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BEJOY NARAYAN MAHAVIDYALAYA

(GOVT. SPONSORED)

NAAC ACCREDITED

P.O. ITACHUNA, DIST. HOOGHLY, PIN - 712147

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Ref. No. .....

Date. 01.08.22

B.Sc Chemistry Honours (CBCS)

PROGRAMME OUTCOMES

The undergraduate (UG) course offered by the Department of Chemistry, Bejoy Narayan Mahavidyalaya follows the CBCS syllabus prescribed by the UGC. The course is a combination of general and specialized education, simultaneously introducing the concepts of in depth learning. After successful combination of a 3 year degree course in Chemistry Honours, the students should be able to

PO-1: Achieve the skills required to succeed for doing jobs in Govt. and private sectors of academia, research and industry.

PO-2: Identify and solve complex scientific problems in research at national and international level.

PO-3: Understand the concept of chemistry to inter relate and interact to other subjects like mathematics, physics, biological science etc.

PO-4: Learn the laboratory skills and safely transfer and interpret the knowledge entirely in the working environment.

PO-5: The course fulfils to produce competent chemists who can think and work independently in chemical laboratories or can fit themselves in chemical industries.

PO-6: Investigate chemical problems using scientific tools for analysis and interpretation of data.

PO-7: Select, design and apply appropriate experiment techniques along with IT tools to solve chemical problems.

PO-8: Communicate effectively through report writing, documentation and effective presentations.

Principal
Bejoy Narayan Mahavidyalaya
P.O.- Itachuna, Dt.- Hooghly.

Shalmali Chakraborty
Head
Chemistry
B. N. Mahavidyalaya
Itachuna, Hooghly
01/08/2022

PO-9: The present curriculum will not only advance their knowledge and understanding of the subject, but will also increase the ability of critical thinking, development of scientific attitude, handling of different instruments, improve practical skills, enhance communication skill, social interaction, increase awareness in environment related issues and recognize the ethical value system.

PO-10: To provide knowledge and skills to the students that will enable them to undertake further studies in chemistry on related areas or multi disciplinary areas that can be helpful for self employment, entrepreneurship or further studies in the same domain.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO-1: Understanding the nature and basic concepts of bonding in molecules, chemical behaviour, stereochemistry of molecules and many interactions within the molecule and with other molecules, and application of different compounds in the field of material sciences, pharmaceutical and agricultural industries.

PSO-2: The course will make them aware of natural resources and help them to make eco-friendly environment.

PSO-3: Hands on training in various fields will develop practical skills, handling equipments and interpreting spectral data.

PSO-4: Knowledge gained through theoretical and lab based experiments will generate technical personnel as analytical chemists, bench chemists for the laboratories and industries, instrument operators in chemical and biochemical laboratories.

PSO-5: 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 and thus make the student a skilled communicator.

PSO-6: The course curriculum has been designed to provide opportunity to act as team player by contributing in laboratory, field based situation and industry.

PSO-7: It is expected that the course curriculum will develop an inquisitive

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characteristics among the students through appropriate questions, planning and reporting experimental investigation.

PSO-8: To execute new ideas in the field of research and development using principles and techniques of science learned through activities such as expert lecturers, workshops, seminars and field projects.

PSO-9: Employ writing conventions appropriate to the discipline and Record keeping and managing the records.

PSO-10: Graduates are expected to be responsible citizen of India and be aware of moral and ethical baseline of the country and the world. They are expected to define their core ethical virtues good enough to distinguish what construes as illegal and crime in Indian constitution. Emphasis be given on academic and research ethics, including fair Benefit Sharing, Plagiarism, Scientific Misconduct and so on.

PSO-11: Introduction to the students on modern tools for scientific approach.

PSO-12: Graduates are expected to possess basic psychological skills required to face the world at large, as well as the skills to deal with individuals and students of various socio cultural, economic and educational levels. Psychological skills may include feedback loops, self-compassion, self reflection, goal-setting, interpersonal relationships, and emotional management.

Course Outcomes (COs) for Chemistry

The core courses would fortify the students with in-depth subject knowledge concurrently; the discipline specific electives will add additional knowledge about applied aspects of the program as well as its applicability in both academia and industry. Generic electives will introduce integration among various interdisciplinary courses. The skill enhancement courses would further add additional skills related to the subject as well as other than subject. In brief the student graduated with this type of curriculum would be able to disseminate subject knowledge along with necessary skills to suffice their capabilities for academia, entrepreneurship and Industry.

