PUNYASHLOK AHILYADEVI HOLKAR,

SOLAPUR UNIVERSITY, SOLAPUR

NAAC Accredited-2022
'B++' Grade (CGPA 2.96)

Name of the Faculty: Science & Technology

CHOICE BASED CREDIT SYSTEM (CBCS) under NEP-2020

Syllabus: ORGANIC CHEMISTRY
M. Sc. II (Sem.-III & IV)

Name of the Course: M.Sc. II (Sem–III & IV)

(Syllabus to be implemented w.e.f. June 2024)

PAH Solapur University, Solapur

M.Sc. II Organic Chemistry (w.e.f. 2024-25)

Syllabus Structure and Credit Distribution

Level/ Difficulty	Semester	Paper Code	Title of the Paper	Semester exam			L	T	P	Credits
6.5/400	III		**Mandatory**	**Theory**	**IA**	**Total**				
		DSC-5	Advanced Spectroscopic Methods	60	40	100	4	--	-	4
		DSC-6	Photochemistry and Pericyclic Reactions	60	40	100	4		-	4
			Elective (Anyone)							
		DSE-3 A	Advanced Organic Chemistry	60	40	100	4		-	4
		DSE-3 B	Applied Organic Chemistry	60	40	100	4		-	
			Field Project/RP/Internship/Apprenticeship/							
		RP	Research Project	60	40	100	4	-	0	4
			Practical							
		DSC-5 P	Spectral Analysis	30	20	50	-	-	2	6
		DSC-6 P	Organic Synthesis	30	20	50	-	-	2	
			Elective (Any one)							
		DSE-3A P	Organic Ternary Mixtures	30	20	50			2	
		DSE-3B P	Applied Organic Chemistry	30	20	50			2	
			Total for III semester	**330**	**220**	**550**	**16**	**550**	**6**	**22**
	IV		**Mandatory**							
		DSC-7	Modern Organic Chemistry	60	40	100	4	--	-	4
		DSC-8	Chemistry of Bioactive Heterocycles	60	40	100	4		-	4
			Elective (Any one)							
		DSE-4A	Retrosynthesis and Disconnection Approach	60	40	100	4		-	4
		DSE-4B	Medicinal Chemistry	60	40	100	4		-	
			Field Project/RP/Internship/Apprenticeship/							
		RP	Research Project	90	60	150	6	-	0	6
			Practical							
		DSC-7 P	Organic Chemistry	30	20	50	-	-	2	4
			Elective (Any one)							
		DSE-4A P	Synthesis of Heterocycles	30	20	50			2	
		DSE-4B P	Medicinal Chemistry	30	20	50			2	
			Total for IV semester	**330**	**220**	**550**	**18**	**550**	**4**	**22**

DSC- Discipline Specific Course,
RM- Research Methodology,
RP – Research Project
L – Lecture, T – Tutorial, P – Practical
Credits of Theory = 4 Hours of teaching per week
2 Credits of Practical = 4 Hours per week

DSE- Discipline Elective course
OJT- On Job Training

M. Sc. II, Semester-III (Organic Chemistry)

	DSC-5: Advanced Spectroscopic Methods **(Credit: 04, Theory: 60 Periods, Marks: 100)**
	Course Objectives:
•	To know the applications of NMR and mass spectroscopy
•	To understand the different types of NMR techniques and their applications for structural determination
•	To get skill for the confirmation of structure of molecule based on mass spectrometry
•	To analyze organic molecules based on all spectral techniques.
Unit 1:	**Nuclear Magnetic Resonance Spectroscopy: [15]**
	General introduction and definition, criteria required for NMR signal, origin of NMR, integration of a peak, different solvents used in NMR, chemical shift and factors affecting on chemical shifts in NMR, origin of spin-spin splitting, coupling constant, Nomenclature for coupling constant (*J*), Spin-spin couplings and n+1 rule, different types of couplings and factors affecting on coupling constants, Karplus equation, Chemical and magnetic equivalence, Nonequivalence within groups, first ordered and second ordered spectra, different spin systems (AB, AX, A_2, AB_2, AX_2, A_2B_2, A_2X_2, AA'XX', AA'BB', ABX, AMX), solvents used in NMR like shift reagents.
Unit 2: A]	**^{13}C-NMR Spectroscopy [08]**
	Salient facts about ^{13}C NMR and elementary ideas, instrumental difficulties, FT technique advantages and disadvantages, factors affecting on chemical shifts, analogy with ^{1}H NMR, calculations of chemical shift of hydrocarbons, different types of carbons (alkene, alkyne, allene, carbonyl, nitrile, oxime, aromatic carbons etc. and effect of substituent on chemical shifts of carbons, chemical shifts of solvents, proton noise decoupling technique advantages and disadvantages, off-resonance technique. spectral problems on ^{13}C NMR application.
Unit 2: B]	**Two-dimensional (2D) NMR spectroscopy: [07]**

