

# Department of Chemistry

## Program Outcome: B.Sc. (Chemistry)

After successful completion of three year (six semester) B.Sc. (Chemistry) degree program students are able to:

- Get elementary knowledge of four basic branch of chemistry viz. Organic Chemistry, Inorganic Chemistry, Physical Chemistry, Analytical Chemistry.
- Application of chemistry in other branch of science and understand chemistry as central science.
- Understand role of chemistry for industrial growth and for the beneficiaries use to the society.
- To know how chemistry is use full for environmental protection by understanding the green synthesis.
- Get acquainted about conventional and instrumental practical methods for qualitative and quantitative analysis in chemistry.
- Developed problem-solving skills. Explore the issues in facing and understanding of safe handling of chemicals.
- Get awareness about literature of chemistry in form of various wellknown books from Indian and international authors.
- To know job opportunity after B.Sc. (chemistry) degree.

## Program Specific Outcome: B.Sc. (Chemistry)

- ✓ Get knowledge of nomenclature, reaction mechanism, reactivity of chemical compounds. Student learn about chemistry of carbohydrates, amino acids, heterocyclic compounds.
- ✓ Student learn the concept of quantum chemistry, chemical bonding, study of elements, molecular symmetry, co-ordination compounds etc.
- ✓ Able to understand concepts of thermodynamics, chemical kinetics, nuclear chemistry, polymers, catalysts, colloids, adsorptions. etc.
- ✓ Student get trained for the solution preparation and learn concept of mole, molarity, normality and understand the idea of various titrations.
- ✓ Students get aware about various spectroscopic and other instrumental methods.
- ✓ Student learn how chemistry is useful in the field of nanotechnology and soil analysis.

## **B.Sc. (Chemistry) Course outcome**

### **Semester-I**

#### **General Chemistry Paper 101**

- ✓ Understand the electron configuration, oxidation states, magnetic properties, colour, absorption spectra and contraction of Lanthanides and Actinides. Also, understand the methods of separation and purification of Lanthanides. Acquainted the knowledge of Nuclear synthesis of trans uranic elements and important of Uranium.
- ✓ Understand the Kjeldahl's method and Kjeldahl's method modified with boric acid for determination of Nitrogen. Know the determination of molecular weight by silver salt and chloroplatinate method.
- ✓ Learn the mechanism of Substitution Nucleophilic unimolecular and bimolecular reactions ( $SN_1$  and  $SN_2$ ). Understand the elementary concept of electrophilic aromatic substitution for nitrations, sulfonations, halogenation and Friedel-Crafts alkylation and acylation.
- ✓ Learn IUPAC nomenclature and preparations of alkanes, alkenes and alkynes. Their oxidation and reduction reactions. Get aware about Wurtz's reaction, Kolbe's electrolytic process and Chlorination of Methane.
- ✓ Understand the Zeroth law, first law, Second law of thermodynamics. Understanding of Carnot's Cycle as a proof of Second law. Knowledge of Entropy, of Gas and calculation of entropy for different processes.
- ✓ 6.Explore the basic principles of chemical kinetics, rate of reaction and molecularity. Explanation regarding derivation of rate constant, rate equation and determination of Half Life Time for 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> order reactions.

#### **Practical Paper 102**

- ✓ Ability for preparation and standardization of NaOH and HCl Solutions. Learning of Titration of Succinic and Oxalic acid against NaOH. Titrations of Sodium carbonate against HCl and determination of concentrations. Complete knowledge of Inorganic qualitative analysis of water soluble and insoluble salts for two radicals.

### **Semester II**

#### **General Chemistry Paper 103**

- ✓ Student learn theory of chemical bonding like Sidgwick Powel theory, VSEPR theory using example of  $H_2O$ ,  $ClF_3$ ,  $SF_4$ ,  $SF_6$ ,  $I_3$ . Student also understand rules and types of hybridization and shape of some molecules.
- ✓ Student get knowledge of Werner's theory for labile and inert complex, get clear understanding of stability of complex and factor influencing it. Also aware about V.B. theory for some complex of  $ML_4$  &  $ML_6$  type (Fe, Co, Ni, Mn).

