Rayat Shikshan Sanstha's

Radhabai Kale Mahila Mahavidyalaya,Ahmednagar

Affiliated to Savitribai Phule Pune University, Pune (PU/AN/ASC/034)

F. Y. B. Sc. (Chemistry)

PO, PSO, CO

PROGRAMME OUTCOMES

PO-1: Conduct research relevant to a scientific issue, evaluate different sources of information including secondary data, understanding that a source may lack detail or show bias.

PO-2: Appreciate the role of science in society; and its personal, social and global importance; and how society influences scientific research.

PO-3: To understand and analyze the data (qualitatively/quantitatively) to identify patterns and relationships, identify anomalous observations, draw and justify conclusions

PO-4: To recognize questions that are appropriate for scientific investigation, pose testable hypotheses, and evaluate and compare strategies for investigating hypotheses.

PO-5: Students should appreciate the role of science in society; and its personal, social and global importance.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO:1- Provide a broad foundation in chemistry that stresses scientific reasoning and Analytical problem solving with a molecular perspective.

PSO:2- Achieve the skills required to succeed in graduate school, the chemical industry and professional school.

PSO:3- Get exposures of a breadth of experimental techniques using modern instrumentation.

PSO:4- Understand the importance of the Periodic Table of the Elements, how it came to be, and its role in organizing chemical information.

PSO:5- Understand the interdisciplinary nature of chemistry and to integrate knowledge of mathematics, physics and other disciplines to a wide variety of chemical problems.

PSO:6- Learn the laboratory skills needed to design, safely and interpret chemical research.

PSO:7- Acquire a foundation of chemistry of sufficient breadth and the depth to enable them to understand and critically interpret the primary chemical literature.

PSO:8- Develop the ability to communicate scientific information and research results in written and oral formats. learn professionalism, including the ability to work in teams and apply basic ethical principles

F.Y.B.Sc. Chemistry

COURSE OUTCOME

CH- 101: Physical Chemistry- After completing the course work learner will be acquired with knowledge of chemical energetics, Chemical equilibrium and ionic equilibria.

CH- 102: Organic Chemistry: Students will learn Fundamentals of organic chemistry, stereochemistry (Conformations, configurations and nomenclatures) and functional group approach for aliphatic hydrocarbons**.**

CH- 201: Inorganic Chemistry: Students will learn quantum mechanical approach to atomic structure, Periodicity of elements, various theories for chemical bonding.

CH-202: Analytical Chemistry: Students will know about basics of analytical chemistry, some techniques of analysis and able to do calculations essential for analysis. Lab Course

CH 103: Chemistry Practical Course I and CH-203: Chemistry Practical Course II

CO1. The practical course is in relevance to the theory courses to improve the Understanding of the concepts.
CO2. It would help in development of practical skills of the students.
CO3. Use of microscale techniques wherever required

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COURSE OUTCOMES (CO)

CH-301: Physical and Analytical Chemistry

CO1. Define / Explain concept of kinetics, terms used, rate laws, molecularity, order.

CO2. Explain factors affecting rate of reaction.

CO3. Explain / discuss / derive integrated rate laws, characteristics.

CO4. Determination of order of reaction by integrated rate equation method.

CO5. Explain / discuss the term energy of activation with the help of energy diagram.

CO6. Explanation for temperature coefficient and effect of temperature on rate constant k.

CO7. Derivation of Arrhenius equation and evaluation of energy of activation graphically.

CO8. Derivations of collision theory and transition state theory.

CO9. Solve / discuss the problem based applying theory and equations.

CH-302: Inorganic and Organic Chemistry

CO1. Define terms related to molecular orbital theory.

CO2. Explain and apply LCAO principle for the formation of MO's from AO's.

CO3. Explain formation of different types of MO's from AO's.

CO4. Distinguish between atomic and molecular orbitals, bonding, anti-bonding.

CO5. Define different terms related to the coordination chemistry

CO6. Explain / discuss synthesis of aromatic hydrocarbons.

CO7. Give the mechanism of reactions involved.

CO8. Explain /Discuss important reactions of aromatic hydrocarbon.

CO9. To correlate reagent and reactions.

CO10. Write / discuss the mechanism of various reactions involved.

CO11. Explain /Discuss important reactions of alcohols / phenols.

CO12. To correlate reagent and reactions of alcohols / phenols

CO13. Give synthesis of expected alcohols / phenols.

CH-303: Practical Chemistry-III [2 credit, 72* L]

CO1. Verify theoretical principles experimentally.

CO2. Interpret the experimental data on the basis of theoretical principles.

CO3. Correlate theory to experiments. Understand/verify theoretical principles.

CO4. Understand systematic methods of identification of substance by chemical methods.

CO5. Write balanced equation for the chemical reactions performed in the laboratory.

CO6. Perform organic and inorganic synthesis

CO7. Set up the apparatus / prepare the solutions - properly for the designed experiments.

CO8. Perform the quantitative chemical analysis of substances explain principles behind it.

CO9. Systematic working skill in laboratory will be imparted in student.

SEMESER-IV

CH-401: Physical and Analytical Chemistry

CO1. Define the terms in phase equilibria such as- system, phase in system, components insystem, degree of freedom, one / two component

system, phase rule, etc.

CO2. Explain meaning and Types of equilibrium such as true or static, metastable and unstableequilibrium.

CO3. Differentiate between ideal and non-ideal solutions and can apply Raoult's law.

CO4. Interpretation of i) vapour pressure–composition diagram ii) temperature- compositiondiagram.

CO5. Explain distillation of liquid solutions from temperature – composition diagram.

CO6. Explain / discuss azeotropes, Lever rule, Henrys law and its application.

CO7. Discuss / explain solubility of partially miscible liquids- systems .

CO8. Explain / discuss concept of distribution of solute amongst pair of immiscible solvents.

CO9. Derive distribution law and its thermodynamic proof.

CO10. Explain / discuss conductometric titrations.

CO11. Apply conductometric methods of analysis to real problem in analytical laboratory.

CO12. Solve problems based on theory / equations.

CO13. Correlate different terms with each other and derive equations for their correlations.

CO14. Apply colorimetric methods of analysis to real problem in analytical laboratory.

CO15. Apply column chromatographic process for real analysis in analytical laboratory.