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SEMESTER 1

Course Code: CC-01 Course Title: Organic Chemistry-I (Theo)	***Basics of Organic Chemistry***	On completion of the course, students will be able to: ➡ understand Bonding and Physical Properties including VB and MO theories. ➡ understand general treatment of Reaction mechanism and intermediates and get a concept ➡ of Stereochemistry of organic molecules.
Course Code: CC-02 Course Title: Physical Chemistry-I	***Kinetic Theory of Gas; Deviation from Ideal Behaviour and Real Gas***	On completion of the course, students will be able to: ➡ Learn kinetic model of an ideal gas. ➡ 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. ➡ Learn the theoretical basis of Equipartition principle and its limitation. ➡ Get an idea about the deviation of ideal behavior of the real gas, formulation of different equation of states (viz. van der Waals equation, Dieterici equation, Barthelot equation) to explain the behavior of real gases under different condition and also their limitations.
	Thermodynamics	On completion of the course, students will be able to: ➡ Know that any system in the universe is governed by the laws of thermodynamics, be it a living cell or be it the solar system. ➡ Get ideas about the principles/laws governing the physiochemical behavior of a system ➡ Know the application of thermodynamic principles for a system performing mechanical work and determination of change in internal energy, enthalpy, entropy, Gibbs free energy,Helmholtz free energy, etc. ➡ Acquire knowledge about the application of laws of thermodynamics in case of chemical reactions and learn fundamental laws governing thermo-chemistry. ➡ Get hands-on experience on determination of enthalpy of various physical and chemical processes.

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	Chemical Kinetics	On completion of the course, students will be able to: ➡ Know how fast a chemical reaction can occur under certain physical conditions and what are the specific roles of different parameters affecting the speed or rate of any chemical reaction. ➡ Understand the role of catalysts and biocatalyst (e.g. enzymes, etc.) in a catalyzed reaction. ➡ Solve numerical problems and experimentally determine the order, rate and activation energy of a chemical reaction.
Course Code: CC-01 Course Title: Organic Chemistry-1 (Prac)	***Basics of Organic Chemistry***	Upon successful completion students should be able to: ➡ Learn Separation based upon solubility ➡ Determination of boiling point ➡ Identification of a Pure Organic Compound by Chemical Test(s)
Course Code: CC-02 Course Title: Physical Chemistry-I (Prac)	***PRACTICAL***	Upon successful completion students should be able to determine and study : ➡ pH of unknown solution (buffer), by color matching method ➡ the reaction rate constant of hydrolysis of ethylacetate in the presence of an equal quantity of sodium hydroxide ➡ Study of kinetics of acid-catalyzed hydrolysis of methyl acetate ➡ Study of kinetics of decomposition of H2O2 by KI ➡ Determination of solubility product of PbI2 by titremetric method

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SEMESTER 2

Course Code: CC-03 Course Title: Inorganic Chemistry-I	***Extra nuclear Structure of atom***	At the end of the course, students will be able to understand ➡ Bohr's theory, Sommerfeld's Theory, ➡ de Broglie equation, Heisenberg's Uncertainty Principle and its significance, ➡ Schrödinger's wave equation, ➡ Pauli's Exclusion Principle, ➡ Hund's rules and multiplicity, ➡ Exchange energy, ➡ Aufbau principle and its limitations
	Chemical periodicity	On completion of the course, students will be able to: ➡ Understand the nature of elements and their different properties, ➡ periodic variation of the properties etc.
	Acid-Base reactions	On completion of the course, students will be able to: ➡ Understand the acid-base behaviours of different organic and inorganic compounds. ➡ Acquire the knowledge of pH in solution of compounds and hence the application in different fields.
	Redox Reactions and precipitation reactions	On completion of the course, students will be able to: ➡ Understand the redox phenomenon of redox active substances and its applications in different fields
Course Code: CC-04 Course Title: Organic Chemistry-II	***Stereochemistry II***	At the end of the course, students will be able to understand: ➡ Chirality arising out of stereoaxis ➡ Concept of prostereoisomerism Conformation ➡ Alkanes, diols and conformation of conjugated systems
	General Treatment of Reaction Mechanism II	On completion, students will learn about ➡ Reaction thermodynamics ➡ Tautomerism ➡ Concept of organic acids and bases ➡ Reaction kinetics
	Substitution and Elimination Reactions	On completion, students will learn about ➡ Free-radical substitution reaction ➡ Nucleophilic substitution reactions and Elimination reactions