- ✓ Acquire knowledge of wave mechanics: understand wave equation, wave functions and its interpretation, acceptance, limitations. Get idea about normalized, orthogonal wave functions. Understand the meaning of Eigen values and Eigen functions.
- ✓ Student obtain knowledge of operators and specifically study Hamiltonian operator for Hydrogen atom, molecule, ions and also for atom of He, Li and B.
- ✓ Get explanations about fundamentals of stereochemistry, chirality, optical isomerism, optical stereoisomers including enantiomers and diastereomers, racemic mixture, and meso compounds. Understand, identify and configure the stereocenters in a molecule and learn R-S and E-Z nomenclature. Learn about conformational analysis of Ethane, n-Butane & Cyclohexane.
- ✓ Students will gain an understanding basic term about electrical conduction. Get understanding of Oswald's dilution law. Student will able to get knowledge about pH scale and relation between various constant of acid and base. Get understanding of Henderson – Hasselbalch equation for buffer solutions. Accustomed with Theory of ionic equilibrium, Indicator and useful pH range of acid-base indicator.
- ✓ Student get idea about radioactivity, disintegration theory, Soddy's group displacement law. Get learning out come about stability of Nucleus by understanding concept of Mass defect, Binding energy and N/P ration.

#### **Practical Paper 104**

- ✓ Students able to perform qualitative analysis (Organic spotting) of organic compounds with mono functional groups in solid as well as liquid states. Get practical knowledge of redox titration and EDTA titrations.

### **Semester III**

#### **Organic Chemistry Paper 201**

- ✓ Student learn about classification, formation of carbohydrates, reactions of monosaccharides. Get knowledge about structures of glucose and fructose. Also, able to understand Fischer's proof of configuration of D-glucose.
- ✓ Student will understand classification and properties of amino acid. Able to get idea about Zwitter ionic nature and Isoelectric point of amino acids. Also get knowledge about Strecker's and Gabreil pthalimide synthesis of amino acids.
- ✓ Get awareness about electrophilic substitution group, its reactivity, orientations, classification and its reactions. Also, effect of orientation in mono and disubstituted benzene.
- ✓ Get exposure about polynuclear hydrocarbons, its nomenclature, synthesis of Naphthalene and its derivatives and various reactions of naphthalene.
- ✓ Student acquire knowledge about structure, synthesis, reactivity, orientation of electrophilic substitutions reactions of five-member heterocyclic compound (Pyrrole, Furan and Thiophene). Also get familiar with structure, basicity, electrophilic and nucleophilic substitution reactions of pyridine.

- ✓ Student get learning about synthesis, hydrolysis of  $\beta$ - dicarbonyl compounds (ethyl acetoacetate- EAA and Diethylmalonate). Also get able to learn about synthesis of Crotonic acid from EAA (ii) Valeric Acid from diethyl malonate.
- ✓ Student get aware about acid- base properties of organic compound, effect of resonance, change of hybridizations on acid-base properties. Also get idea about inductive, electrometric, steric effect, hydrogen bonding, Lewis acid-base concept, tautomerism and difference between resonance and tautomerism.

### **Physical Chemistry Paper-202**

- ✓ Student understand the physical significance of entropy. Change in entropy with phase change and for reversible and irreversible reactions. Student get knowledge about work and free energy functions.
- ✓ Theories of reactions rates and effects of temperature on reactions rates.
- ✓ Student will understand concept of transport number and it's determinations, Principal and advantages of conductometric titrations, Acid-base conductometric titrations, activity and activity co-efficient.
- ✓ Get introduction about phase rule, phase diagram of one component systems, condensed phase rule.
- ✓ Student acquire knowledge of adsorptions, derivation of adsorptions of isotherm, applications of adsorption.
- ✓ Know the meaning, characteristics of catalysis, understand the Enzyme catalysed reactions.
- ✓ Understand the terms related with polymer chemistry, classification of polymers
- ✓ Get idea about colloidal systems, their preparations, properties.