CH-402: Inorganic and Organic Chemistry

CO1. Isomerism in coordination complexes

CO2. Explain different types of isomerism in coordination complexes.

CO3. Apply principles of VBT to explain bonding in coordination compound

CO4. Correlate no of unpaired electrons and orbitals used for bonding.

CO5. Identify / explain / discuss inner and outer orbital complexes.

CO6. Explain / discuss limitation of VBT.

CO7. Explain principle of CFT.

CO8. Apply crystal field theory to different type of complexes (Td, Oh, Sq. Pl complexes)

CO9. Explain: i) strong field and weak field ligand approach in Oh complexes

CO10. Write / discuss the mechanism reactions aldehydes and ketones.

CO11. Explain /Discuss important reactions of aldehydes and ketones.

CO12. To correlate reagent and reactions of aldehydes and ketones

CO13. Explain /Discuss important reactions of carboxylic amines.

CO14. To correlate reagent and reactions of carboxylic amines.

CO15. Draw structures of different conformations.

CO16. Identify cis- and trans-isomers of 1, 2 dimethyl substituted cyclohexane

CH-403: Practical Chemistry-IV

CO1. Interpret the experimental data on the basis of theoretical principles.

CO2. Correlate the theory to the experiments. Understand / verify theoretical principles byexperiment or explain practical output with the help of theory.

CO3. Understand systematic methods of identification of substance by chemical methods.

CO4. Write balanced equation for all the chemical reactions performed in the laboratory.

CO5. Perform organic and inorganic synthesis and able to follow the progress of the chemicalreaction.

CO6. Set up the apparatus properly for the designed experiments.

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PSO:6- Learn the laboratory skills needed to design, safely and interpret chemical research.

PSO:7- Acquire a foundation of chemistry of sufficient breadth and the depth to enable them to understand and critically interpret the primary chemical literature.

PSO:8- Develop the ability to communicate scientific information and research results in written and oral formats. learn professionalism, including the ability to work in teams and apply basic ethical principles

CH-501: Physical Chemistry- I

CO1. Know historical of development of quantum mechanics in chemistry.

CO2. Understand and explain the differences between classical and quantum mechanics.

CO3. Understand the idea of wave function

CO4. Understanding of De Broglie hypothesis and the uncertainty principle

CO5. Understanding the operators: Position, momentum and energy

CO6. Solving Schrodinger equation for 1D, 2D and 3D model

CO7. Physical interpretation of the ψ and ψ2 and sketching the wave function

CO8. Applications to conjugated systems, zero-point

CO9. Understand the term additive and constitutive properties.

CO10. Understand the term specific volume, molar volume and molar refraction.

CO11. Understand the meaning of electrical polarization of molecule, induced and orientationpolarization.

CO12. Dipole moment and its experimental determination by temperature variation method.

CO13. Electromagnetic spectrum, Nature of wave and its characteristics such as wavelength,wave number, frequency and velocity, Energy level diagram,

CO14. Classification of molecules on the basis of moment of Inertia,

CO15. Pure rotational Raman spectra of diatomic molecules, Energy Expression, Selection rule,Rotational energy level diagram, Rotational Raman spectrum and Problems

CO16. Photochemical reactions: photosynthesis, photolysis, photocatalysis, photosensitization

CO17. Various photochemical phenomena like fluorescence and phosphorescence, Chemiluminescence,

CH-502: Analytical Chemistry- I

CO1. Define basic terms in gravimetry, spectrophotometry, qualitative analysis and parameters in instrumental analysis. Such as: Gravimetry, precipitation, solubility product, ionic product. Define / Explain concept of kinetics, terms used, rate laws, molecularity, order.

CO2. Explain factors affecting rate of reaction.

CO3. Explain / discuss / derive integrated rate laws, characteristics, expression for half-life and examples of zero order, first order, and second order reactions.

CO4. Determination of order of reaction by integrated rate equation method, graphical method, half-life method and differential method.

CO5. Explain / discuss the term energy of activation with the help of energy diagram.

CO6. Explanation for temperature coefficient and effect of temperature on rate constant k.

CO7. Derivation of Arrhenius equation and evaluation of energy of activation graphically.

CO8. Derivations of collision theory and transition state theory of bimolecular reaction and comparison.

CO9. Solve / discuss the problem based applying theory and equations.

CH-504: Inorganic Chemistry – I

CO1. The meaning of metal & semiconductor.

CO2. The difference between metal, semiconductor and insulator.

CO3. Metallic bond on the basis of band theory.

CO4. The energy band and energy curve.

CO5. Draw n (E) & N (E) curves.

CO6. Explain the electrical conductivity of metals with respect to valence electrons.

CO7. Explain the effect of temperature and impurity on conductivity of metals and semiconductors.

CO8. Intrinsic and extrinsic semiconductor.

CO9. The term valance band and conduction band.

CO10. n and p type of semiconductors.

CO11. Non-stoichiometry and semi conductivity.

CO12. Insulators on the basis of band theory.

CO13. The difference between Na, Mg, and Al in terms of valence electrons and conductivity.

CH-505: Industrial Chemistry – I

CO1. Importance of chemical industry,

CO2. Meaning of the terms involved,

CO3. Comparison between batch and continuous process,

CO4. Knowledge of various industrial aspects

CO5. Concept of basic chemicals,

CO6. Their uses and manufacturing process.

CO7. They should also know the physico-chemical principals involved in manufacturing process

CH-507: Organic Chemistry – I

CO1. Define and classify polynuclear and hetreonuclear aromatic hydrocarbons.

CO2. Write the structure, synthesis of polynuclear and hetreonuclear aromatic hydrocarbons.

CO3. Understand the reactions and mechanisms

CO4. Explain the reactivity of polynuclear and hetreonuclear aromatic hydrocarbons.

CO5. Describe the synthesis of chemical reactions of polynuclear and hetreonuclear aromaticHydrocarbons.

CO6. Meaning of active methylene group

CO7. Reactivity of methylene group,

CO8. Synthetic applications ethyl acetoacetate and malonic ester

CO9. To predict product with panning or supply the reagent/s for these reactions

CO10. Electrocyclic rearrangement with their mechanisms Chapter

CO11. E1, E2 and E1cB mechanism with evidences of these reactions 4

CO12. Understand stereochemistry by using models and learn reactivity of geometrical isomers

CO13. Orientation and reactivity in E1 and E2 elimination

CO14. Hoffmann and Saytzeff's Orientation

CO15. Effect of factors on the rate elimination reactions

CH- 506: Inorganic Chemistry Practical-I

CO1. Gravimetric estimation of Fe as Fe2O3.

