Rayat Shikshan Sanstha's

Mahatma Phule Mahavidyalaya, Pimpri, Pune

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Affiliated to Savitribai Phule Pune University, Pune (PU/PN/ACS/053)

Department of Chemistry

Course Outcomes

M.Sc.

Name of the department	Class	Course name	Course code	Course outcome
Department of Chemistry	**M.Sc I** **Sem I**	**Physical Chemistry**	**CHP110**	CO 1 Describe the importance of quantum chemistry CO 2 Interpret Valence bond theory, hybrid orbitals, geometry and hybridization, molecular orbital theory CO 3 Explain the facts of Thermodynamics CO 4 Analyze Kinetics of Complex Reactions & Molecular Reaction Dynamics
		Inorganic Chemistry	**CHI130**	CO 1. Summarize chemistry of s and p block elements w.r.t. their compounds, their reactions and applications. CO 2. Describe the advance chemistry of boranes, fullerene, zeolites, polymers etc. CO 3. Identify Organometallic chemistry of some important elements from the main groups and their applications CO 4. Illustrate molecules in 3 dimensions.

				CO 5. To infer concept of symmetry and able to pass various symmetry elements through the molecule. CO 6. Interpret the concept and point group and apply it to molecules.
		Organic Chemistry	**CHO150**	CO 1 Understand the concept of aromaticity and its application to carbocyclic and heterocyclic systems. CO 2 Analyze the synthesis, reactivity, aromatic character, and importance of heterocyclic compounds such as Furan, Pyrrole, Thiophene, Pyrazole, Imidazole, Pyridine, and Pyrimidine. CO 3 Comprehend the principles of stereoisomerism, enantiomeric relationship, distereomeric relationship, and R and S, E and Z nomenclature in C, N, S, P containing compounds, and optical activity in biphenyls, spiranes, allenes, and Topicity. CO 4 Analyze the conformational analysis of di-, tri-, tetra-substituted 5-6 membered rings and decalins. CO 5 Understand the structure, stability, and reactions of reactive intermediates such as

				carbocation, carbanion, free radical, carbenes, and nitrenes, as well as the concept of NGP: Neighbouring group participation. CO 6 Analyze the different rearrangements such as Beckmann, Hofmann, Curtius, Schmidt, Wolff, Lossen, Bayer-villiger, Sommelet, Favorskii, Pinacol-pinacolone, Benzil-benzilic acid, Fries, and Tiffeneau Demjanov. CO 7 Comprehend the concept of ylides, specifically Phosphorus, Nitrogen, and Sulphur ylides. CO 8 Analyze the different oxidation and reduction reactions, including oxidizing agents such as CrO3, PDC, PCC, KMnO4, MnO2, Swern, SeO2, Pb(OAc)4, Pd-C, RuO4, OsO4, m-CPBA, O3, NaIO4, HIO4, TEMPO, IBX, CAN, Dess-Martin, DDQ, and Ag2O; as well as reducing agents such as Boranes and hydroboration reactions, MPV reduction, reduction with H2/Pd-C, Raney-Ni, NaBH3CN, Willkinsons catalyst, DIBAL, Wolff-Kishner reduction, Birch, Clemenson, Dissolving metal.

		Introduction to Chemical Biology-I	Elective Option-C:	CO1) Analyze new areas of research in both chemistry and allied fields of science and technology. CO 2) Students will be able to function as a member of an interdisciplinary problem-solving team. CO3) To summarize thorough idea in the chemistry of carbohydrates, amino acids, proteins, and nucleic acids etc. CO4) Interpret the chemical basis for replication, transcription, translation and how each of these central processes can be expanded to include new chemical matter.
	M.Sc. I **Sem II**	**Physical Chemistry**	**CHP 210**	CO1 Summarize Applications of Radioactivity CO2 Explain discovery of nuclear fission CO3 Infer the introduction to Molecular Spectroscopy
		Inorganic Chemistry	**CHI 230**	CO1 Explain the importance of bioinorganic chemistry. CO2 Interpret Role of metals in Metalloprotein and metalloenzymes. CO3 Predict the similarities in coordination theory for metal complexes and metal ions complexed with biological ligands. CO 4 Summarize the importance and transport of metal ions. CO5. Estimate no of microstates and meaningful term symbols, construction of microstate table for various configuration