### **Inorganic & Physical chemistry Practical paper 203**

- ✓ Student able to perform semi micro analysis of inorganic mixture (four radicals).
- ✓ Understand strength of HCl and H<sub>2</sub>SO<sub>4</sub>, adsorption of organic acid on animal charcoal, conductometric titrations of acid and base, concepts of viscosity and specific refraction and molar refraction of liquid.

### **Semester-IV**

#### **Inorganic Chemistry Paper 204**

- ✓ Student know the basic postulates of quantum mechanics, operator and their basic Mathematical process, theory for particles in one dimensional box, zero potential energy, characteristics of wave functions and electron in a ring.

- ✓ Get understanding of coordination compounds and V.B. theory, CFT theory. Orientation of d-orbitals, crystal field splitting in various complex and factor influences splitting, colours of Transition metal complex and Jahn-Teller effect.
- ✓ Student able to explore the Molecular orbital (MO) theory, LCAO theory, MO energy level diagram, mixing of MO, Electronic configuration of heteronuclear diatomic and polyatomic species. MO theory of  $[\text{Co}(\text{NH}_3)_6]^{3+}$  and  $[\text{CoF}_6]^{3-}$  and metals.
- ✓ Able to understand non-aqueous solvent, properties of ionising solvents. Various properties, reaction and advantages and disadvantages of liquid ammonia as a non-aqueous solvent. Student also able to learn about various reaction and properties of liquid  $\text{SO}_2$ , solubility of inorganic and organic compound and electrical conductance behaviour of liquid  $\text{SO}_2$  as a solvent. Study Liquid HF as non-aqueous solvents and its solutions of biological interest.
- ✓ Student get aware about Physical-chemical principles of sodium carbonate ( $\text{Na}_2\text{CO}_3$ ), sodium bicarbonate ( $\text{NaHCO}_3$ ); sodium hydroxide ( $\text{NaOH}$ ).

### **Analytical Chemistry Paper 205**

- ✓ Student get understanding of common ion effects, separation of cations and anions in groups for qualitative analysis, solubility product principle, get elementary idea about volumetric titrations, understand terms like molarity and normality of solutions.
- ✓ Student get complete understanding of redox titrations, use of electrochemical potential methods and ways of location end point for redox titrations.
- ✓ Student get exposure to acid-base titrations theory, ways of location of acid-base titrations. Able to study various factors that determining the exact form of a pH curve.
- ✓ Know the theory of complexometric titration involving EDTA. Various form of EDTA and effect of pH on titrations. Ways of locating the end point and estimation of calcium and magnesium by complexometric EDTA titrations.
- ✓ Get aware about precipitation titration it's feasibility, Indicators, Able to understand Mohr, Volhard and Fajans' methods. Also, factor affecting solubility.
- ✓ Student learn about various step of precipitation gravimetry, use of organic reagent for precipitations and problem involved in precipitation gravimetry.

### **Organic and Analytical Chemistry Practical Paper 205**

- ✓ Student get practical training for qualitative analysis of organic compound (Organic Spotting) also able to know estimation of organic compound like acetamide, phenols and glucose.

- ✓ Student get acquainted practical knowledge of volumetric titration and practical application of EDTA titrations for determination of water hardness, amount Ni and nitrites. Also learn gravimetric analysis of (a) Fe as  $\text{Fe}_2\text{O}_3$  (b) Ba as  $\text{BaSO}_4$  (c) Al as  $\text{Al}_2\text{O}_3$ .

