

Name of the Department:Chemistry

System: Part (2016-2017)

Programme Outcome:

PO-1: Disciplinary knowledge and skill: A graduate student is expected to be capable of

demonstrating comprehensive knowledge and understanding both theoretical and practical

knowledge in all disciplines of Chemistry. Students can solve their subjective problems very

methodically, independently and finally draw a logical conclusion. Further, the student will be

capable of applying modern technologies, handling advanced instruments and Chemistry related

soft-wares for chemical analysis, characterization of materials and in separation technology.

PO-2: Skilled communicator: The course curriculum incorporates basics and advanced training

in order to make a graduate student capable of expressing the subject through technical writing

as well as through oral presentation.

PO-3: Critical thinker and problem solver: The course curriculum also includes components

that can be helpful to graduate students to develop critical thinking and to design, carry out,



record and analyze the results of chemical reactions. Students will be able to think and apply evidence based comparative chemistry approach to explain chemical synthesis and analysis.

PO-4: Sense of inquiry: It is expected that the course curriculum will develop an inquisitive characteristics among the students through appropriate questions, planning and reporting experimental investigation.

PO-5: Team player: The course curriculum has been designed to provide opportunity to act as team player by contributing in laboratory, field based situation and industry.

PO-6: Skilled project manager: The course curriculum has been designed in such a manner as to enabling a graduate student to 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-7: Digitally literate: The course curriculum has been so designed to impart a good working knowledge in understanding and carrying out data analysis, use of library search tools, use of chemical simulation software and related computational work.

PO-8: Ethical awareness: A graduate student requires understanding and developing



ethical

awareness or reasoning which is adequately provided through the course curriculum.

Students

can also create an awareness of the impact of chemistry on the environment, society, and also

make development outside the scientific community.

PO-9: Environmental Awareness: As an inhabitant of this green planet a Chemistry graduate

student should have many social responsibilities. The course curriculum is designed to teach a

Chemistry graduate student to follow the green routes for the synthesis of chemical compounds

and also find out new greener routes for sustainable development. The course also helps them to

understand the causes of environmental pollution and thereby applying environmental friendly

policies instead of environmentally hazard ones in every aspect.

PO-10: Lifelong learner: The course curriculum is designed to inculcate a habit of learning

continuously through use of advanced ICT technique and other available e-techniques, e-books

and e-journals for personal academic growth.

PO-11: Analytical skill development and job opportunity: 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
analyze the
chemical compounds very skillfully. Such a wonderful 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 Outcome:

PSO-1: Core competency: The chemistry graduates are expected to gain knowledge
of the
fundamental concepts of chemistry and applied chemistry through theory and
practical. These
fundamental concepts would be reflected in the latest understanding of the field to
keep
continues its progression.

PSO-2: Communication skills: Chemistry graduates are expected to possess
minimum
standards of communication skills to read and understand documents so that they
can solve their
problems very methodically, independently and with logical argument. Graduates are
expected to
build good communication skill so that they can easily share their
idea/finding/concepts to
others.



PSO-3: Critical thinking: Chemistry graduates are expected to achieve critical thinking ability

to design, carry out, record and analyze the results of chemical reactions. They can have that

much potential and confidence that they can overcome many difficulties with the help of their

sharp scientific knowledge and logical approaches. performing, observing and giving conclusion of a particular reaction. It is also important for self-compassion, self-reflection, interpersonal relationships, and emotional management.

PSO-4: Psychological skills: Chemistry graduates are expected to possess basic psychological

skills so that they can deal with individuals and students of various socio-cultural, economic and

educational levels. Psychological skills are very important for proper mind setting during performing, observing and giving conclusion of a particular reaction. It is also important for self-compassion, self-reflection, interpersonal relationships, and emotional management.

PSO-5: Problem-solving: Graduates are expected to be well trained with problem-solving

philosophical approaches that are pertinent across the disciplines.

PSO-6: Analytical skill development and job opportunity: Chemistry graduates are expected

to possess sufficient knowledge how to synthesize a chemical compound and perform necessary

characterization and analysis in support of the formation of the product by using



modern

analytical tools and advanced technologies. Because of this course curriculum

chemistry

graduates have lot of opportunity to get job not only in academic and administrative field but

also in industry.

PSO-7: Research motivation: Chemistry graduates are expected to be technically well trained

with modern devices and Chemistry based software and has powerful knowledge in different

disciplines of Chemistry so they can easily involve themselves in theory and laboratory-based

research activities.

PSO-8: Teamwork: Graduates are expected to be team players, with productive co-operations

involving members from diverse socio-cultural backgrounds.