	Introduction, Types of 2D NMR, COSY, TOCSY or HOHAHA, 2D-INADEQUATE, NOESY, ROESY, DEPT and APT, HETCOR (including interpretation of COSY and HETCOR spectra).
Unit 3:	**Mass Spectrometry [15]** Introduction, principle of MS, Formation of ions, ion production (EI, CI, FD, MALDI, FAB), ion analysis, ion abundance, factors affecting on fragmentation, Different types of ion peaks like molecular ion peak, base peak, isotopic peaks, metastable peak, Nitrogen rule, fragmentation of different functional groups, Retro-Diels-Alder reaction, McLafferty rearrangement, Ortho-effect.
Unit 4:	**Joint problems based application of IR, NMR & Mass spectroscopy [15]**
	Course Outcomes After completion of course students will be able to ➢ Determine the structure from the provided structural data ➢ Apply the theoretical knowledge of spectroscopy to determine the structure of unknown compounds. ➢ The student can determine the structure of drug molecules on the basis of different NMR techniques. ➢ The student can adopt the skill to interpret spectra of drug molecules. ➢ The student is able to analyse and confirm drug molecules by using spectral techniques. ➢ The student is able to apply IR techniques to drug molecules.
	Reference books:
	1. Sharma B K: Instrumental methods of Chemical Analysis, Goel Publishing House 2. Silverstein R M, Bassler G C: Spectrometric Identification of Organic Compounds, John Wiley 3. Sharma Y R: Elementary Organic Spectroscopy, Jalandhar 4. Kalsi P S: Spectroscopy of Organic Compounds, New Age International Ltd. 5. D. L. Pavia, G.M. Lamp man, G. S. Kriz, 3rdEd. Introduction to Spectroscopy, Harcourt College publishers 6. V. M. Parikh: Absorption spectroscopy of organic molecules

	7. D. H. Williams and I. Flemming: Spectroscopic methods in organic chemistry, McGraw Hill 8. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer-Verlag (1986) 9. Atta -Ur-Rehman: One- and Two-dimensional NMR Spectroscopy- Elsevier (1989) 10. Joseph B. Lambert, Shurvell, Lightner: Organic structural spectroscopy-Cooks, Prentice-Hall (1998) 11. Field L. D., Kalman J.R. and Sternhell S: Organic structures from spectra-4thEd. John Wiley and sons Ltd. 12. Jackmann and Sternhell S: NMR spectroscopy of Organic compounds

	DSC-6: Photochemistry and Pericyclic Reactions **(Credit: 04, Theory: 60 Periods, Marks: 100)**
	Course Objectives:
●	To understand the basics of MOT.
●	To understand the types of pericyclic reactions with their mechanism.
●	To understand the different types of photochemical reactions with their applications.
●	To understand the applications of MOT, pericyclic reactions and photochemistry of organic molecules.
Unit 1:	**Molecular Orbital Theory** **[15]**
	Energies calculation of cyclic and acyclic system orbitals, Determination energies and stabilities of different systems, Calculation of charge densities, PMO theory and reactivity index
Unit 2:	**Pericyclic Reactions-I** **[15]**
	Features and classification of pericyclic reactions, Phases, nodes and symmetry properties of molecular orbital in ethylene, 1,3-butadiene, 1,3,5-hexatriene. allyl cation, allyl radical, pentadienyl cation and pentadienyl radical, Thermal and photochemical reactions. Electrocyclic reactions: Con-rotation and dis-rotation, electrocyclic closure and