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Course Code: CC-03 Course Title: Inorganic Chemistry-I (Prac)	***Oxidation-Reduction Titrimetric***	Upon successful completion students should be able to estimate: ➡ Fe(II) using standardized $KMnO_4$ 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)	***Organic Preparations***	Upon successful completion students should be able to perform the following reactions with the calculation of the yield product: ➡ Nitration of acetanilide ➡ Condensation reactions: Synthesis of 7-hydroxy-4-methylcoumarin ➡ Hydrolysis of amides/imides/esters ➡ Acetylation of phenols/aromatic amines (using Zn-dust/Acetic Acid) ➡ Benzoylation of phenols/aromatic amines ➡ Side chain oxidation of toluene and p-nitrotoluene ➡ Diazo coupling reactions of aromatic amines ➡ Bromination of acetanilide using green approach (Bromate-Bromide method) ➡ Green 'multi-component-coupling' reaction: Synthesis of dihydropyrimidone ➡ Selective reduction of m-dinitrobenzene to m-nitroaniline

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Course Code: CC-05 Course Title: Physical Chemistry-II	***Transport Processes***	At the end of the course the student will learn 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.
	Application of Thermodynamics – I	On completion, students get to know about ➡ 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. ➡ Distribution Law and ➡ Chemical Potential of pure and mixtures of ideal substances.
	Foundation of Quantum Mechanics	On completion of the course, students will be able to: ➡ Acquire fundamental knowledge regarding Planck's hypothesis and quantization of energy level, historical chronology leading to the development of Quantum Mechanics, wave-particle, duality of light and its consequences, explanation of several physical processes such as Black-body radiation, photo-electric effect, Compton effect, specific heats of solids, etc. ➡ Know Schrodinger's wave equation (time-independent), several mathematical techniques viz. operator algebra and their application to determine the physical property of different model and real quantum mechanical system, such as particle in a box, simple harmonic oscillator, rigid rotor and one-electron system like hydrogen atom.

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Course Code: CC-06 Course Title: Inorganic Chemistry-II (Theo)	***Chemical Bonding-I***	On completion of the course, students will learn: ➡ Ionic and Covalent Bond explained with Bent's rule ➡ Dipole moments ➡ VSEPR theory
	Chemical Bonding-II	On conclusion of this topic the students learn about ➡ Molecular orbital concept of bonding ➡ Metallic Bond and ➡ Weak Chemical Forces
	Radioactivity	On completion of the course, students will be able to: ➡ Understand the radioactivity and related phenomena of radioactive atoms. ➡ Know 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. ➡ Understand the hazards of radiations and also know the safety measures
Course Code: CC-07 Course Title: Organic Chemistry-III (Theo)	***Chemistry of alkenes and alkynes***	With completion of this course the students will be able to understand ➡ Addition to C=C: mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity ➡ Addition to C≡C (in comparison to C=C): mechanism, reactivity, regioselectivity (Markownikoff and anti-Markownikoff addition) stereoselectivity
	Aromatic Substitution	On completion of the course, students will be able to: ➡ Understand Electrophilic aromatic substitution ➡ and Nucleophilic aromatic substitution
	Carbonyl and Related Compounds	The completion of this course enabkes the student to understand ➡ Addition to C=O with benzoin condensation, Cannizzaro and Tischenko reactions, reactions with ylides: Wittig reaction; oxidations and reductions: Clemmensen, Wolff-Kishner, LiAlH4, NaBH4, MPV, Oppenauer, Bouveault-Blanc, acyloin condensation; oxidation of alcohols with PDC and PCC; periodic acid and lead tetraacetate oxidation of 1,2-diols. ➡ Exploitation of acidity of α-H of C=O, Aldol, Friedel-Crafts, Michael, Knoevenagel, Cannizzaro, Benzoin condensation and Dieckmann condensation by greener approach