PSO-9: Digital Literacy: Graduates are expected to be digitally literate for them to enroll and

increase their core competency via e-learning resources such as MOOC and other digital tools

for lifelong learning.

PSO-10: Social Awareness: As an inhabitant of this green world it is our duty to make our

planet clean and suitable for living to all. In this context Chemistry graduates are expected to be



more aware about finding green chemical reaction routes for sustainable development. They are expected to maintain good laboratory practices and safety.

Course Outcome: (ChemistryHons.) :



Semester/Part	Course Type	Paper Description	Course Outcome
Part-I	Paper-I	Inorganic Chemistry	CO-1: To understand atomic structure and periodic properties , Bohr's model, Sommerfeld's extension, de Broglie's wave particle duality, characteristics of s-/p-/d-orbital, Mendeleev-Seaborg's periodic table, chemical Periodicity, Group trends and periodic trends in respect of s-, p- and d-block elements
			CO-2: To know about Bonding and structure , different bonds like ionic, covalent, dative, retrodative, hydrogen, metallic, Fajan's rules; VB, LCAO, MO, HOMO-LUMO, VB-MO comparison; bond multiplicity, bond strength
			CO3: To study different concepts of acid-base and donor-acceptor , HOMO-LUMO and acid-base interactions, anisotropicity of hardness/softness
			CO4: To learn Redox system , electrochemical series, basis of redox titration, redox indicator, disproportionation, comproportionation
			CO5: To understand about Coordination chemistry-I , Werner's theory, chelate effect, stabilization of different oxidation states, types of isomerism, IUPAC nomenclature
Part-I	Paper-II	Organic Chemistry	CO-1: It is about general introduction that is nomenclature of organic molecules with special reference to polycyclic, bridge head, aromatic, heteroaromatic and heterocycles compounds
			CO-2: To learn about structure and properties, nature of bonding in aliphatic, alicyclic, aromatic and heterocyclic compounds, resonance, tautomerism, aromaticity, Huckel's rules, aromatic, nonaromatic and antiaromatic compounds, inductive, field effects, dipole moment
			CO-3: To understand the introduction of organic reactions, types of reactions, Bronsted-Lowry concept, Lewis concept, acid-base reactions, thermodynamics and kinetics of organic reactions, kinetically and thermodynamically controlled reactions



			CO-4: To learn about reactive intermediates, classical and non-classical carbocations, carbanions, free radicals, arynes, ylides, carbenes and nitrenes	
			CO-5: To understand what is stereochemistry, stereochemical representation, geometrical isomerism, conformation of alkanes and cycloalkanes, optical activity, strains in molecules	
Part-I			CO-6: To study aliphatic nucleophilic substitution reactions , free radical and nucleophilic substitutions at SN1, SN2, SNi SN1', SN2', SNi' reactions	
			CO-7: To learn elimination reactions , Saytzeff/Hofmann orientation and stereoselectivity	
			CO-1: To understand the basic concept of kinetic theory of gases and know how to solve numerical problems related to that topic, collision of gas molecules, van der Waals equation and its features	
	Paper-III	Physical Chemistry		CO-2: To study thermodynamics-I, zeroth law, 1 st law of thermodynamics, Laws of thermochemistry
				CO-3: To understand thermodynamics-II that is second law of thermodynamics, physical concept of entropy, thermodynamic relations
				CO-4: To learn chemical kinetics, rate law, order, molecularity , temperature dependence of reaction rate
Part-II	Paper-V	Inorganic Chemistry	CO-1: To understand coordination chemistry-II , crystal Field Theory, general comparison, chemical bonding and molecular structure, MLCT/LMCT/IVCT/LLCT/MMCT transition, different types of magnetic molecules	
			CO-2: To know in detail about chemistry of transition elements, normal and inert gas elements, transition metals, lanthanoids and actinoids	
			CO-1: To understand stereochemistry, Stereogenicity, chirotopicity, prochirality, stereoselective, Asymmetric synthesis: Cram's rule	
			CO-2: To know Electrophilic and radical addition to C-C multiple bonds, Halogenation, hydration, epoxidation, ozonolysis, Diels-Alder reaction, addition of carbenes	