	opening in 4n and 4n+2 systems, Woodward-Hoffmann selection rules for electrocyclic reactions. Explanation for the mechanism of electrocyclic reactions by: (i) Symmetry properties of HOMO of open chain partner; (ii) Conservation of orbital symmetry and orbital symmetry correlation diagram and (iii) Huckel-Mobius aromatic and antiaromatic transition state method
Unit 3:	**Pericyclic Reactions-II [15]**
	(a) Cycloaddition reactions: Suprafacial and antarafacial interactions. (π2-cycloadditions, Cycloreversions, Stereochemical aspects in supra–supra, antara-supra and antara-antara (π2 and π4 cycloadditions, Diels-Alder reaction, Woodward-Hoffmann selection rules for cycloaddition reactions, Explanation for the mechanism of cycloaddition reactions by 1) Conservation of orbital symmetry and orbital symmetry correlation diagrams 2), Fukui Frontier Molecular Orbital (FMO) theory and (3) Huckel-Mobius aromatic and antiaromatic transition state method. Endo-exo selectivity in Diels-Alder reaction and its explanation by FMO theory, Examples of cycloaddition reactions. (b) Sigmatropic reactions: [1,j] and [i,j] shifts. Suprafacial and antarafacial shifts, Selection rules for [i, j] shifts. Cope, degenerate Cope and Claisen rearrangements, Explanation for the mechanism of sigmatropic reactions: 1) symmetry properties of HOMO 2) Huckel-Mobius aromatic and antiaromatic transition state method, chelotropic reactions and explanation of mechanism by FMO theory
Unit 4:	**Photochemistry [15]**
	Free radical reactions: Types of free radical reactions, detection by ESR, free radical substitution mechanism, mechanism at aromatic substrates, neighboring group assistance. Reactivity for aliphatic and aromatic substitution at a bridge head. Reactivity in attacking radicals. The effect of solvent on reactivity. Allylic hydrogenation (NBS), Oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salt, Sandmeyers reaction. Free radical rearrangement, Hunsdiecker reaction. Photochemistry of (π, $\pi*$) transitions: Excited state of alkenes, cis-trans isomerisation, photochemistry state, electrocyclisation and Sigmatropic

	rearrangements, di π-methane rearrangement. Intermolecular reactions: photocycloadditions, photodimerasation of sample and conjugated olefins, addition of olefins to α, β unsaturated carbonyl compounds, excimers and exiplexes. Photoaddition reactions. Excited states of aromatic compounds, photodimerisation of benzene, photosubstitution reactions of aromatic compounds and Photo-Fries rearrangement. Photochemistry of (n, π∗) transitions: Excited state of carbonyl compounds, haemolytic cleavage of α-bond-Norrish type I reaction in acyclic, cyclic ketones and strained cycloalkanediones. Intermolecular abstraction of hydrogen: Photo reduction and photo oxidationinfluence of temperature, solvent, nature of hydrogen donors and structure of the substrate. Intramolecular abstraction of hydrogen: Norrish type II reaction in ketones, esters and 1, 2-diketones. Addition to C-C multiple bonds: Paterno-Buchi reaction, photodecarboxylation, photochemistry of alkyl peroxides, hypohalites and nitriles. Barton reaction. Photochemistry of azo compounds, diazo compounds, azides and diazonium salts. Singlet oxygen-photo oxygenation reactions. Ene reaction, formation of dioxetanes and endoperoxides. Chemiluminescent reactions. Oxidative coupling.
	Course Outcomes:
●	Students will be able to understand basic principle of Photochemistry.
●	Students will understand MOT and its applications.
●	Students will understand different types of photochemical reactions.
●	Students will be able to apply the knowledge of photochemistry and pericyclic reactions.
	Reference books:
	1. Lehar and Merchand: Orbital Symmetry 2. R. B. Woodward and Hoffman: Conservation of Orbital symmetry. 3. Photochemistry and pericyclic reactions by Jagdamba Shingh 4. Cixon and Halton : Organic photochemistry 13 5. Arnold: Photochemistry