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		➡ Nucleophilic addition to α,β-unsaturated carbonyl system ➡ Substitution at sp^2 carbon (C=O system)
	Organometallics	On completion of the course, students will be able to: ➡ Understand the different types of organic reactions involving carbon metal bonds. ➡ Understand the role of metals in controlling the regio- and stereo- specificities of the reactions. ➡ Realize the industrial application of organometallic chemistry. ➡ Know the use of organometallic compounds in the fields of catalysis, medicine etc.
Course Code: SEC-1 Course Title: Basic Analytical Chemistry	***Analytical Chemistry***	On completion of the course, students will be able to understand about ➡ Analysis of soil, Analysis of water, Analysis of food products, Chromatography, Ion-exchange and Analysis of cosmetics
Course Code: CC-05 Course Title: Physical Chemistry-II (Prac)	***Practical***	Upon successful completion students should be able to study the viscosity of unknown solution ➡ Study of viscosity of unknown liquid ➡ Determine the partition coefficient for the distribution of I2 between water and CCl4. ➡ Determine the Keq for KI + I2 □ KI3, using partition coefficient between water and CCl4 ➡ Conductometric titration of an acid (strong, weak/ monobasic, dibasic) against strong base. ➡ Study the saponification reaction conductometrically. ➡ Verify the Ostwald's dilution law and determination of Ka of weak acid.
Course Code: CC-06 Course Title: Inorganic Chemistry-II (Prac)	***Iodo/Iodimetric Titrations***	Upon successful completion students should be able to estimate: ➡ Cu(II), Vitamin C., arsenite by iodimetric method, Cu in brass and Cr and Mn in Steel
Course Code: CC-07 Course Title: Organic Chemistry-III (Prac)	***Qualitative Analysis of Single Solid Organic Compounds***	Upon successful completion students should be able to ➡ Detect special elements by Lassaigne's test ➡ check their solubility and classify them ➡ detect the different functional group, like, aromatic amine, nitro, amido,phenolic, carboxylic and carbonyl group ➡ learn to check the melting point and prepare a derivative.

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Course Code: CC-08 Course Title: Physical Chemistry-III (Theo)	***Application of Thermodynamics – II***	After the completion of the course the students learn ➡ Colligative properties ➡ Phase rule ➡ First order phase transition and Clapeyron equation; Clausius-Clapeyron equation – derivation and use ➡ Three component systems ➡ Binary solutions
	Electrical Properties of molecules	On completion of the course, students will be able to: ➡ Learn how to treat solutions containing ionic species thermodynamically; get an idea about activity and activity coefficient of various ionic species present in the solution; variation of activity coefficient with ionic strength. ➡ Get semi-qualitative ideas about Debye-Huckel limiting law and its application and limitation. ➡ 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. ➡ Concentration cells with and without transference, liquid junction potential ➡ Learn the application of potentiometric titration as analytical techniques and solving

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		numerical problems related to this topic
	Quantum Chemistry	After the completion of the course the students learn about ➡ Angular momentum ➡ Qualitative treatment of hydrogen atom and hydrogen-like ions ➡ LCAO and HF-SCF
Course Code: CC-09 **Course Title: Inorganic Chemistry-III (Theo)**	***General Principles of Metallurgy***	After the completion of the course the students 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.
	Chemistry of s and p Block Elements	After the completion of the course the students learn ➡ Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. ➡ Allotropy and catenation. ➡ Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Beryllium hydrides and halides. Boric acid and borates, boron nitrides, borohydrides (diborane) and graphitic compounds, silanes. Oxides and oxoacids of nitrogen, phosphorus, sulphur and chlorine. Peroxo acids of sulphur. Sulphur-nitrogen compounds. Basic properties of halides and polyhalides, interhalogen compounds, polyhalides, pseudohalides, fluorocarbons and chlorofluorocarbons
	Noble Gases	After the completion of the course the students learn about ➡ Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation, structures (VSEPR theory) and properties of XeF2, XeF4 and XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2 and XeF4). Xenon-oxygen compounds.
	Inorganic Polymers	On completion of this topic the students learn about ➡ Types of inorganic polymers, comparison with organic polymers, synthesis, structural