Part-II	Paper-VI	Organic Chemistry	CO-3: To understand Nucleophilic addition to carbonyl group, Clemmensen reduction, addition of organometallics, Cannizzaro reaction, aldol condensation, Claisen condensation, nucleophilic addition (Michael addition) to α,β -unsaturated carbonyl system
			CO-4: To learn Molecular rearrangement, Wagner-Meerwein, Pinacol-Pinacolone, Dakin, Bayer-Villiger, Beckmann, Favorasky, Hoffmann, dienone-phenol, Wolf, Claisen, Orton, Demjanov, benzidine-semidine
			CO-5: To know about reagents in organic synthesis like Grignard, alkyl lithium, LDA, LiAlH_4 , B_2H_6 , Me_3SiCl , R_2CuLi , Wilkinson catalyst, NaBH_4 , DIBAL-H, 1,3-dithiane, OsO_4 , KMnO_4
			CO-6: To know about Named reactions like Birch, von Richter, Houben-Hoesch, Arndt-Eistert homologation, Hell-Volhard-Zelinsky, Hunsdiecker, Oppenauer, Sandmeyer, Stephen, Williamson ether synthesis
			CO-7: To study about Alicyclic compounds, Synthesis and reactions in cyclohexane systems
			CO-8: To know Synthesis, physical properties and reactions Aliphatic and aromatic nitrogen compounds, nitrophenols, aminophenols, nitroanilines
			CO-9: To learn about Aromatic electrophilic substitution, Mechanism, orientation and reactivity
			CO-10: To know Aromatic nucleophilic substitution, Addition-elimination mechanism, ArSN_1 mechanism, elimination-addition (benzyne) mechanism; orientation and reactivity
			CO-1: To understand Thermodynamics and equilibrium, Additivity rule, Thermodynamic condition of equilibrium, Activity and activity coefficients of electrolyte, Ostwald's dilution law
			CO-2: To learn Phase equilibrium and colligative properties, Liquid-vapour equilibrium for two-component systems, ΔG , ΔS , ΔH and ΔV of mixing for binary solutions
			CO-3: To understand Chemical kinetics II, Collision



Part-II	Paper-VII	Physical Chemistry	theory of bimolecular reactions, unimolecular reactions, Homogeneous catalysis with reference to acid base and enzyme catalyses
			CO-4: To know Properties of fluids, General features of fluid flow, Nature of the liquid state, vapour pressure, surface tension, surface energy
			CO-5: To understand Macromolecules, Introduction, types of polymers, classification of solvents; determination of molecular weights by osmometry and viscometry
Part-III	Paper-IX	Inorganic Chemistry- Group A	CO-1: To know about Inorganic solids, Close-packed structures, different polyhedra, Lave's principle, radius ratio rule and its limitations
			CO-2: To learn Reaction mechanism, Fundamentals, energy profile of reactions, measurement of reaction rates, rate laws, substitution reactions in octahedral cobalt(III) and square planar platinum(II) complexes
			CO-3: To understand metal ions in living systems, Essential elements, biological metal ions/ligands, Na ⁺ ion - K ⁺ ion pump; metals and chelating agents as drugs; toxicity of metal ions
			CO-4: To know Organometallic compounds, Definition, nomenclature, classification; 18-electron rule – application/exception, EAN; preparation, properties, structure, bonding, reactivities and applications of alkyls and aryls of Li, Al, Hg, Sn
			CO-5: To understand Synthesis, structure, bonding (using IR results) and reaction, Carbonyl complexes, Nitrosyl complexes, Cyclopentadienyl, benzene, acetylacetonate, cyanide, N ₂ and O ₂ complexes
			CO-6: To know Nano and supramolecular chemistry, Definition, molecule to supramolecule, molecular aggregate to crystalline aggregate;
			CO-7: To understand Nuclear and radioanalytical chemistry various radioactive disintegration modes, nature of radiations, theory of radioactive disintegration, different types of radioactive equilibria, different nuclides/radionuclides, Mass defect and binding energy
			CO-8: To know Statistical methods in analytical