CO2. Gravimetric estimation of Ba as BaSO4 using homogeneous precipitation method.

CO3. Gravimetric estimation of Nickel as Ni – DMG.

CO4. Analysis of sodium bicarbonate from mixture by thermal decomposition method.

CO5. Determination of water of crystallization by thermal decomposition.

CO6. Analysis of Food/Pharmaceutical sample for ash and sulphated ash example-Aspirin

CO7. Preparation of inorganic complexes and spot tests for metal ions and ligands:

CO8. Inorganic Qualitative analysis

CH-507: Organic Chemistry - I

CO1. Define and classify polynuclear and hetreonuclear aromatic hydrocarbons.

CO2. Write the structure, synthesis of polynuclear and hetreonuclear aromatic hydrocarbons.

CO3. Understand the reactions and mechanisms

CO4. Explain the reactivity of polynuclear and hetreonuclear aromatic hydrocarbons.

CO5. Describe the synthesis of chemical reactions of polynuclear and hetreonuclear aromatic Hydrocarbons.

CO6. Meaning of active methylene group

CO7. Reactivity of methylene group,

CO8. Synthetic applications ethyl acetoacetate and malonic ester

CO9. To predict product with panning or supply the reagent/s for these reactions

CO10. What is rearrangement reaction?

CO11. Different types of intermediate in rearrangement reactions?

CH-508: Chemistry of Biomolecules

CO1. Introduction to molecular logic of life. The student will understanding of Cell types, Difference between a bacterial cell, Plant cell and animal cell. Biological composition and organization of cell membrane, structure and function of various cell organelles of plant andanimal cell. Concepts of biomolecules, Bonds that link monomeric units to form macromolecules

CO2. Carbohydrates: The student will understand the types of carbohydrates and their biochemical significance in living organisms, structure of carbohydrates and reactions ofcarbohydrates with Glucose as example. Properties of carbohydrates.

CO3. Lipids: The student needs to know the types of lipids with examples, structure of lipids,properties of lipids

CO4. Amino acids and proteins: The student will understand the structure and types of amino acids. Reactions of amino acids. Properties of amino acids. Peptide bond formation. Typesof proteins. Structural features in proteins. Effect of pH on structure of amino acid, Determination of N and C terminus of peptide chain.

CO5. Enzymes: The student know the classes of enzymes with subclasses and examples. Enzyme specificity, Equations of enzyme kinetics Km and its significance, features of various types of enzyme inhibitions, industrial applications of enzymes.

CH-509: Organic Chemistry Practical-I

CO1. Understand the phenomenon of catalysis, its basic principles and terminologies.

CO2. Define and differentiate homogeneous and heterogeneous catalysis.

CO3. Give examples and brief account of homogeneous catalysts.

CO4. Understand the essential properties of homogeneous catalysts-Give the

catalytic reactions for Wilkinson's Catalysis, hydroformylation reaction, Monsanto acetic acid synthesis,

CO5. Heck reaction

CO6. Understand the principle of heterogeneous catalyst and development in it.

CO7. Give examples of heterogeneous catalysts.

CO8. Understand the classification and essential properties of heterogeneous catalysts.

CO9. Give the brief account of Hydrogenation of olefins , Zeolites in catalysis, biodiesel synthesis, Automotive Exhaust catalysts

CO10. Understand the catalytic reactions used in industries around.

CO11. Identify the biological role of inorganic ions & compounds.

CO12. Know the abundance of elements in living system and earth crust.

CO13. Give the classification of metals as enzymatic and non-enzymatic.

CO14. Understand the role of metals in non-enzymatic processes.

CH-510 B Polymer Chemistry

CO1. History of polymers.

CO2. Difference between simple compounds and polymer.

CO3. Names of polymers.

CO4. Various ways of nomenclature.

CO5. Difference between natural, synthetic, organic and inorganic polymers.

CO6. Terms-Monomer, Polymer, Polymerization, Degree of polymerization, Functionality, Number average, Weight average molecular weight.

CO7. Mechanisms of polymerization.

CO8. Polymerization techniques.

CO9. Uses & properties of polymers.

CO10. Role of polymer industry in the economy.

CO11. Advantages of polymers

CH-511 (A): Environmental Chemistry

CO1. Importance and conservation of environment.

CO2. Water resources

CO3. Hydrological Cycle

CO4. Organic and inorganic pollutants

CO5. Water quality parameters

Semester II

CH-601: Physical Chemistry-II

CO1. Electrochemical cells: Explanation of Daniell cell, Conventions to representelectrochemical cells

CO2. Thermodynamic conditions of reversible cell, Explanations of reversible and irreversibleelectrochemical cell with suitable example,

CO3. EMF of electrochemical cell and its measurement.

CO4. The Weston standard cell

CO5. The primary reference electrode: The standard hydrogen electrode (SHE) with reference to diagram, Construction, representation, working and limitation,

CO6. Types of concentration cells: Concentration cells without and with transferenceConcentration cells with liquid junction potential

CO7. Liquid junction potential and salt bridge

CO8. Applications of emf measurements: 1. Determination of pH of a solution by using hydrogen electrode, quinhydrone electrode and glass electrodes 2. Potentiometric titrations: i) Acid-base titrations, (ii) Redox titrations and (iii) Precipitation

CO9. Primary Batteries: Dry Cells, alkaline batteries with respect to construction, diagram and working

CO10. Methods of Crystal structure analysis: The Laue method and Braggs method: Derivationof Bragg's equation,

CO11. Determination of crystal structure of NaCl by Bragg's method,

CO12. X ray analysis of NaCl crystal system and Calculation of d and λ for a crystal system,

CO13. Radioactivity

CO14. Types and properties of radiations: alpha, beta and gamma

CH-602 Physical Chemistry-III

CO1. Meaning of the terms-Solution, electrolytes, nonelectrolytes and colligative properties,

CO2. Lowering of vapour pressure of solvent in solution,

CO3. Elevation of B.P. of solvent in solution, Landsberger's method,

CO4. Factors affecting on solid state reactions,

CO5. Rate laws for reactions in solid state

CO6. Applying rate laws for solid state reactions

CO7. Results of kinetics studies

CO8. Cohesive Energy of ionic crystals based on coulomb's law and Born Haber Cycle

CH-603 : Physical Chemistry Practical-II

CO1. To determine the PKa value of given monobasic weak acid by potentiometric titration.