	6. N. Turro : Modern Molecular Photochemistry 7. Rohatgi- mukherji : Fundamentals of photochemistry. 8. Ginsburg: Nionbenzoid aromatic compound 9. A. Streitfwieser: Molecular orbital theory for organic chemistry. 10. E. Clerk: The aromatic sextet. 11. Lloyd: Carbocyclic non- benzoid aromatic compounds. 12. G. M. Bandger ; The structure and reactions of aromatics compounds 13. W. B. Smith; Molecular orbital methods in Organic Chemist

	DSE-3A: Advanced Organic Chemistry **(Credit: 04, Theory: 60 Periods, Marks: 100)**
	Course Objectives:
●	To understand the enolate chemistry in different reactions
●	To study different name reactions, reagents and rearrangements.
●	To know in detail chemistry of organoboranes.
●	To apply knowledge of all types of reactions while designing the organic molecules
Unit 1:	**Alkylation of Enolates and Other Carbon Nucleophiles [15]**
	Generation and Properties of Enolates and Other Stabilized Carbanions: Generation of Enolates by Deprotonation, Regioselectivity and Stereoselectivity in Enolate Formation from Ketones and Esters, Other Means of Generating Enolates, Solvent Effects on Enolate Structure and Reactivity. Alkylation of Enolates: Alkylation of Highly Stabilized Enolates, Alkylation of Ketone Enolates; Alkylation of Aldehydes, Esters, Carboxylic Acids, Amides, and Nitriles; Generation and Alkylation of Dianions; Intramolecular Alkylation of Enolates; Control of Enantioselectivity in Alkylation Reactions. The Nitrogen Analogs of Enols and Enolates: Enamines and Imine Anions.
Unit 2:	**Name reactions [15]**
	Darzen, Prins, Henry, Bamford-Steven, Baylis-Hillmann, Corey-Fuchs Reaction, Julia Olefination, Mukaiyama aldol, Corey-Winter olefination, Shapiro, Ritter, Stille, Heck, Sonogashira, Suzuki, Negishi, Kumada, Hiyama,

	Tsuji-Trost, Duff, Chugaev, Ring closing metathesis (Grubb's metathesis), Aldol-Tishchenko reaction (Evans-Tishchenko reaction), Strecker amino acid synthesis, Biginelli reaction, Gewald reaction, Hantzsch pyridine synthesis, Mannich reaction, Ugi reaction, Passerini reaction, Petasis reaction.
Unit 3:	**Rearrangements and Reagents [15]**
	Rearrangements: Payne, Eschenmoser fragmentation, Brook, Wagner-Meerwein, Wolf, Semipinacol, Epoxide rearrangement with lewis acid, Tiffeneau-Demjanov, von Richter, Wittig, Neber, Smiles, Steven, Hofmann, Iodolactonisation, Hoffmann-Loffler Fretag reaction **Reagents**: Lithium dialkylcuprate (LDC), DCC, DDQ, Organotin reagents, Peterson's synthesis, Trimethylsilyl iodide, PPA, Selenium dioxide.
Unit 4:	**Organoboranes [15]**
4.1	Preparation and properties of organoborane reagents e.g. RBH_2, R2BH, R_3B, 9-BBN, catechol borane. Thexylborane, cyclohexylborane, $ICPBH_2$,-21-IPC_2BH, Hydrboration mechanism, stereo and regeoselectivity, uses in synthesis of primary, secondary tertiary alcohols, aldehydes, ketones, alkenes. Synthesis of EE, EZ, ZZ dienes and alkyenes. Mechanism of addition of IPC_2BH. Allyl boranes- synthesis, mechanism and uses.
	Course Outcomes:
●	The student is able to understand enolate chemistry in different reactions
●	The student study different name reactions, reagents and rearrangements.
●	The student knows in detail chemistry of organoboranes.
●	The student able to apply knowledge all types of reactions while designing the drug molecules.
	Reference books:
	1. A guidebook to Mechanism in Organic Chemistry (Orient- Longmens)- Peter Sykes 2. Organic Reaction Mechanism (Benjamin)-R. Bresslow 3. Mechanism and Structure in Organic Chemistry (Holt Reinhartwinston)- B. S. Gould 4. Organic Chemistry (McGraw Hill)-Hendrikson, Cram and Hammond