				CO6 Infer Hund's rules for arranging the terms according to energy. CO7 Interpret interelectronic repulsion. CO8 Interpret concept of weak and strong ligand field.
		Organic Chemistry II	CHO – 250	CO 1 Understand the principles of photochemistry and its application in the reactions of carbonyl compounds, alkenes, dienes, and aromatic compounds. CO 2 Comprehend the concepts of pericyclic reactions and analyze them using correlation diagrams. CO 3 Able to use UV and IR spectroscopy to determine the structure of organic compounds by analyzing spectra of functional groups with and without conjugation, ring size effect, effect of H-bonding, resonance effect, and inductive effect. CO 4 Able to apply the principles of 1H-NMR spectroscopy to identify chemical and magnetic nonequivalence, Homotopism, enantiotopism, diastereotopism, chemical shifts, electronegativity, NMR solvent polarity, temperature, anisotropic effect, chemical shifts of acidic protons, D2O exchange, Multiplicity patterns and Coupling constants, Integration, and complex splitting patterns in aromatic, vinylic, saturated monocyclic compounds, bicyclic compounds, and NMR of racemic mixture.

				CO 5 Able to apply the principles of 13C-NMR spectroscopy to determine chemical shift and factors affecting chemical shifts in 13C NMR and analyze off resonance and proton decoupled spectra. CO 6 Able to apply the principles of mass spectrometry (MS) to determine the molecular formula of organic compounds and analyze fragments of alkanes (cyclic and acyclic), alcohols, and amines.
		Introduction to Chemical Biology-II	**CHG 190**	CO 1 Interpret the new areas of research in both chemistry and allied fields of science and technology. CO 2 Students will be able to function as a member of an interdisciplinary problem solving team. CO 3 Summarize thorough idea in the chemistry of carbohydrates, amino acids, proteins and nucleic acids etc. CO 4 Compare the chemical basis for replication, transcription, translation and how each of these central processes can be expanded to include new chemical matter.

		Chemical Biology-II **Practical**		CO1 Interpret the chemistry of carbohydrates, amino acids, proteins and nucleic acids etc. CO2 Describe the chemical basis for replication, transcription, translation and how each of these central processes can be expanded to include new chemical matter.
Department of Chemistry	**M.Sc II**	**Organic Chemistry**	**CHO-350** **Organic Reaction Mechanism**	CO 1 Explain the various methods for determining reaction mechanisms, including kinetic and non-kinetic methods. CO 2 Describe the generation, stability, and reactivity of free radicals, as well as their use in substitution and addition reactions, synthesis, inter- and intra-molecular bond formation, cleavage of C-X, C-Sn, C-S, and O-O bonds, oxidative coupling, C-C bond formation in aromatics, and SNAr reactions. CO 3 Analyze linear free energy relationships and Hammet plots, including the Hammet equation, substituent and reaction constants, and the calculation of k and K. Evaluate deviations from straight line plots and solvent effects. CO 4 Apply knowledge of free radicals and organic reaction mechanisms to solve problems in organic synthesis. CO 5 Identify and classify terpenoids based on their number of isoprene units, and describe their biosynthesis and important members, such as mono-, sesqui-, di-, and tri-terpenoids, as well as cholesterol.

				CO 6 Explain the biosynthesis and importance of alkaloids derived from ornithine, lysine, nicotinic acid, tyrosine, and tryptophan. CO 7 Describe the Shikimate pathway and its role in the biosynthesis of cinnamic acids, lignans and lignin, coumarins, flavonoids and stilbens, isoflavanoids, and terpenoid quinones. CO 8 Analyze a case study on the alkaloids isolated from the roots of Piper nigrum and apply knowledge of biogenesis to understand their biosynthesis and structural features.
			CHO 351 Structure Determination of Organic Compounds by Spectroscopic Methods	CO 1 Explain the principles of NMR spectroscopy, including chemical and magnetic equivalence, homotopic, enantiotopic, and diastereotopic protons, first and second order splitting, complex multiplicity patterns, and coupling constants in asymmetric compounds. Interpret spectra to determine stereochemistry and solve problems in structure elucidation. CO 2 Apply APT, DEPT, and INEPT techniques for 13C NMR spectroscopy in structure elucidation. CO 3 Describe the fundamentals and applications of 15N, 19F, and 31P NMR spectroscopy in structure elucidation of organic compounds, catalysts, and biomolecules. CO 4 Analyze complex NMR spectra using 2D NMR techniques, including homonuclear techniques such as COSY, TOCSY, 2D-