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		aspects and applications of silicones and siloxanes, Borazines, silicates and phosphazenes.
	Coordination Chemistry-I	On completion of this topic the students learn about ➡ Double and complex salts. ➡ Werner's theory of coordination complexes, Classification of ligands, chelates, coordination numbers, ➡ IUPAC nomenclature of coordination complexes (up to two metal centers), ➡ Isomerism in coordination compounds, constitutional and stereo isomerism, ➡ Geometrical and optical isomerism in square planar and octahedral complexes.
Course Code: CC-10 Course Title: Organic Chemistry-IV (Theo)	*Nitrogen compounds*	On completion of this topic the students learn about ➡ Amines ➡ Nitro compounds (aliphatic and aromatic) ➡ Alkylnitrile and isonitrile ➡ Diazonium salts and their related compounds
	Rearrangements	On completion of this topic the students learn about ➡ Rearrangement to electron-deficient carbon, ➡ Rearrangement to electron-deficient nitrogen: ➡ Rearrangement to electron-deficient oxygen ➡ Aromatic rearrangements ➡ Migration from nitrogen to ring carbon ➡ Rearrangement reactions by green approach
	The Logic of Organic Synthesis	On completion of this topic the students learn about ➡ Retrosynthetic analysis ➡ Strategy of ring synthesis and ➡ Asymmetric synthesis
	Organic Spectroscopy	On completion of this topic the students learn about ➡ UV Spectroscopy, ➡ IR Spectroscopy, ➡ NMR Spectroscopy and ➡ Applications of IR, UV and NMR spectroscopy for identification of simple organic molecules
Course Code: SEC-2 Course Title: Pharmaceuticals Chemistry	*Drugs & Pharmaceuticals*	This course mainly deals with the ➡ structural determination, ➡ synthesis and uses of some drugs such as antipyretics,analgesic,sulpha-drugs penicillin etc.
	Fermentation	On completion of this course students understand ➡ Aerobic and anaerobic fermentation

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Course Code: CC-08 Course Title: Physical Chemistry-III (Prac)	***PRACTICAL***	Upon successful completion students should be able to ➡ 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 K2Cr2O7 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. ➡ Study the phenol-water phase diagram.
Course Code: CC-09 Course Title: Inorganic Chemistry-III (Prac)	***Complexometric titration***	Upon successful completion students should be able to perform the quatitative titration of ➡ Zn(II), Zn(II) in a Zn(II) and Cu(II) mixture, Ca(II) and Mg(II) in a mixture ➡ Find the Hardness of water
	Inorganic preparations	At the end of the course students should learn about the preparation of ➡ [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)	***Estimation of different organic compounds***	At the end of the course students learn 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.

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Course Code: CC-11 Course Title: Inorganic Chemistry-IV (Theo)	***Coordination Chemistry-II***	On completion of this topic the students learn about ➡ VB description and its limitations. ➡ Elementary Crystal Field Theory Magnetism and Colour, quenching of magnetic Moment ➡ Racah parameter. ➡ Selection rules for electronic spectral transitions; spectrochemical series of ligands; charge transfer spectra
	Chemistry of d- and f- block elements	On completion of this topic the students learn about ➡ Transition Elements ➡ Lanthanoids and Actinoids
Course Code: CC-12 Course Title: Organic Chemistry-V (Theo)	***Carbocycles and Heterocycles***	On completion of the course, students will be able to: ➡ Know about different heterocyclic compounds of different sizes especially 5 and 6-membered heterocycles. ➡ Know the synthesis and reactions of different heterocycles. ➡ Understand many biological roles of some heterocycles.
	Cyclic Stereochemistry	On completion of the course, students will be able to: ➡ Alicyclic compounds: concept of I-strain; conformational analysis: cyclohexane, mono and disubstituted cyclohexane; ➡ symmetry properties and optical activity; ring-size and ease of cyclisation; conformation & reactivity in cyclohexane system: consideration of steric and stereoelectronic requirements; ➡ elimination (E2, E1), nucleophilic substitution (SN1, SN2, SNi, NGP), merged substitution-elimination; rearrangements; oxidation of cyclohexanol, esterification, saponification, lactonisation, epoxidation, pyrolytic syn elimination and fragmentation reactions.
	Pericyclic reactions	On completion of the course, students learn about ➡ Mechanism, stereochemistry, regioselectivity in case of 1. Electrocyclic reactions 2. Cycloaddition reactions and 3. Sigmatropic reactions
	Carbohydrates	On completion of the course, students will be able to understand ➡ different reactions and conformations of Monosaccharides
	Biomolecules	On completion of the course, students will be able to understand about ➡ Amino acids, Peptides and Nucleic acids