CO2. To determine the formal redox potential of Fe_2+/ Fe_3+ system potentiometrically.

CO3. To determine the amount of NaCl in the given solution by potentiometric titration againstsilver nitrate.

CO4. To determine the solubility product and solubility of AgCl potentiometrically usingchemical cell.

CO5. Estimate the amount of Cl-, Br- and I- in given unknown halide mixture by titrating itagainst standard AgNO3 solution (mixture of any two ions).

CO6. To prepare standard 0.2 M Na2HPO4 and 0.1 M Citric acid solution, hence prepare four different buffer solutions using them. Determine the pH value of these and unknownsolution.

CO7. To determine the standard electrode potentials of Cu and Ag electrodes and to determinethe EMF of a concentration cell.

CO8. To determine the degree of hydrolysis of aniline hydrochloride.

CO9. To determine the dissociation constant of oxalic acid by pH-metric titration with strongbase.

CO10. Determination of Pka of given weak acid by pH metry titration with strong base

CO11. To determine the acid and base dissociation constant of an amino acid and hence theisoelectric point of an acid.

CO12. pH metric titration of strong acid against strong base by pH measurement and hencedetermine the concentration and strength of strong acid.

CO13. To determine plateau voltage of the given G M counter.

CO14. To determine the resolving time of GM counter.

CO15. To determine the molecular weight of solute by depression in freezing point method

CO16. To study the association of Benzoic acid in benzene by Beckmann Method

CO17. titration orcalibration curve method)

CO18. To determine the molecular weight of a given polymer by turbidometry

CH-604 : Inorganic Chemistry -II

CO1. To understand M-C bond and to define organometallic compounds

CO2. To define organometallic chemistry

CO3. To understand the multiple bonding due to CO ligand

CO4. Define and differentiate homogeneous and heterogeneous catalysis.

CO5. Give examples and brief account of homogeneous catalysts.

CO6. Understand the essential properties of homogeneous catalysts-Give the catalytic reactionsfor Wilkinson's Catalysis, hydroformylation reaction, Monsanto acetic acid synthesis.

CO7. Understand the principle of heterogeneous catalyst and development in it.

CO8. Give examples of heterogeneous catalysts.

CO9. Know the metalloproteins of iron.

CO10. Explain the functions of hemoglobin and myoglobin in O_2 transport and storage.

CO11. Understand the toxicity of CN- and CO binding to Hb.

CO12. Draw the structure of Vit.B_{12} and give its metabolism.

CH-605: Inorganic Chemistry -III

CO1. Student will learn the concept of acid base and their theories.

CO2. They will also come to know different properties of acids and bases.

CO3. Strength of various types acids.

CO4. How acid and base strengths get affected in non-aqueous solvents..

CO5. Be able to define Pauling's univalent radius and crystal radius

CO6. Different Zeolite Framework Types and their classification

CO7. Various methods of nanoparticle synthesis

CO8. Stabilization of Nanoparticles in solution

CO9. Properties and Application of Nanoparticles

CO10. Know about carbon nanotube and its application

CH-606: Inorganic Chemistry Practical-II

CO1. Analysis of Phosphate (PO_4^{3-}) from Fertilizer.

CO2. Analysis of Iodine from Iodized salt.

CO3. Strength of medicinal H_2O_2.

CO4. Analysis of Calcium from milk powder.

CO5. Analysis of Cu from Cu-Fungicide.

CO6. Estimation of Na by flame photometry by calibration curve method.

CO7. Estimation of Na by flame photometry by regression method.

CO8. Estimation of K by flame photometry by calibration curve method.

CO9. Band gap calculation for the nanomaterial TiO_2/ SnO_2/ ZnO from its electronic spectra (UV-Visible).

CH-607: Organic Chemistry-II

CO1. Students will learn the principle of mass spectroscopy, its instrumentation and nature of massspectrum.

CO2. Students will understand the principle of UV spectroscopy and the nature

of UV spectrum.They will learn types of electronic excitations.

CO3. Students will be able to calculate maximum wavelength for any conjugated system.

CO4. And fromthe value of λ-max they will be able to find out the extent of conjugation in the compound.

CO5. Students will understand the principle of IR spectroscopy, types of vibrations and the nature ofIR spectrum.

CO6. From the IR spectrum, they will be able to find out IR frequencies of different functionalgroups. And thus, they will be able to find functional groups present in the compound.

CO7. Students will understand the principle of NMR spectroscopy and will understand variousterms used in NMR spectroscopy. They will learn measurement of chemical shift and coupling constants.

CH-608: Organic Chemistry-III

CO1. Students will be able to interpret the NMR data and they will be able to use it fordetermination of structure of organic compounds.

CO2. Students will be able to determine the structure of simple organic compounds on the basis ofspectral data such as λ max values, IR frequencies, chemical shift (δ values).

CO3. The use of models to draw different types of disubstituted cyclohexanes in chair form

CO4. The geometrical isomerism in disubstituted cyclohexanes

CO5. The stability, energy calculations and optical activity of these conformers

CO6. The use models and to draw different types of conformational isomers of decalin in chair form to know the stability of geometrical isomers of decalin

CH-609: Organic Chemistry Practical-II

CO1. Explain “fingerprint region” of an infrared spectrum can used in the identification

of anunknown compound.

CO2. Identify the functional group or groups present in a compound.

CO3. Identify the broad regions of the infrared spectrum in which occur absorptions caused byN−H, C−H, and O−H, C≡C and C≡N, C=O, C=N, and C=C.

CO4. Understand use NMR spectra to determine the structures of compounds.

CO5. Interpret integration of NMR spectra

CO6. Calculate coupling constants from 1 H NMR spectra.

CO7. Interpret elemental analysis technique

CH-610: Skill Enhancing Course-III

CO1. Understood various components of soil and soil properties and their impact on plantgrowth.

CO2. Understood the classification of the soil.