				INADEQUATE, 2D-ADEQUATE, NOESY, and ROESY, as well as heteronuclear techniques such as HSQC, HMQC, and HMBC. Interpret spectra to solve problems in structure elucidation. CO 5 Explain the principles of mass spectrometry, including ionization methods such as EI, CI, ES, MALDI, and FAB, fragmentation of typical organic compounds, stability of fragments, rearrangements, factors affecting fragmentation, and ion analysis. Interpret spectra to determine molecular formula and solve problems in structure elucidation. CO 6 Analyze biomolecules such as proteins and peptides, oligonucleotides, and oligosaccharides using mass spectrometry to determine the elemental composition and isotopic abundance. Apply knowledge of mass spectrometry to solve problems in structure elucidation. CO 7 Integrate data from UV, IR, 1D (1H and 13C) NMR, and 2D NMR (1H-1H, 13C-1H COSY/HETCOR only), APT, DEPT, and MS to solve complex problems in structure elucidation.
			CHO-352 **Stereochemistry and Asymmetric Synthesis of Organic Compounds**	CO 1 Understand the principles of stereochemistry and conformational analysis of organic compounds including polysubstituted cyclohexane, six-membered rings with SP2 carbon, heterocycles with N and O, anomeric effect, stereochemical principles involved in reactions of six-

				membered rings and other than six-membered rings, and concept of I-strain. CO 2 Understand the stereochemistry of fused and bridged ring systems, including nomenclature, synthesis, stereochemical aspects of Perhydrophenanthrene, Perhydroanthracene, hydrindane, steroids, bridged system (bi, tri, and polycyclo system) including heteroatoms, and Bredt's Rule. CO 3 Understand the determination of configuration, Cram's rule, Cram's cycle model, Cram's dipolar model, Felkin-Anh Model; resolution and analysis of stereomers, formation of racemization, and methods of resolution. Understand the stereochemistry of a polymer chain and the types and examples of tacticity. CO 4 Understand the stereochemistry of decalols, decalones, octahydronaphthalenes, decahydroquinolines. CO 5 Understand the introduction of asymmetric synthesis, Chiral pool, and chiral auxiliaries. CO 6 Understand asymmetric organocatalysis. CO 7 Understand asymmetric aldol reaction, enantioselective, diastereoselective, and double diastereoselective aldol reactions. CO 8 Understand transition metal-catalyzed homogeneous asymmetric hydrogenation.

				CO 9 Understand transition metal-catalyzed homogeneous asymmetric hydroxylation and epoxidation. CO 10 Understand asymmetric phase-transfer and ion pair catalysis.
			CHO-353 (B) **Designing Organic Syntheses and Heterocyclic** **Chemistr**	CO 1 Concepts of Retrosynthesis: Retrosynthetic analysis, disconnection approach, Synthons, multiple step synthesis, functional group intercoversion, Illogical two group interconversion, C-C disconnection, Donor and acceptor Synthons, two group i. disconnection, 1,5 related functional group disconnection, Umpolung, convergent ii. synthesis, special methods for small rings, Heteroatom and Heterocyclic compounds, iii. problems CO 2 Application of Retrosynthetic Approach: Retrosynthesis and synthesis of following CO 3 Molecules: Strychnine, Reserpine, Thienamycin, Asteltoxin, Indolizomycin,,Erythronolide B. CO 4 Systematic nomenclature (Hantzsch-Widman System) for monocyclic, fused and bridged heterocycles. Tautomerism in aromatic heterocycles. Strain-bond angle, torsional strains