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	Alkaloids and Terpenoids	At the end of this course students can get a idea on ➡ terpenoids and alkaloids; ➡ determination of structure of α-Terpenol and ephedrine.
Course Code: DSE-1 Course Title: Advanced Physical Chemistry (Theo)	*Crystal Structure*	On completion of the course, students will be able to: ➡ Get an idea about the specific heat of solids, Einstein and Debye theory related to it; ➡ Laws of Crystallography;x-ray diffraction as a technique to explore the atomic/molecular-level structure of a crystalline solid. ➡ Learn Bragg's law and crystal planes; Miller indices; Idea about Bravais lattices and detailed discussion about cubic crystal system.
	Statistical Thermodynamics	On completion of the course, students will be able to: ➡ Understand the significance of this subject and will be able to appreciate the role it plays in bridging the two pillars of Physical Chemistry – Thermodynamics and Quantum Mechanics. ➡ Understand the "inside out" approach of this subject and acquire the basic knowledge about ensemble, kinds of ensemble, partition function and significance of partition function and representation of different thermodynamic quantities in terms of partition function. ➡ Get idea about classical statistical thermodynamics and Quantum statistics on an elementary level. ➡ Understand the relation between entropy and arrangement of different particles in various energy levels at the atomic level. ➡ Learn the mathematical derivation of Maxwell-Boltzmann distribution law and should be able to solve numerical problems related with this topic.
	Special selected topics	On completion of the course, students will be able to: ➡ Specific heat of solid ➡ 3rd law ➡ Polymers ➡ Dipole moment and polarizability
Course Code: DSE-2 Course Title: Analytical methods in chemistry (Theo)	*Qualitative and quantitative aspects of analysis*	On completion of the course, students will learn: ➡ Sampling, evaluation of analytical data, errors, accuracy and precision, methods of theirexpression, normal law of distribution, indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals

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	Optical methods of analysis	On completion of the course, students will learn: ➡ Origin of spectra, ➡ UV-Visible Spectrophotometry, ➡ Basic principles of quantitative analysis, ➡ Basic principles of quantitative analysis and ➡ Flame Atomic Absorption and Emission Spectroscopy
	Thermal methods of analysis	On completion of the course, students will be able to understand ➡ Theory of thermogravimetry (TG), ➡ basic principle of instrumentation. ➡ Techniques for quantitative estimation of Ca and Mg from their mixture.
	Electroanalytical methods	On completion of the course, students will be able to understand ➡ 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.
	Separation techniques	On completion of the course, students will be able to understand ➡ Solvent extraction, ➡ Technique of extraction, ➡ Qualitative and quantitative aspects of solvent extraction, ➡ Chromatography, ➡ Development of chromatograms, ➡ Qualitative and quantitative aspects of chromatographic methods of analysis, ➡ Stereoisomeric separation and analysis and ➡ Role of computers in instrumental methods of analysis
Course Code: CC-11 Course Title: Inorganic Chemistry-IV (Prac)	*Chromatography of metal ions*	On completion of the course, students will be able 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)

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	Gravimetry	On completion of the course, students will be able to understand ➡ Estimation of nickel (II) using Dimethylglyoxime (DMG). ➡ Estimation of copper as CuSCN ➡ Estimation of Al (III) by precipitating with oxine and weighing as Al(oxine)3 (aluminium oxinate) ➡ Estimation of chloride
	Spectrophotometry	On completion of the course, students will be able to learn ➡ spectrophotometric measurement of 10Dq of 3d metal complexes and ➡ Determination of λmax of KMnO4 and K2Cr2O7.
Course Code: CC-12 Course Title: Organic Chemistry-V (Prac)	***Chromatographic Separations***	On completion of the course, students will be able to learn about ➡ TLC, ➡ Column Chromatography ➡ Paper Chromatography separation.
	Spectroscopic Analysis of Organic Compounds	On completion of the course, students will be able to learn ➡ how to assign labelled peaks in the 1H NMR spectra and IR spectra and ➡ also to record the full spectral analysis of different compounds.
Course Code: DSE-1 Course Title: Advanced Physical Chemistry (Prac)	***PRACTICAL***	On completion of the course, students will be able to learn about Computer Programming based on numerical methods for ➡ Roots of equations, ➡ Numerical differentiation, ➡ Numerical integration and ➡ Matrix operations

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Course Code: DSE-2 Course Title: Analytical methods in chemistry (Prac)	***Separation Techniques - Chromatography***	On completion of the course, students will be able 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.
	Solvent Extractions	On completion of the course, students will be able to learn about ➡ separation of mixtures by solvent extraction, ➡ analysis of soil and ion exchange methods
	Spectrophotometry	On completion of the course, students will be able to learn ➡ how to determine pKa values of indicator using spectrophotometry, ➡ chemical oxygen demand, ➡ Biological oxygen demand