### Semester-V

#### **Organic Chemistry Paper CHE 301**

- ✓ Student know fundamental of stereochemistry and learn optical activity in absence of chiral carbon by the example of biphenyls, allenes and spirans.
- ✓ Student gain knowledge about the concepts of stereoselectivity and stereospecificity and learn mechanism of addition of halogens and stereochemistry of syn anti elimination ( $\text{E}_2$ ) reactions.
- ✓ Get to know use of specific inorganic reagent like (i) Aluminium Isopropoxide (ii) Lithium Aluminium Hydride (iii) Adams's catalyst ( $\text{PtO}_2$ ) (iv) Selenium Dioxide (v) Osmium Tetroxide (vi) Lead Tetraacetate in organic synthesis with mechanism.
- ✓ Get aware about principle, mechanism, and synthetic applications of molecular rearrangements occurring through carbocations, carbenes and nitrene via name reaction such as; (i) Wolf rearrangement (ii) Fries migration (iii) Hoffmann reaction
- ✓ (iv) Oppenauer oxidation reaction (v) Diels-Alder reaction (vi) Birch Reduction
- ✓ Student attain the knowledge about characteristics, scope and stereochemistry of nucleophilic substitution at a saturated carbon atom. Reactivity of in substitution with respect to solvent, variation at carbon activity of leaving group.
- ✓ Get acquaintance about nucleophilic aromatic substitution reaction in bimolecular displacement mechanism, learn effect of reactivity, orientation, electron withdrawal by resonance. Also, able study Evidence for the two steps-mechanism, Elimination-addition mechanism-Benzyne.
- ✓ Get detailed knowledge of about structure determination of disaccharides such as (+) maltose, (+) cellobiose, (+) lactose and (+) sucrose. Also, learn about synthesis of some important amino acids of Purine and Pyrimidines types.

#### **Inorganic Chemistry CHE Paper 302**

- ✓ Student get idea of molecular symmetry and able to identified  $C_n$ ,  $\sigma$ ,  $S_n$ ,  $i$  and  $E$  point of groups in molecule. Student also learn about  $C_{2v}$ ,  $C_{2h}$  and  $C_{3v}$  point groups.
- ✓ Student able to learn VB and MO treatment of  $\text{H}_2$  and  $\text{H}_2^+$  and MO treatment of some metal-ligand complex.
- ✓ Get to learn about preparation, structure of diborane and get clear about bonds found in higher boranes.
- ✓ Student know about trans effect in co-ordination compound. Get clear about application of trans effect in synthesis and analysis and get exposure to theories of trans effect.

- ✓ Get knowledge of nucleophilic substitutions in octahedral and square planar complex also learn acid, base hydrolysis, cis effect and electron transfer and mechanism of redox reactions.
- ✓ Learn about classification of inorganic polymers. Preparations, physical, chemical properties, structures and use of inorganic polymer containing boron and silicone.
- ✓ Get familiar with principal, instrumentation and experimental technique for Mossbauer Spectroscopy. Also learn about application for iron complexes

### **Physical Chemistry Paper CHE 303**

- ✓ Get clear understanding of Zeroth law of thermodynamics. Students learn derivation of Clausius- Clapeyron equation, Trouton's rule, craft's equations and van't Hoff's isotherm and isochore equation. Get able to solve problem based on above equations.
- ✓ Student gain knowledge of electrochemical, electrolytic, reversible and irreversible electrodes. Learn about various standard reference electrode and also know the application of EMF to calculate thermodynamic parameters,  $K_{sp}$ ,  $K_{eq}$ ,  $K_w$  and  $K_h$ .
- ✓ Learn about how to predict reaction rate and primary and secondary salt effect, get idea about kinetics of heterogeneous and retardation reactions.
- ✓ Know classification of polymers, learn thermodynamics study of polymer solutions and various methods to determine molecular weight of polymer.
- ✓ Learn identification of isotopes using various mass spectrograph and able to solve example based on use of mass spectrograph. Also, know application of isotopes.
- ✓ Able to understand origin of spectra, derived equation of frequency for pure rotational, vibrational-rotational spectra. Also get idea about ortho and para hydrogen.