CO3. Explores the problems and potentials of soil and decide the most appropriate treatmentfor land use.

CO4. Understood the Reclamation and management of soil physical and chemical constraints.

CO5. Useful in making decisions on nutrient dose, choice of fertilizers and method ofapplication etc. practiced in crop production.

CO6. Got experience on advanced analytical and instrumentation methods in the estimation ofsoil.

CO7. Understood various Nutrient management concepts and Nutrient use efficiencies ofmajor and micronutrients and enhancement techniques.

CO8. Proper understanding of chemistry of pesticides will be inculcated among the students.

CO9. Imparts knowledge on different pesticides, their nature and, mode of action and their fatein soil so as to monitor their effect on the environment.

CH-610 (A): Chemistry of Soil and Agrochemicals

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CH-611(A): Analytical Chemistry-II

CO1. Define basic terms in solvent extraction, basics of chromatography, HPLC, GC, and AAS and AES.

CO2. Identify important parameters in analytical processes or estimations. Example: minimum analyte concentration in particular method, reagent concentration for particular analysis,

CO3. Perform quantitative calculations depending upon equations students has studied in the theory.Furthermore, student should able to solve problems on the basis of theory.

CO4. Discuss / Describe procedure for different types analyses included in the syllabus.

CO5. Select particular method of analysis if analyte sample is given to him.

CO6. Differentiate / distinguish / compare among the different analytical terms, process and analytical methods.

CO7. Demonstrate / explain theoretical principles with help of practical.

CO8. Design analytical procedure for given sample.

CO9. Apply whatever theoretical principles he has studied in theory during practical in

laboratory.

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Affiliated to Savitribai Phule Pune University, Pune (PU/AN/ASC/034)

M.Sc. (Chemistry) Part-I
Choice Based Credit System Syllabus
PO, PSO, CO

Programme Outcomes (POs)

PO No.	PO Statement	Knowledge and Skill
PO-1	Learn the terms theories, assumptions, methods, principles, theorem statements andclassification	Disciplinary knowledge
PO-2	Fix out the problem and resolve it using theories and practical knowledge.	Critical thinking and Problem solving
PO-3	Inculcate knowledge for carrying projects and advanced research related skills.	Research related skill
PO-4	Actively participate in team on case studies and field-based situations.	Cooperation/Team work
PO-5	Analyze and interpret ideas, evidences and experiences with learned scientific reasoning	Scientific reasoning
PO-6	Aware and implement the subject facts thatcan be applied for the personal and social development	Reflective thinking
PO-7	Use digital literacy to retrieve and evaluate subject related information	Information/Digitally literacy
PO-8	Get moral and ethical values for society as well as in research	Moral and ethical awareness
PO-9	Give analytical reasoning to interpret research data.	Analytical Reasoning
PO-10	Improve their managerial skills and abilities in subject related activities.	Leadership readiness/qualities
PO-11	Inculcate continuous learning habit through all available resources.	Lifelong readiness/qualities

Programme Specific Outcomes (PSOs)

PO-No.	Outcomes	Component
PSO-1	Demonstrate a comprehensive knowledge of all disciplines.	Disciplinary knowledge
PSO-2	To assess and evaluate facts, claims and arguments using their scientific knowledge	Critical thinking
PSO-3	To define a problem, analyse, interpret and drawconclusion by planning, implementing and reporting the results of an experiment.	Research relatedskills
PSO-4	To access, evaluate and apply a variety of useful sources	Information/digital literacy
PSO-5	To participate in multicultural society and communicate the subject knowledge for thebetterment of society	Multicultural competence
PSO-6	To acquire knowledge and skills	Lifelonglearning

Course Outcomes

Semester I

CHP-110, Physical Chemistry-I

CO1: Students should be able to remember the concepts of thermodynamic parameters, quantum mechanical postulates, rate laws of chemical reactions and computation of macroscopic properties of matter.

CO2: Students should understand the basics like state function and path function, Schrodinger wave equation, kinetics of fast reactions, partition functions and ensembles.

CO3: Students should be able to apply the knowledge of various quantum mechanical methods to determine the different molecular properties and built the concept of the relation between thermodynamics and quantum mechanics.

CO4: Students should be able to analyze the rates of various chemical reactions both theoretically and experimentally and also observe the effect of catalyst and determine energies of activation of such reactions.

CHI-130, Inorganic Chemistry-I

CO1. Student should visualize/ imagine molecules in 3 dimensions.
CO2. To understand the concept of symmetry and able to pass various symmetry elementsthrough the molecule.
CO3. Understand the concept and point group and apply it to molecules.
CO4. To understand product of symmetry operations.
CO5. To apply the concept of point group for determining optical activity and dipole moment.

CHO-150, Organic Chemistry-I

CO1. To understand some fundamental aspects of organic chemistry, to learn the concept aromaticity, to understand the various types of aromaticity

CO2. To study heterocyclic compound containing one and two hetero atoms with their structure, synthesis and reactions.

CO3. To know stereochemistry of organic compounds; able to do interconversion of Fischer to Newmann, Newmann to Sawhorse and vice versa, Able to assign R and S to given molecules; understand stereoselective and stereospecific reactions; acquire knowledge on topicity.

CO4. To study structure, formation, stability and related name reaction of intermediates like Carbocation, Carbanion, Free Radical, Carbenes and nitrenes; Recognize neighboring group participation

CO5. To study rearrangement reaction with specific mechanism and migratory aptitude of different groups.

CO6. To study Ylides and their reaction.

CO7. To understands the basis of redox reaction; acquire knowledge about the reagents which causes selective oxidation / reduction in various compounds; learn the basic mechanismof oxidation / reduction in organic compounds.

CHG – 190, General Chemistry-I

Elective Option-A: Introduction to Solid State of Matter

CO1. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.

CO2. Students will be able to function as a member of an interdisciplinary problem solving team.

CO3. To impart the students thorough idea in the chemistry of carbohydrates, amino acids, proteins and nucleic acids etc.

CO4. Be able to describe the chemical basis for replication, transcription, translation and how each of these central processes can be expanded to include new chemical matter.

CO5. Develop skills to critically read the literature and effectively communicate research in a peer setting.

