title: Analytical methods in chemistry (Theo)	CO-1:Help to understand about Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution, indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals. CO-2:Help to know about Origin of spectra, UV-Visible Spectrophotometry, Basic principles of quantitative analysis, Basic principles of quantitative analysis and Flame Atomic Absorption and Emission Spectroscopy. CO-3:To learn about Theory of thermogravimetry (TG),

		basic principle of instrumentation, Techniques for quantitative estimation of Ca and Mg from their mixture. **CO-4**:Help to know about Solvent extraction, Technique of extraction, Qualitative and quantitative aspects of solvent extraction, Chromatography,Developmentof chromatograms, Qualitative and quantitative aspects of chromatographic methods of analysis, Stereoisomeric separation and analysis and Role of computers in instrumental methods of analysis. **CO-5**: To gain vast knowledge about Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations and learn techniques used for the determination of equivalence points and techniques used for the determination of pKa values.
	Course Code: CC-11 Course Title: Inorganic Chemistry-IV (Prac)	**CO-1**: To learn the gravimetric estimation of nickel (II) using Dimethylglyoxime (DMG), copper as CuSCN, Al (III) by precipitating with oxine and weighing as Al(oxine)3 (aluminium oxinate) and chloride as AgCl. **CO-2:** To study experimentally the λ_{max} values of $KMnO_4$ and $K_2Cr_2O_7$. **CO-3:** To calculate the 10Dq value by spectrophotometric method. **CO-4**:To understand the principles involved in Chromatography , with experiments in Paper Chromatography Separation of Ni (II) and Co (II) and Fe (III) and Al (III)
	Course Code: CC-12 Course Title: Organic Chemistry-V (Prac)	**CO-1:** To learn experimentally how to separate molecules by chromatographic methods **CO-2:** To study how to analyze the Organic compounds by spectroscopic techniques.
	Course Code: DSE-1 Course Title: Advanced Physical Chemistry (Prac)	**CO-1**: To learn about Computer Programming based on numerical methods for Roots of equations, Numerical differentiation, Numerical integration and Matrix operations.
	Course Code: DSE-2 Course Title: Analytical methods in chemistry (Prac)	**CO-1**: to learn about Chromatographic Separation of mixtures, active ingredients of plants, flowers and juices use TLC and technique and identify them on the basis of their Rf values. **CO-2**: To learn about separation of mixtures by solvent extraction, analysis of soil and ion exchange methods. **CO-3**: to learn experimently how to determine pKa values of indicator using spectrophotometry, chemical oxygen demand, Biological oxygen demand.

SEM-6	**Course Code: CC-13** **Course Title: Inorganic Chemistry-V (Theo)**	**CO-1**: Developing the idea and concepts of Bio-inorganic chemistry including different aspects (structures and biological functions) of the biomolecules like the metalloproteins, metalloenzymes etc containing metal ions. **CO-2**:To understand about the different aspects like oxygen transport, electrontransport, hydrolysis of peptides in vertebrates and invertebrates. **CO-3:**Understanding of Organometallic chemistry from Inorganic Point of view. **CO-4**: To know about the catalytic role of organometallic compounds in different types of industrial processes. **CO-5**: Understanding inorganic reaction mechanism and kinetics.
	Course Code: CC-14 **Course Title: Physical Chemistry-IV (Theo)**	**CO-1**: Understanding of molecular spectroscopy using Born-Oppenheimer approximation. **CO-2**: Get elementary ideas about the fundamental laws governing the chemical reaction induced by light. **CO-3**:To know Know the representation of various photophysical processes by Jablonsky diagram. **CO-4**: To know details about surface energy and surface tension; Classification, Adsorption Isotherms and applications of Adsorption; Classification, rules and properties of Colloids.
	Course Code: DSE-3 **Course Title: Green Chemistry (Theo)**	**CO-1:** To learn about green chemistry and its necessity. **CO-2:** To study about the principles of green chemistry and designing the green synthetic routes. **CO-3:** To know about the examples of green reactions and future trends in green reaction. **CO-4:** To learn the synthesis, psychological properties, isolation medicinal importance and other synthetic use of terpenes and alkaloids **CO-5:** To learn how to perform green synthesis of a number of organic compounds in the laboratory.
	Course Code: DSE-4 **Course Title: Dissertation followed by power point presentation**	**ANALYTICAL METHODS IN CHEMISTRY** **CO-1:** To study the fundamental laws of spectroscopy and Selection rules, to know the basic principles of Instrumentation for UV-visible spectroscopy and Infra-red spectroscopy and their use for the determination of composition of inorganic complexes, estimation of metal ions in aqueous solution, quantitative analysis of geometrical isomers and keto-enol tautomerism. **CO-2:** To learn in detail about the Flame Atomic Absorption and Emission Spectrometry and its application. **CO-3:** To know the basic concepts of thermogravimetry and quantitative estimation of Ca and Mg from their mixture, to learn about the electroanalytical methods and their applications for the determination of equivalence point and pKa values. **CO-4:** To learn experimentally about different types of