### **Analytical Spectroscopic Techniques Paper CHE-310**

- ✓ Get knowledge of UV spectroscopy, origin of spectra (electronic transition) get clear about value of  $\lambda_{max}$  and factors affecting it. Get idea about various effects related with  $\lambda_{max}$  and value of  $\lambda_{max}$  for aromatic and polynuclear aromatic hydrocarbons.
- ✓ Student able to calculate value of  $\lambda_{max}$  dienes, ketones, aldehydes using Woodward-Fieser rules.
- ✓ Acquire knowledge of principle, theory, instrumentations, selection rules of IR spectroscopy. Learn factors affecting stretching frequencies of various bonds and able to elucidate structure of organic compounds.
- ✓ Get some fundamental ideas about Raman spectroscopy and know the difference between Raman and IR spectroscopy.
- ✓ Student learn about principle, instrumentation, concept of coupling of NMR spectroscopy. Able to identify equivalent, non-equivalent protons and solve simple structural problems.
- ✓ Student get ability to elucidate structure of organic compound based on data of UV, IR and NMR spectroscopy.

- ✓ Understand Beer Lambert's law, instrumentation part of visible spectrophotometers. Get to know about Atomic spectroscopy (Absorption and emission), burners and advance technique like Inductively coupled plasma Emission Spectroscopy (ICPES).

### **Subject Elective (Soil Composition and Analysis) Paper CHE 305**

- ✓ Student learn about soil, it's formation, composition, profile, types and micro and macro plant nutrients.
- ✓ Know the methods of determination of nitrogen, phosphorus, potassium (primary nutrients) in soil. Also learn about fertility and productivity of soil.
- ✓ Student able understand determination of sulphur, calcium, magnesium (secondary nutrients), lime, liming material in soil.
- ✓ Acquired knowledge about determination of total manganese in soil, determination of Fe (II), Fe (III), silica in soil, salts in soil, sodium in soil.

### **Practical Papers CHE 306**

- ✓ Student learn inorganic qualitative analysis of mixture containing six radicals only.
- ✓ Get able to find out order of reactions using graphical methods.
- ✓ Able to determine dissociation constant of acid using pH meter. Able to determine amount of base in given mixture conductometrically. Know the determination of ferrous in the solutions of FAS potentiometrically. Learn to determine amount of  $\text{Cu}^{+2}$  and  $\text{Fe}^{+3}$  in solution colorimetrically.
- ✓ Able to prepare acetanilide, Benzilic acid, 1,5-Diphenyl-penta-1,4-diene-3-one and also understand diels-alder reactions between furan and maleic acids by green preparation.
- ✓ Able to estimate ketone, esters and organic acid. Learn the analysis of drugs by TLC.

## **Semester-VI**

### **Organic Chemistry Paper CHE 307**

- ✓ Student know the concept of prostereo isomerism, chiral synthesis, Cram's rule, Prelog's generalization and able to identified configuration using Prelog's rul. Get knowledge of stereochemistry of N, P and S containing compound.
- ✓ Get familiar with classification, methods of determining structure and chemistry of alkaloids and terpenoids.
- ✓ Student learn about classification of dyes and their synthesis. Preparation of explosive like RDX, PETN, Nitroglycerin. Preparation of various pesticides
- ✓ Able to know general classification of drugs and synthesis and use of Antipyrine, Phenacetin, n-Hexyl resorcinol, Alprazolam, Zaleplon, Benzocaine, Lidocaine, Chloroquine, Atenolol, Sulphadiazine, Trimethoprim and Tolbutamide.
- ✓ Get knowledge of structure and biochemistry of Vitamin-A ( $\text{A}_1$ ) (Retinol), Vitamin-B<sub>6</sub> (Pyridoxine).