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Course Code: CC-13 Course Title: Inorganic Chemistry-V (Theo)	***Bioinorganic Chemistry***	On completion of the course, students will be able to: ➡ Understand different aspects (structures and biological functions) of the biomolecules like the metalloproteins, metalloenzymes etc containing metal ions. ➡ Know the different aspects like oxygen transport, electrontransport, hydrolysis of peptides in vertebrates and invertebrates.
	Organometallic Chemistry	On completion of the course, students will be able to ➡ Define and classify organometallic compounds on the basis of bond type. ➡ Concept of hapticity of organic ligands ➡ 18-electron and 16-electron rules (pictorial MO approach) and its application ➡ Zeise's salt, Ferrocine and Reactions of

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		organometallic complexes
	Catalysis by Organometallic Compounds	➡ On completion of the course, students will learn about different industrial processes like Alkene hydrogenation, Hydroformylation, Wacker Process, Synthetic gasoline and Ziegler-Natta catalysis for olefin polymerization
	Reaction Kinetics and Mechanism	At the end of the course, the students will be able to understand the ➡ Inorganic reaction mechanism.
Course Code: CC-14 Course Title: Physical Chemistry-IV (Theo)	***Molecular Spectroscopy***	At the end of the course, the students will be able to understand ➡ Interaction of electromagnetic radiation with molecules and various types of spectra and Born-Oppenheimer approximation ➡ Rotation spectroscopy ➡ Vibrational spectroscopy ➡ Raman spectroscopy ➡ Nuclear Magnetic Resonance (NMR) spectroscopy
	Photochemistry	On completion of the course, students will be able to: ➡ Get elementary ideas about the fundamental laws governing the chemical reaction induced by light ➡ Know the representation of various photo-physical processes by Jablonsky diagram. ➡ Be accustomed with the different scientific nomenclature frequently used for further extensive studies of the subject.
	Surface phenomenon	On completion of the course, students will be get to learn about ➡ Surface tension and energy ➡ Adsorption - Know about basic laws governing the adsorption; acquire an elementary idea about physisorption and chemisorptions. ➡ Have an idea about different adsorption isotherms and their theoretical derivation, thermodynamic aspects of sorption processes, role and function of heterogeneous catalysts. ➡ Colloids and Micelle formation
Course Code: DSE-3 Course Title: Green Chemistry (Theo)	***Green Chemistry: Principles and applications***	On completion of the course, students will be able to: ➡ Understand the source of environmental pollutions and their role in making a green world. ➡ Know the use of alternative energy sources, renewable feedstock and innocuous solvents. ➡ Understand the merits of using biodegradable materials and developing recyclable materials.

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		➡ Know about the developments of biofuels, rightfit pigments, green oxidants healthier fats and oils etc. ➡ Examples of Green Synthesis/ Reactions and some real world cases
Course Code: DSE-4 **Course Title: Dissertation followed by power point presentation**		On learning the course, the students will be able to ➡ Analyze the existing problems for which research can provide solutions and select the problem for research ➡ Know the various chemical publishers, journals and perform literature survey ➡ Synthesize new chemical compounds through various methods ➡ Characterize the compounds using various analytical and spectroscopical studies ➡ Learn to write their findings in a paper form ➡ Learn to present their dissertation in a power point
Course Code: CC-13 **Course Title: Inorganic Chemistry-V (Prac)**	***Qualitative semimicro analysis***	On completion ofthe course students will be able to perform ➡ Qualitative semimicro analysis of mixtures containing four radicals
Course Code: CC-14 **Course Title: Physical Chemistry-IV (Prac)**	***PRACTICAL***	On completion ofthe course students will be able to ➡ Determine the surface tension of a liquid using Stalagmometer. ➡ Determine the CMC from surface tension measurements. ➡ Verifify Beer and Lambert's Law for KMnO4 and K2Cr2O7 solution. ➡ Determine the pH of unknown buffer, spectrophotometrically.
Course Code: DSE-3 **Course Title: Green Chemistry (Prac)**	***PRACTICAL***	On completion of the course students will be able to learn about ➡ Preparation of propene, ➡ Benzoin condensation and ➡ Photo reduction of benzophenone to benzopinacol in the presence of sunlight.

Principal
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