		separation techniques such as Solvent extraction technique and Chromatography technique. **CO-5:** To learn the methods of separation of stereoisomers, calculation of enantiomeric and diastereomeric excess ratios and determination enantiomeric composition by spectral, chemical and chromatographic data analysis. **CO-6:** To study experimentally how to separate a mixture of monosaccharides, a mixture of dyes and active ingredients of plants, flowers and juices by chromatography method. **CO-7:** To learn experimentally how to separate a mixture of ions by solvent extraction technique; determination of pH of soil and estimation of Ca, Mg and phosphate ion in soil. **CO-8:** To determine the pKa values, COD and BOD by Spectrophotometry method in presence of a indicator. **POLYMER CHEMISTRY** **CO-1:**To learn about the history, classification and functionality of polymeric materials. **CO-2:** To know about the kinetics of polymerization, details on crystallization and morphology of crystalline polymers, determination of crystalline melting point of a crystalline material and the factors effecting crystalline melting point. **CO-3:**To understand the nature and structure of polymers, determination of molecular weight of polymers and thermodynamics of polymer solution. **CO-4:**To study the preparation, structure, properties and application of different types of addition and condensation polymers. **CO-5:** To know how to prepare polymers by using free radical polymerization, redox polymerization, interfacial polymerization, precipitation polymerization, addition polymerization and condensation polymerization process. **CO-6:** To learn experimentally how to characterize and analyze a polymeric compound or material. **DISSERTATION** **CO-1:** To know how to do research work and write a review article on a particular field/topic as assigned by the teacher. **CO-2:** To know how to handle the technical devices for presenting research works.
	Course Code: CC-13 **Course Title: Inorganic Chemistry-V (Prac)**	**CO-1:** To study experimentally the qualitative detection of known and unknown radicals and insoluble materials in a mixture.
	Course Code: CC-14 **Course Title: Physical Chemistry-IV (Prac)**	**CO-1:** To know how to determine surface tension of a liquid; Indicator constant of an acid base indicator; pH of an unknown buffer solution and CMC of a micelle experimentally. **CO-2:** To study the determine the pH of unknown buffer, spectrophotometrically and Verification of Beer and

		Lambert's Law for KMnO4 and K2Cr2O7 solution experimentally
	Course Code: DSE-3 Course Title: Green Chemistry (Prac)	**CO-1:** To learn about preparation of propene, Benzoin condensation and Photo reduction of benzophenone to benzopinacol in the presence of sunlight.

Programme Outcomes: B. Sc. Chemistry (Hons.)

After successful completion of three year degree program in Chemistry a student should be able to;

PO-1: Competent of demonstrating comprehensive knowledge and understanding both theoretical and practical knowledge in all disciplines of Chemistry.

PO-2: Solve the problem very methodically, independently and finally draw a logical conclusion.

PO-3:Capable of applying modern technologies, handling advanced instruments and Chemistry related soft-wares for chemical analysis, characterization of materials and in separation technology.

PO-4. Create an awareness of the impact of chemistry on the environment, society, and development outside the scientific community.

PO-5: To develop critical thinking and to design, carry out, record and analyze the results of chemical reactions.

PO-6: To develop inquisitive characteristics among the students through appropriate questions, planning and reporting experimental investigation.

PO-7: Become a skilled project manager by acquiring knowledge about chemistry project management, writing, planning, study of ethical standards and rules and regulations pertaining to scientific project operation.

PO-8: Follow the green routes for the synthesis of chemical compounds and also find out new greener routes for sustainable development.

PO-9: Understand the causes of environmental pollution and thereby applying environmental friendly policies instead of environmentally hazard ones in every aspect.

PO-10: The course curriculum is designed in such a way that Chemistry graduate students can handle many Chemistry based software, decent instruments and advanced technologies to synthesize, characterize and analyse the chemical compounds very competently. Such a

brilliant practice in the graduate level will bring a good opportunity to the students for getting job in industries besides academic and administrative works.

Programme Specific Outcomes

PSO-1. Gain the knowledge of Chemistry through theory and practical experiments.

PSO-2. To explain nomenclature, stereochemistry, structures, reactivity, and mechanism of the chemical reactions.

PSO-3. Classify chemical formulae and solve numerical problems.

PSO-4. To understand the basic principles of Organic, Inorganic, Physical and Analytical Chemistry and its applications through various laboratory experiments.

PSO-5. Use modern chemical tools, Models, Chem-draw, Charts and Equipments.

PSO-6. Understand good laboratory practices and safety.

PSO-7. Develop research oriented skills.

PSO-8. Aware and handle the sophisticated instruments/equipments.