	5. Basic principles of Organic Chemistry (Benjamin) J. D. Roberts and M. C. Caserio. 6. Reactive intermediates in Organic Chemistry 9 Jojn Wiley) N. S. Issacs. 7. Organic reaction mechanism (Mc Graw Hill) R. K. Bansal 8. Advanced organic chemistry, part B: Reaction and synthesis by Francis A. Carey, Richard Y. Sandburg. 9. Organic Chemistry by Clayden, Greeves, Warren and Wothers.

	DSE-3B: Applied Organic Chemistry **(Credit: 04, Theory: 60 Periods, Marks: 100)**
	Course Objectives:
•	To understand basic principles and applications of green chemistry.
•	To understand chemistry of carbohydrates.
•	To understand basics and applications of supramolecular chemistry.
•	To understand basics and applications of Polycyclic aromatic compounds.
Unit 1:	**Green Chemistry: [15]**
	Introduction and basic principles, Ideal synthesis, theoretical and functional details of eco-friendly synthetic protocols with suitable examples and applications: Neat synthesis (solvent free synthesis), Non-volatile organic media and water as green media in organic transformations like ionic liquid, PEG and water, Microwave irradiation as alternative energy source for the chemical transformations, Heterogeneous catalysis/ Immobile catalysis, Ultrasound assisted synthesis.
Unit 2:	**Carbohydrate Chemistry [15]**
	Introduction, Classification, Monasaccharides, Fisher projection, Dand L-configuration, Conversion of Fisher projection to furanose and pyranose form, Haworth Structure, 4C1 and 1C4 Conformations, Conformation of monosaccharides, anomeric effect, Reactions of Monasaccharides, Derivatives of Monosaccharides: Disaccharides, Polysaccharides, homopolysaccharides, heteroploysccarides. Mucopolysaccharides, Gycoprotiens
Unit 3:	**Supramolecular Chemistry [15]**
	Fundamentals of Supramolecular Chemistry: Terminology and definitions in

	supramolecular chemistry. Intermolecular forces, Solvent and solution properties, solvation and hydrophobic effect. Binding constants; definition and use. Molecular Recognition: Principle of molecular recognition, host-guest complementarity, preorganisation, chelate effect, cooperativity. Synthesis and applications of supramolecular host (crown ethers, lariat ethers, podands, cryptands, spherands, calix[n]arenes, cyclodextrine) as cation and anion binding receptors and receptors for ion-pair recognition. Supramolecular Reactivity and Catalysis: Organocatalysis mediated through hydrogen bonding, acid-base catalysis.
Unit 4:	**Polycyclic Aromatic Compounds [15]**
	Introduction,Comparative study of the aromatic character of linear and nonlinear Ortho fused Polynuclear Hydrocarbon. General methods of preparation of polycyclic hydrocarbons: Fittig reaction, Ullmann diaryl synthesis, friedel-Craft reaction, Elbs reaction, Phenanthrene synthesis by Paschorr, Haworth, Stobbe condensation, Bardhan-Sengupta, Bogert-Cook methods, Dehydrogenation of hydroaromatic compounds with sulphur, selenium or palladised charcoal. Naphthacene, Rubrene (pentacene and hexacene), 2-benzanthracene, 6-benzanthracene, 4-benzpyrene and 20-methylcholanthrene, Phenanthrene Derivatives: Chrysene, Picene, Pyrene, Perylene, coronene.
	Course Outcomes:
●	Students will be able to understand basic principles of green chemistry.
●	Students will be able to understand applications of supramolecular chemistry.
●	Students will be able to understand applications Polycyclic Aromatic Compounds.
●	Students will be able to understand chemistry of carbohydrates.
●	**Reference Books**
●	1) Supramolecular Chemistry: from Molecules to Nanomaterials Eds. by P.A. Gale and J.W. Steed (2012). 2) Modern Supramolecular Chemistry by F. Diederich, P. J. Stang, R. T. Tykwinski (2008). . Page 20 of 21 3) Core Concepts in Supramolecular Chemistry and Nanochemistry by J. W. Steed, D. R. Turner, K. J. Wallace (2007).