				CO 5 and their consequences in small ring heterocycles. CO 6 General chemical behaviour of heterocyclic compounds and their applications in: CO 7 Biological systems (Anthocyanins, Flavones, Neurotransmitters), Natural Products CO 8 (Alkaloids: Nicotin, Quinine), Drugs and Medicines (Omeprazole, Amlodipine, CO 9 Cilostazol) CO 10 Synthesis, reactions and structural effects of heterocyclic rings a) Common Methods in Ring Synthesis of Aromatic Heterocyclic Systems: Typical ring synthesis involving C – Heteroatom, C – C bond formations, Electrocyclic processes in heterocyclic Synthesis: 1,3 -dipolar cycloadditions producing five - membered heterocycles, Nitrenes in heterocyclic synthesis, Palladium catalysis in the synthesis of Benzo - Fused heterocycles, Fischer synthesis, Epoxidation, Use of Sulphur Ylides, Azides for small rings b) Three and four membered heterocylces: Aziridines, Oxiranes, Thirienes, Azetidines, Oxetanes and Thietanes

				c) Five-membered and benzo-fused five membered heterocycles: Oxazole, Isoxazole, Thiazole, Pyrazole, Imidazole, Benzothiazole and Benzimidazole d) Six membered and benzo-fused six membered heterocycles: Pyrazine, Pyridazine, Pyrimidine, Quinazoline, Quinoxaline, Aziridines, Quinoline
			CHO-354 **Solvent Free Synthesis**	CO 1 Understand the principles of solvent-free organic synthesis and its advantages over traditional synthesis methods. CO 2 Acquire hands-on experience in performing various solvent-free carbon-carbon, carbon-nitrogen, carbon-sulfur, carbon-halogen, and nitrogen-nitrogen bond-forming reactions. CO 3 Understand the mechanism and scope of various solvent-free reactions, including pinacol coupling, Knoevenagel condensation, Claisen reaction, Pechmann reaction, Beckmann rearrangement, and Baeyer-Villiger oxidation. CO 4 Develop skills in analyzing and interpreting spectroscopic data, such as IR and NMR, to confirm the formation of desired products. CO 5 Understand the principles and strategies of supramolecular assembly formation using solvent-free methods. CO 6 Learn the practical aspects of handling and manipulating hazardous

				chemicals, such as N-bromosuccinimide and phenylboronic acid, in a safe and effective manner. CO 7 Develop critical thinking and problem-solving skills by designing and optimizing reaction conditions for various solvent-free reactions. CO 8 Acquire skills in using common laboratory equipment and techniques, such as melting point determination and TLC analysis, to characterize and purify synthesized products.
			CHO-450 **Chemistry of Natural Products**	CO 1 Students will be able to analyze the synthetic routes of longifolene from different research articles and compare their strategies, challenges and limitations. CO 2 Students will be able to design a viable synthetic plan for the total synthesis of a natural product while considering the stereochemistry and using appropriate chemical reactions and techniques. CO 3 Students will be able to critically evaluate the synthetic strategies, experimental details, and characterization methods used in the total synthesis of hirsutellone B, ribisins A and B, and subincanadine E. A) Vannusals CO 4 Students will be able to describe the chemical structure, biosynthesis, and biological activity of vannusals.

				CO 5 Students will be able to explain the different synthetic routes and methods used for the synthesis of vannusals and analyze their advantages and limitations. CO 6 Students will be able to propose modifications of vannusals that could improve their biological activity or pharmacokinetic properties. B) Pinnaic acid CO 7 Students will be able to explain the biosynthesis, chemical structure, and properties of pinnaic acid. CO 8 Students will be able to design a synthetic plan for the total synthesis of pinnaic acid and evaluate different synthetic routes and methods. CO 9 Students will be able to analyze the biological activity and potential therapeutic applications of pinnaic acid and related compounds.
			CHO-451 **Organometallic Reagents in Organic Synthesis**	CO 1 Understand the role of transition metal complexes in organic synthesis, specifically Pd, Ni, Ru, Fe, Ir, and Cu, in C-C, C-N, and C-O bond formation reactions with catalytic cycle, ligand, and % mole concepts. CO 2 Compare and contrast various C=C formation reactions, including Wittig, Horner-Wordworth-Emmons, Shapiro, Bamford-Stevens, McMurry, Julia-Lythgoe, and Peterson olefination reactions. CO 3 Analyze the mechanism and application of multi-component reactions,