CHP-107: Practical Course – I

CO1. Students will grasp the concept of reaction rate and its significance in Chemical Kinetics.
CO2. Students will learn how to use experimental data to deduce rate laws and rate constants.
CO3. Students will be familiar with the fundamental principles of colorimetry and spectrophotometry including Beer's law, Lambert- Beer's law and the relationship between absorbance and concentration.
CO4. Students will able to operate the instruments like spectrophotometer and colorimeter.
CO5. Students will be able to determine the densities of the solutions and can calculate molar volumes.

Semester - II
CHP-210, Physical Chemistry-II

CO1. Remember basic concepts of molecular spectroscopy, selection rules, intensity of spectral lines, radioactive decay and decay kinetics.
CO2. Understand principles and applications of rotational, vibrational, Raman, electronic and Mossbauer spectroscopy. Understand concepts of nuclear and radiation Chemistry. Applications of Radioisotopes
CO3. Apply various spectroscopic techniques for gaining insights into molecular structure
CO4. Analyse vibrating diatomic molecule, simple harmonic and anharmonic oscillator, Scattering of light, Raman Spectrum, interaction of γ radiation with matter and radiation dosimetry.

CHI-230, Inorganic Chemistry-II

CO1. Student should able to find out the no of microstates and meaningful term symbols, construction of microstate table for various configuration
CO2. Hund's rules for arranging the terms according to energy.
CO3. Student should understand interelectronic repulsion.
CO4. Student should know the concept of weak and strong ligand field.
CO5. Student able to find out splitting of the free ion terms in weak ligand field and strong ligand field. Importance of bioinorganic chemistry.
CO6. Role of metals in Metalloprotein and metalloenzymes.
CO7. Similarities in coordination theory for metal complexes and metal ions complexed with biological ligands.
CO8. Importance and transport of metal ions.

CHO – 250, Organic Chemistry-II

CO1. MOT and will be able to extend this in predicting reaction mechanism and stereochemistry of electrocyclic reactions.
CO2. The concepts in free radical reactions, mechanism and the stereo chemical outcomes.
CO3. The basic principle of spectroscopic methods and their applications in structure elucidation of organic compounds using given spectroscopic data or spectra.

CHG – 290, General Chemistry -II

CO1. Valence electron count, back bonding in organometallics, spectral characterization of

organometallic compounds.

CO2. Catalytic reaction involving organometallic compounds and mechanism of these reactions

CO3. Types of reaction involving organometallic compounds

CHP-227: Practical Course-II

CO1. Students are trained to different purification techniques in organic chemistry like recrystallization, distillation, steam distillation and extraction.

CO2. Students are made aware of safety techniques and handling of chemicals

CO3. Students are made aware of carrying out different types of reactions and their workup methods.

CO4. This practical course is designed to make student aware of green chemistry and role of green chemistry in pollution reduction

Rayat Shikshan Sanstha's

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M.Sc. (Organic Chemistry) Part-II

Choice Based Credit System Syllabus

PO, PSO, CO

PO No.	PO Statement After completing the Programme Master of Science in Organic Chemistry, students will be able to	Knowledge and Skill
PO-1	Learn the terms, theories, assumptions, methods, principles, theory statements, and classification.	Disciplinary knowledge
PO-2	Fixed out the problem and resolved it using theories and practical knowledge.	Critical thinking & Problem-solving
PO-3	Inculcate his knowledge for carrying projects and advanced research-related skills.	Research related skill
PO-4	Actively participate in the team on case studies and field-based situations.	Cooperation/Teamwork
PO-5	Analyse and interpret ideas, evidence, and experiences with learned scientific reasoning	Scientific reasoning
PO-6	Aware and implement the subject facts that can be applied to personal and social development	Reflective thinking
PO-7	Use digital literacy to retrieve and evaluate subject-related information	Information/Digitally literacy:
PO-8	Get moral and ethical values for society as well as in research	Moral and ethical awareness
PO-9	Give analytical reasoning to interpret research data.	Analytical Reasoning
PO-10	Improve their managerial skills and abilities in subject-related activities.	Leadership readiness/qualities
PO-11	Inculcate continuous learning habits through all available resources.	Lifelong readiness/qualities

PROGRAM SPECIFIC OUTCOMES (PSOs)

PO No.	PSO Statement After completing the Programme Master of Science in Organic Chemistry, students will be able to
PSO-1	Demonstrate proficiency in advanced terms, theories, principles, and techniques of chemistry through different courses, laboratory experiments, and research projects.
PSO-2	Develop a foundational understanding of research methodologies, including literature review, hypothesis formulation, experimental design, data analysis, and interpretation.
PSO-3	Acquire hands-on experience with advanced chemistry-related equipment.
PSO-4	Apply modern research techniques to investigate complex chemical phenomena and solve practical problems.
PSO-5	Demonstrate competence in quality assurance and quality control practices essential for industry.

Semester III

CHO-350 Organic reaction mechanism and Biogenesis

CO1. Acquire familiarity with fundamental organic reaction mechanisms and stereochemistry principles.

CO2. Gain a comprehensive understanding of Theoretical Concepts to Predict Reactivity and Selectivity.

CO3. Apply concepts of reaction mechanisms and stereochemistry

CO4. Learn the fundamental aspects and knowledge of natural products

CO5. Know the different pathways and biogenesis of natural products .

CO6. Apply the gained knowledge in the synthesis of natural products .

CHO-351: Structure Determination of Organic Compounds bySpectroscopic Methods

Course Outcomes:

After completion of this course, the student will student will be able to

CO1. Learn the fundamental knowledge of 1H NMR, 13C NMR, 19F NMR and Mass Spectral techniques.

CO2. Acquire advanced knowledge of 1H NMR, 13C NMR, 19F NMR and Mass Spectral techniques.

CO3. Apply the knowledge of 1H NMR, 13C NMR, 19F NMR and Mass Spectral techniques for structure determination.

CO4. Discuss probable spectral signals.
CO5. Interpret different types of spectra. CO6: Deduce the structure of the unknown compound using 1H NMR, 13C NMR and Mass Spectra

CHO-352: Stereochemistry and Asymmetric Synthesis of Organic Compounds

Course Outcome

CO1. Understand the stereochemistry, reactivity and conformational effects of six membered rings.
CO2. Understand the stereochemistry, shapes of rings other than six membered rings.
CO3. Understand the role various resolution methods, stereoselective synthesis and asymmetric synthesis.
CO4. Understand the stereochemistry of polymer chain

CHO-353 Protection Deprotection, Chiron approach and Carbohydrate synthesis

Course Outcome

CO1. Recall monosaccharide structures and D/L forms in Fisher projections.