Part-III	Paper-IX	Inorganic Chemistry- Group B	chemistry, Qualitative idea about different frequency distribution, Propagation of errors
			CO-9: To understand a) Analytical methods, Volumetric analysis, Acid-base reaction, Redox titrations: Complexometric reaction, EDTA titration, masking/demasking agent Precipitation reaction, b) Electroanalytical analysis c) Spectrophotometric analysis
			CO-10: To understand Methodologies in separational chemistry, Basic principle of solvent extraction, distribution ratio
	Paper-X	Organic Chemistry- Group A	CO-1: To know about Dyes, Phenolphthalein, methyl orange, malachite green, alizarin
			CO-2: To understand Medicinal chemistry, Preliminary concept on pharmacodynamics and pharmacokinetics
			CO-3: To know Heterocyclic compounds, Syntheses, properties and uses of furan, pyrrole, thiophene, pyridine
			CO-4: To understand Amino acids and proteins, Essential and non-essential amino acids, isoelectric point, ninhydrin reaction
			CO-5: To know Carbohydrate chemistry, Chemistry of monosaccharides and disaccharides including structures and configurations
			CO-6: To learn Alkaloids and terpenoids, General studies of terpenoids and alkaloids; biosynthesis of terpenes; determination of structures of citral, nerol, α -terpineol, piperin, ephedrine and coniine
		Organic Chemistry- Group B	CO-7: To know Methodology in organic synthesis, Disconnection approach, synthon, synthetic equivalents, umpolung, one-group disconnection of alcohols
			CO-8: To understand Pericyclic reactions, FMO approach, definition, classification, electrocyclic reactions
			CO-9: To learn Spectroscopy, UV, IR, $^1\text{H-NMR}$
			CO-10: To know Nucleic acids, Heterocyclic bases, nucleosides, modified nucleosides, nucleotides; idea



			about DNA and RNA
			CO-11: To learn principles, starting materials, reagents, solvents, catalysts, utilities Green chemistry,
	Paper-XI	Physical Chemistry-A	CO-1: To know Electrochemistry, Conductance and its measurement, cell constant, Electrochemical cells,
			CO-2: To understand Properties of solids, interfaces and dielectrics, Unit cell, Bravais lattice, crystal system, Special feature of interfaces, physical and chemical adsorptions, Electrical properties of molecules, polarizability
		Physical Chemistry-B	CO-3: To learn Symmetry and group, Introduction, symmetry elements and operations with illustrations, symmetry elements and physical properties
			CO-4: To understand Quantum chemistry, Black body radiation, Planck's radiation law, Elementary concept of operators, Particle in a box, Stationary Schrödinger equation for the H-atom in polar coordinates
			CO-5: To learn Photochemistry and spectroscopy, Primary photophysical processes, Rotational spectroscopy of diatomic molecules, Vibrational spectroscopy of diatomic molecules, characteristic feature and condition of Raman activity with illustrations, rotational and vibrational Raman spectra, NMR spectra
			CO-6: To know Statistical thermodynamics and the third law, Thermodynamic probability, entropy and probability, Boltzmann distribution formula, Nernst heat theorem and its implications



Course Outcome: (Chemistry General) :

Semester/ Part	Course Type	Paper Description	Course Outcome
Part-I	Paper-I	Group A General Principles	CO-1: To understand atomic structure Bohr's theory: energy and radius calculations for H-like atoms
			CO-2: To learn Radioactivity, Theory of disintegration, rate constant, half life period
			CO-3: To know Periodic Table and Periodic Properties, Periodic law, Periodic classification of elements on the basis of electron distribution
			CO-4: To learn Chemical Forces and Molecular Structure, ionic bond, covalent bond, Born-Haber cycle, hydrogen bond
			CO-5: To know Oxidation and Reduction, Electronic concepts, oxidation number, ion-electron method of balancing equations
			CO-6: To understand Acids and Bases, Buffers and Ionic Equilibrium, Different concept of acids and bases, ionic product of water, salt hydrolysis, pH and its colorimetric determination
		Group B Organic Chemistry	CO-1: To learn Functional Nature of Organic Compounds, Classification of organic compounds in terms functional groups, their IUPAC nomenclature and valence bond structures
			CO-1: To understand Electron Displacement in Molecules
			CO-2: To learn Introduction to Organic Reaction Mechanism, Classification of organic reactions



			CO-3: To know Chemistry of Hydrocarbons, Free radical substitutions of alkanes; b) Formation of alkenes, electrophilic addition
			CO-4: To learn Mono and Bifunctional Compounds, Preparations and properties of primary, secondary and tertiary monohydric alcohols
			CO-5: To know about Stereochemistry, Concept of optical activity, cis-trans and E, Z nomenclature
			CO-6: To understand about Chemistry of Aromatic Compounds, Modern concept of structure of benzene, general mechanism of aromatic electrophilic substitution reactions
			CO-7: To learn Organic Synthesis, Preparation and synthetic uses of diethyl malonate and ethylacetoacetate. Application of Grignard reagents in synthesis of ketones, secondary and tertiary alcohols and carboxylic acids.
			CO-8: To know Carbohydrates, Open-chain and ring structures glucose, fructose and their mutarotation, idea of disaccharides with reference to cane sugar
Part-II	Paper-II	Group A Inorganic Chemistry	CO-1: To learn Coordination Chemistry Double and complex salts, Werner's theory, ligands, coordination number, inner metallic complexes
			CO-2: To know about Group Chemistry, Group trends and periodic trends in respect of s-, p- and d-block elements
			CO-3: To know in detail about chemistry of transition elements
		Group B Physical Chemistry	CO-1: To learn Kinetic Theory of Gases, Ideal gas equation, derivation of gas laws, Maxwell's speed and energy distributions, critical constants
			CO-2: To know To study thermodynamics-I, zeroth law, 1 st law of thermodynamics, Laws of thermochemistry, is 2 nd of thermodynamics, physical concept of entropy