				specifically Ugi, Passerini, Biginelli, and Mannich reactions. CO 4 Evaluate the mechanism and application of ring formation reactions, specifically Pausan-Khand, Bergman, and Nazerov cyclization. CO 5 Understand the criteria for click reactions, particularly Sharpless azides cycloadditions, and their application in the synthesis of bioconjugates such as sugars and proteins. CO 6 Analyze the mechanism and application of metathesis reactions, specifically Schrock and Grubbs catalyst, Olefin cross coupling (OCM), ring closing (RCM), and ring opening (ROM) metathesis, and their application in polymerization and synthesis of small organic molecules. CO 7 Understand the use of Boron and Silicon reagents in organic synthesis and their mechanism and application. CO 8 Understand the mechanism and application of other important reactions, specifically Baylis Hilman, Eschenmoser-Tanabe fragmentation, and Mitsunobu reaction.

			CHO-452(A): Concepts and Applications of Medicinal Chemistry	CO 1 Understand the basic concepts of peptides, proteins, and nucleic acids and their biological roles in metabolism, as well as the chemistry of cofactors/coenzymes, including TPP, PLP, Folic Acid and other vitamins. CO 2 Develop an understanding of the principles of drug design and the chemistry of diseases and drug development, including proton pump inhibitors, and apply problem-solving skills in drug design. CO 3 Gain knowledge about peptides and their sequencing and applications in therapeutics, as well as the modern techniques for biomolecules and disease diagnosis. CO 4 Understand the history, drug targets, and drug discovery, design, and development, including a case study of the design of Oxamniquine. CO 5 Develop knowledge about pharmacokinetics and pharmacodynamics of drugs, including drug absorption, distribution, metabolism, elimination, and toxicity, drug metabolism, biotransformation, drug receptor interactions, Hansch Equation, and significance of terms involved in it. CO 6 Analyze the structure and activity relationship of drugs using QSAR and understand the applications of SAR and QSAR in drug design, including the physicochemical parameters of lipophilicity, partition coefficient, electronic ionization constant. Apply this knowledge to a case study of statins.

				CO 7 Gain an understanding of the developments, SAR, mode of action, limitations, and adverse effects of anti-infective agents, including beta-lactam antibacterial agents (Penicillins, Cephalosporins), Tetracyclines, Macrolides, Chloramphenicol, Polyenes, Amphotericin-B, Azoles, Amantadine, Acyclovir, Quinine, Quinolines, Quinolones, Refamycine, Sulphonamide.
			CHO-453: Practical-III: Section-I: Ternary Mixture Separation **Section-II: Carbohydrates Synthesis and Isolation Natural Products**	CO 1 Understand and employ concept of type determination and separation CO 2 Meticulously record physical constants CO 3 Perform micro scale chemical elemental analysis CO 4 Perform qualitative estimation of functional groups CO 5 Recrystallize /distill the separated compounds CO 6 Extend these skills to organic synthesis CO 7 Understand the meaning of dry condition in reaction. CO 8 Learn to prepare dry solvents. CO 9 Learn Workup of reaction in minimum quantity of water. CO 10 Acquire skill in handling of carbohydrates reaction.

			CHO-454: Practical-II: Convergent and Divergent Organic Syntheses	CO 1	Able to perform convergent and divergent organic syntheses using multi-step and single-step reactions.Able to apply reduction and acylation reactions to synthesize organic compounds.
				CO 2	Learn to use multicomponent reactions (MCR) to synthesize complex organic molecules.
				CO 3	Learn to use various functional group transformations such as diazonium coupling, bromination, methylation, sulfonation, and resolution techniques to synthesize organic compounds.
				CO 4	Gain hands-on experience in using different synthetic techniques such as Reimer-Tiemann reaction and [3 + 2 + 1] cycloaddition reaction.
				CO 5	Learn to use analytical tools such as TLC, IR, NMR, and GC to analyze the synthesized compounds and to determine the purity and yield of the products.