CO2. Understand cyclic hemiacetal forms and anomeric configurations.

CO3. Applying Chiron approaches, they'll design syntheses of complex chiral molecules.

CO4. Analyze protective group strategies between temporary and permanent groups.

CO5. Evaluate glycosylation methods, stereoselectivity, and coupling efficiency.
CO6. Summarize the planning of synthesis, pathways for chiral compound synthesis.

CCPP-3, CHO-354: Practical-I Solvent Free Organic Synthesis

Course Outcome

CO-1: Know the principles of green chemistry and the importance of sustainability in chemical processes.

CO-2: Identify solvent-free reactions using appropriate techniques and equipment.

CO-3: Optimize green chemistry reactions in the laboratory.

CO-4: Analyze the advantages and disadvantages of solvent-free reactions, green catalysts, andgreen solvents in comparison to traditional chemical methodologies.

CO-5: Assess the role of green catalysts in promoting the desired reactions while minimizing wasteand environmental impact.

CO-6: Communicate experimental procedures, results, and conclusions effectively through written reports and oral presentations.

Semester IV

CCTP- 10, CHO-450: Chemistry of Natural Products

Course Outcome

CO1: Learn the fundamental aspects and knowledge of natural products.
CO2: Know the different pathways and biogenesis of natural products
CO3: Apply the gained knowledge in the synthesis of natural products.
CO4: Categorize the organic functional group transformations in their synthesis.
CO5: Interpret the logical retrosynthetic analysis.
CO6: Design the mechanism and stereochemistry of Natural products.

CHO-451 Organometallic Reagents in Organic Chemistry

Course Outcome

CO1: Learn the fundamental concepts of organometallic reactions and their bonding, reactivity,and mechanism.

CO2: Understand the significance of advanced organometallic reagents in organic chemistry. CO3: Employ synthetic methodologies for cross-coupling reactions, enabling the formation of C-C, C-N, and other bonds.

CO4: Analyze the products of synthetic organic reactions.
CO5: Relate the products of the retrosynthetic transformations with the Target Molecules. CO6: Design the summary of advanced synthetic reagents, their reactions and the products.

CHO-452 Medicinal Chemistry

CO1: Identify drug and learn different stages of drug design and development.

CO2: Know the application of computers in drug design.

CO3: Categorize various stages of Drug action and analyze various factors affecting drug action.

CO4: distinguish between infectious and non-infectious diseases

CO5: Relate the infectious diseases and causative agents.

CO6: Summarize the overall significance, development and applications of various drugs.

CHO-453 Sec I: Ternary Mixture Separation

Sec II: Carbohydrate synthesis and isolation of natural products

CO1: understand the concept of type determination and apply separation techniques.
CO2: comprehend different purification techniques.
CO3: accurately record and report physical constants.
CO4: analyze microscale chemical elemental analysis.
CO5: evaluate and execute qualitative estimation of functional groups.
CO6: create a report on ternary mixture separation.

CHO-454 Convergent and divergent Organic synthesis

CO-1: Learn new synthetic methodologies for the selective modification of starting materials.

CO-2: Recognize the reactivity of starting materials towards different reagents and reaction conditions.

CO-3: Apply multi-step synthesis strategies to construct complex molecules from simple starting materials.

CO-4: Analyze reaction mechanisms and intermediates to understand the synthesis pathways.

CO-5 Evaluate the efficiency and practicality of different synthetic routes based on yield and selectivity.

CO-6: Create novel synthesis routes based on the principles of organic chemistry and reactivitypatterns.

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M. Sc. II Analytical Chemistry (CBCS-2023 Pattern)
Semester I
PO, PSO, CO
PROGRAM OUTCOMES

PO No.	PO Statement	Knowledge and Skill
PO-1	Learn the terms, theories, assumptions, methods, principles, theory statements, and classification	Disciplinary knowledge
PO-2	Fixed out the problem and resolved it using theories and practical knowledge.	Critical thinking & Problem-solving
PO-3	Inculcate his knowledge for carrying projects and advanced research-related skills.	Research related skill
PO-4	Actively participate in the team on case studies and field-based situations.	Cooperation/Teamwork
PO-5	Analyse and interpret ideas, evidence, and experiences with learned scientific reasoning	Scientific reasoning
PO-6	Aware and implement the subject facts that can be applied to personal and social development	Reflective thinking
PO-7	Use digital literacy to retrieve and evaluate subject-related information	Information/Digitally literacy:
PO-8	Get moral and ethical values for society as well as in research	Moral and ethical awareness
PO-9	Give analytical reasoning to interpret research data.	Analytical Reasoning
PO-10	Improve their managerial skills and abilities in subject-related activities.	Leadership readiness/qualities

PROGRAM SPECIFIC OUTCOMES

PO No.	PSO Statement After completing the Programme Master of Science in Analytical Chemistry, students will be able to
PSO-1	Demonstrate proficiency in advanced terms, theories, principles, and techniques of chemistry through different courses, laboratory experiments, and research projects.
PSO-2	Develop a foundational understanding of research methodologies, including literature review, hypothesis formulation, experimental design, data analysis, and interpretation.
PSO-3	Acquire hands-on experience with advanced chemistry-related equipment.
PSO-4	Apply modern research techniques to investigate complex chemical phenomena and solve practical problems.
PSO-5	Demonstrate competence in quality assurance and quality control practices essential for industry.

COURSE OUTCOMES

CHA-390: Electrochemical and Thermogravimetric Methods of Chemical Analysis

CO1. Define various terms in electrochemistry and thermogravimetry.
CO2. Explain instrumentation in electrochemistry and thermogravimetry.
CO3. describe basic principles of electrochemistry and thermogravimetry.
CO4. Explain /Describe applications of electrochemistry and thermogravimetry in industry and in analytical laboratory.
CO5. Apply / select particular method of analysis for sample to be analysed.
CO6. Solve numerical problems on electrochemistry and thermogravimetry.
CO7. Interpret polarogram, cyclic voltammogram, pulse polarogram, thermogram, differential thermogram and DSC thermogram.