			CO-3: To learn conditions of spontaneity and equilibrium
			CO-4: To know Phase Equilibria and Colligative Properties, abnormal behaviour of electrolytic solutions
			CO-5: To know Properties of Matter, Viscosity of fluids, Unit cell, Bravais lattice
			CO-6: To understand Electrochemistry, Electrochemical cell
			CO-7: To learn Chemical Kinetics, Order and molecularity of reactions, elementary treatment of mechanism of catalysis
			CO-8: To know Photochemistry and Spectroscopy, Absorption, Lambert-Beer's law, photochemical laws, Elementary idea of rotational and vibrational spectra
Part II	Paper III	Practical (Inorganic and Organic Qualitative Analysis)	CO-1: To learn detection of anion and cation radicals by analysis of mixture. CO-2: To learn detection of elements (N, S, Cl) and any one of the functional groups in organic compounds.
Part III	Paper IV	Chemistry (General)	CO-1: To understand Analytical Chemistry Accuracy and precision in analysis, types of errors, data analysis and curve fitting (linear $Y = mX + C$ type), numerical problems, mean, mode and variant. Principles of acid-base titration, use of indicators and indicator constant, Single electrode potential and emf of a chemical cell, principles of redox titration, use of redox potentials, iodometry, use of $K_2Cr_2O_7$ and $KMnO_4$ as oxidant (acid, neutral and alkaline media).
			CO-2: To learn Green Chemistry; Basic principles of green chemistry, tools of green chemistry including the use of alternative feed stocks or starting materials, reagents, solvents, target molecules, and catalysts (homogeneous, heterogeneous and biocatalysis), green chemistry as the alternative chemistry for protection of environment.
			CO-3: To understand Chemistry of Selected Biomolecules, structural aspects (excluding



			elucidation and stereochemistry, unless specified) and important function of idea of denaturation of proteins, classification and functions of enzymes in general), pyrrole, pyridine, pyrimidine and purine, nucleic acids (DNA and RNA), nucleotide and nucleoside.
			CO-4: To gain knowledge about Medicinal Chemistry, Antipyretics and analgesics like paracetamol and aspirin, sulpha-drugs like sulphadiazine, drugs used for AIDS.
			CO-5: To learn Nano Chemistry, Elementary idea on nano materials. Basic chemical strategy for making nanomaterials. Nanoclusters, Nanowires and Carbon Nanotubes. Applications.
			CO-6: To understand Colloidal State, General classification, general methods of preparation of lyophobic colloids and general properties of colloids, ideas of coagulation, peptization, protective colloids, dialysis, gold number, isoelectric point, Brownian motion
			CO-7: To understand Macromolecular Chemistry, definition of macromolecules, natural and synthetic polymers, monomers, polymers, degree of polymerization, simple idea of polymer structure: homopolymer (linear, branched, cross-linked) and copolymer (random, block, graft), polymerization reaction step (growth, addition, ring opening), importance of polymers both natural and synthetic Number and weight average molecular weights of polymers – significance, structure and use of natural
	Papers V	Practical (Inorganic Quantitative Analysis)	CO-1 : a. Titration of $\text{Na}_2\text{CO}_3 + \text{NaHCO}_3$ mixture vs HCl using phenolphthalein and methyl orange indicators b. To find the total hardness of water by EDTA titration c. To find the pH of an unknown solution by comparing colour of a series of (HCl solutions + 1 drop of methyl orange) and a similar series of (NaOH solutions + 1 drop of phenolphthalein) d. Estimation of saponification equivalent of a supplied ester/oil. Titration of ferrous iron by $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ f. Titration of ferric iron by



			KMnO ₄ /K ₂ Cr ₂ O ₇ using SnCl ₂ reduction e. Titration of ferrous iron by KMnO ₄ /K ₂ Cr ₂ O ₇ f. Titration of ferric iron by KMnO ₄ /K ₂ Cr ₂ O ₇ using SnCl ₂ reduction.
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