### **Inorganic Chemistry Paper CHE 308**

- ✓ Student understand the concept of term symbol able to calculate number of microstates and learn Pigeon hole diagram of  $p^2$  and  $d^2$  and hole formulation.
- ✓ Able to understand electronic spectra of metal complex, Orgel energy diagram of  $d_1 - d_9$ ,  $d_2 - d_8$ ,  $d_3 - d_7$ ,  $d_4 - d_6$  and their spectra. Also learn concept of Jahn Teller distortion. Get information about spectrochemical series.
- ✓ Get detail knowledge about Hermitian operators, Equation for particle in 3D box, rigid rotator. Learn about Schrodinger equation in spherical polar coordinates for hydrogen. and learn about solution of equation like  $R$ ,  $\theta$  and  $\Phi$ .
- ✓ Able to understand Huckel MO theory, solution of secular equations, HMO treatment to ethylene molecule, allylic cation, allylic free radical and allylic anion. Also, learn hybridization wave function of  $sp$ ,  $sp^2$  and  $sp^3$ .
- ✓ Learn about hybridization and various properties of metal carbonyls and their hydrides. Also, study use of IR spectroscopy for the structure determination of metal carbonyls.
- ✓ Get information about classification, definition, properties, structure application and synthesis of Mg, Al, Be, Fe containing organometallic compounds.

### **Physical Chemistry Paper CHE 309**

- ✓ Student get knowledge of colligative properties, learn to derive equation for Molal elevation and depression constant. Able to calculate absolute value of entropy using third law of thermodynamics. Understand law of mass action based on chemical potential.
- ✓ Learn concept of concentrating cell its use to determine activity and activity coefficient. Get idea about liquid junction potential, also learn about decomposition potential, over voltage and its determination using Tafel equation.
- ✓ Able to understand phase diagram of binary systems, know concept of zeotropic and azeotropic mixture. Learn about process of steam distillation and zone refining.
- ✓ Acquire knowledge of osmosis, dialysis and application to remove Cu, Ag and Fe from waste water.
- ✓ Learn about laws of photochemistry and get familiar with concept of Fluorescence and Phosphorescence, Chemiluminescence, Photosensitized reactions.
- ✓ Learn types of corrosion its privation and electrochemistry involve in corrosion process.

### **Analytical Chemistry Paper CHE 310**

- ✓ Student learn the concept of errors, accuracy and precision. Learn how reject result using various test of significance, correlation coefficient and numerical. Get idea about literature of analytical chemistry.
- ✓ Separation of elements using organic reagents.

- ✓ Able to know the principle and theory of various chromatographic separation techniques. Get aware about instrumentation of GC and HPLC. Also learn to solve numerical base on chromatographic methods.
- ✓ Learn principle, theory, process, choice of solvent for solvent extraction separation and numerical base on solvent extractions.
- ✓ In electroanalytical techniques learn principle and basic terms about polarography, use of half wave potential and Ilkovic equations. Also, learn application of polarography by solving numerical.
- ✓ Get knowledge of various potentiometry titration, methods of determination of end points. Also, learn about the concept of ion selective electrode (ISE) and learn construction and working of some ISE.
- ✓ Able to learn about basic concepts of titration and theory of titration of polyprotic acids, salts.
- ✓ Get complete information about redox titration that also include Iodometry and Iodometric titration. Learn application metal reductant in titrations.
- ✓ In complexometric titration section student acquire knowledge of EDTA titration. Learn about various types (back, displacement, indirect titrations) of EDTA Titrations. Learn concept of masking, demasking and auxiliary complexing agent.

#### **Nanomaterials and Nanotechnology (Subject Elective) Paper CHE 311**

- ✓ Student get brief introduction of nanomaterials, their properties and preparation.
- ✓ Know about quantum dots, carbon nanotubes, graphenes, nano particles.
- ✓ Learn about characterization techniques such as laser scattering, microscopy, X-ray diffractions, Augur emission, ESCA techniques.
- ✓ Learn about applications of nanomaterials in the field of solar energy conversion, liquid crystals, polymer chemistry, data storage, biosensors etc.

#### **Practical Paper CHE 312**

- ✓ Able to perform gravimetry analysis for determination of the radicals, analysis of alloy, able to investigate order of reactions by graphical methods.
- ✓ Understand use of pH meter, conductometer for titration and able to determine concentration using colourimetry.
- ✓ Able to use polarimetry in order to determine specific rotation of glucose.
- ✓ Get knowledge about separation and identification of organic compound in binary mixture.
- ✓ Learn use of EDTA titration for the estimation of ions and hardness of water. Able to understand Mohr's methods. Also learn to determine % purity of H<sub>2</sub>O<sub>2</sub>.