CHA-391: Analytical Method Development and Extraction Techniques

Course Outcomes

CO1. Define / understand various terms in analytical extraction and method development and validation.
CO2. Explain instrumentations and methodology in analytical extraction.
CO3. Explain / describe basic principles of analytical extraction method development and validation.
CO4. Explain /Describe applications analytical extraction and method development

and validation in industry and in analytical laboratory.

CO5. Apply / select particular method of analysis for sample to be analysed.

CO6. Solve numerical problems on analytical extraction and method development and validation.

CO7. Develop analytical method for analysis of given sample. Apply statistical treatment to the analytical data. Select appropriate parameters for the development of analytical method

CHA-392: Advanced Chromatographic Methods of Analysis

Course Outcomes

CO1. Define / understand various terms in chromatography (GC and HPLC) and mass spectroscopy.

CO2. Explain instrumentations in chromatography (GC and HPLC) and mass spectroscopy.

CO3. Explain / describe i) basic principles of chromatography (GC and HPLC) and mass spectroscopy. ii) separation in GC / HPLC column. iii) Functioning and construction of GC / HPLC/ MS detectors.

CO4. Explain /Describe applications chromatography (GC and HPLC) in industry and in analytical laboratory.

CO5. Apply / select particular method / instrumental parameters for analysis for sample GC / HPLC.

CO6. Solve numerical problems on chromatography (GC and HPLC) and mass spectroscopy.

CO7. Integrate GC and HPLC chromatogram, Mass spectrum

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CHA-393: B) Analysis of Food and Controlled Substances

Course Outcomes

CO1. Define / understand various terms in food analysis techniques and methods, forensic science and drug substances.

CO2. Explain methods and principles of analysis of i) Food - carbohydrates, proteins, preservatives, ii) drug substances.

CO3. Select appropriate methods of food analysis for its quality.

CO4. Select appropriate methods for identification of drug and analysis of drug from sample.

CO5. Select and describe the parameters required for food quality.

CO6. Solve numerical problems on analysis food and drug substances.

CO7. Interpret food quality and drug substances from analytical results.

Semester II

CHA-490: Advanced Analytical Spectroscopic Techniques

Course Outcomes

At the end of course students should able to-

CO1. Define / understand various terms in atomic absorption, atomic emission, fluorescence, ESR and electron spectroscopy.

CO2. Explain instrumentation of atomic absorption, atomic emission, ICPAES, ICPAES-MS, fluorescence, ESR and electron spectroscopy.

CO3. To describe basic principles of atomic absorption, atomic emission, ICPAES, ICPAES- MS, fluorescence, ESR and electron spectroscopy.

CO4. Select appropriate methods for sample treatment in AAS / AES, ICPAES, ICPAES-

MS.

CO5. Explain advantages of ICPAES-MS over AES spectroscopy, fluorescence spectroscopy.

CO6. Solve numerical problems on analysis all these spectroscopic methods.

CO7. Interpret ESR spectra, super hyperfine splitting and g value in ESR, and parameters affecting it.

CO8. Calculate theoretical parameters from ESR data and characterize compound.

CHA-491: Chemical Methods of Pharmaceuticals Analysis

Course Outcomes

CO1. Define / understand various terms in pharmaceutical raw material and finished product analysis.

CO2. Explain various pharmaceutical dosage forms and types of raw materials used.

CO3. To describe basic principles of methods of pharmaceutical analysis according to IP.

CO4. Explain importance particular test in pharmaceutical raw material and finished product analysis.

CO5. Perform and explain importance of limit tests, identification tests and micobiological limit test of raw materials and finished products.

CO6. Solve numerical problems on analysis pharmaceutical raw material and finished product analysis.

CO7. Interpret IR spectra, HPLC chromatogram, UV-Visible spectra of pharmaceutical materials.

CO8. To perform total analysis of pharmaceutical raw material and finished product analysis according to IP / BP / USP.

CO9. Standardize analytical instruments according IP /BP/ USP.

CHA-492: B) Analytical Chemistry of agriculture, Polymer Detergents

Course Outcomes

CO1. Define / understand various terms in soil analysis, pesticide residue analysis, detergent analysis and polymer analysis.

CO2. Explain / describe techniques / methods of soil analysis, pesticide residue analysis, detergent analysis and polymer analysis.

CO3. To describe basic principles techniques / methodssoil analysis, pesticide residue analysis, detergent analysis and polymer analysis.

CO4. Explain importance of soil analysis, pesticide residue analysis, detergent analysis and polymer analysis.

CO5. Choose suitable method / techniques to characterize quality of soli polymer and detergent.

CO6. Describe / explain results of analysis soil, pesticide residue, detergent and polymer.

CO7. Solve numerical problems on analysis soil, pesticide residue, detergent and polymer.

CHA-493-A: Optional Analytical Chemistry Practical

Course Outcomes

CO1. Maintain proper record of analytical data in notebook. Observer personal safety in laboratory and able handle all chemicals, instruments, etc safely in laboratory.

CO2. Define / understand various terms involved practical methods of quantitative analysis.

CO3. To analyse organic and inorganic materials using appropriate chemical / instrumental methods

CO4. Explain / describe basic principles of chemical / instrumental methods used for analysis. Able to handle particular instrument according to SOP.
CO5. Perform analysis of sample with described procedure. Able to handle analytical instruments.
CO6. Apply / select particular method / instrumental parameters for analysis of given sample.
CO7. Maintain appropriate reaction conditions as described in procedures.
CO8. To perform i) selective analysis of particular component from sample. ii) Analysis at trace level from sample.
CO9. To conclude the results able to take the decision regarding quality of sample.

CHA-494: Practical II: Applied Analytical Chemistry

Course Outcomes

CO1. Maintain proper record of analytical data in notebook. Observer personal safety in laboratory and able handle all chemicals, instruments, etc safely in laboratory.
CO1. Define / understand various terms involved practical methods of quantitative analysis.
CO2. To analyse organic and inorganic materials using appropriate chemical / instrumental methods.
CO3. Explain / describe basic principles of chemical / instrumental methods used for analysis. Able to handle particular instrument according to SOP.
CO4. Student should understand the importance of Orthogonality Theorem.
CO5. Student should correlate the application of symmetry to spectroscopy.
CO6. Students able to find out the possible modes of vibration.