	4) Supramolecular Chemistry by J.W. Steed and J.L. Atwood (2011). 5) Supramolecular Chemistry: Concepts and Perspectives by J.-M. Lehn, Wiley VCH, Weinheim (1995). 6) Supramolecular Chemistry by V. Balzani (Editor), L. De Cola, Kluwer, Dordrecht (1992). 7) Introduction to Supramolecular Chemistry by H. Dodziuk, Kluwer Academic Publishers, The Netherlands (2002). 8) Supramolecular Assemblies Y. Murakami (Editor), Mita Press, Tokyo, (1990). 9) Advances in Supramolecular Chemistry, Vol 1 (1990), Vol 2 (1992), Vol 3 (1993) by G. W. Gokel (Editor), JAI Press, Greenwich. 10) Supramolecular Chemistry – Fundamentals and Applications. Advanced Textbook by T. Kunitake, K Ariga, Berlin: Springer-Verlag Heidelberg, 2006. 208 p. ISBN 978-3-540- 01298-6

	RP: Research Project **(Credit: 04, Marks: 100)**
	➢ The research project for M. Sc. Medicinal Chemistry is constructed to get familiarize with literature survey important for designing of organic product/new organic molecules/synthetic routes and related applications. ➢ It is expected that project should provide hands on training to the students on various instruments. ➢ They should learn independent working on a short research project. Students are required to work for a specific project under supervision of concerned faculty member. There will be computer laboratory session for hands on Chem draw software and literature survey by using Google Scholar/ Science Direct/Scopus/Web of Science etc. A student shall be expected to carry out literature survey in the field of interest and to select a topic for his/her project work in consultation with the supervisor. It shall be expected that a student justifies the gravity and also the relevance of the problem through his/her seminar. Candidates are expected to do the following work at computer laboratory. 1. Literature survey 2. Work plan 3. Handling of Chem draw software for structure drawing

	4. Chem draw assignment 5. Synopsis preparation The allotment of the topic will be done in the initial period of third semester. Hence students can start their work in the third semester itself. Each student is supposed to work for at least 60 hours for his/her project. At the last he/she must submit project report and present the work done at the time of viva voce.

	DSC-5 P: Spectral Analysis **(Credit: 02, Practical: 60 Periods, Marks: 50)**
	Identification of Organic compounds by the analysis of their spectra. Photocopies of UV, IR, NMR and Mass spectra of standard compounds are to be interpreted to determine the structure of the compound. At the time of practical examination, candidates are expected to submit the Journal.

	DSC-6 P: Organic Synthesis **(Credit: 02, Practical: 60 Periods, Marks: 50)**
	One/Two organic preparations starting with 5g or less (Any five) (TLC, MP /BP analysis and recrystalization of product is recommended)
	1. Preparation of aromatic aldehydes by Vilsmer Haack reaction or R. T. 2. Preparation of p-chloronitrobenzene by Sandmeyer reaction 3. Preparation of p-Iodonitrobenzene by Sandmeyer reaction 4. Stork enamine synthesis 5. Mukaiyama Esterification 6. Pechmann Condensation (Coumarin synthesis) 7. Aldol condensation (Chalcone) 8. Benzilic acid rearrangement 9. Fischer indole synthesis 10. Friellander Synthesis 11. Preparation of Benzanilide by Beckmann rearrangement 12. Preparation of Antharanilic acid 13. Preparation of Phthalimide 14. Preparation of N-Bromosuccinamide 15. Preparatin of p-Aminobenzoic acid 16. Pinacol- Pinacolone rearrangement 17. Preparation of Acetophenones by Fries rearrangement

	18. Wittig reaction 19. Preparation of Benzopyrazole 20. Hantzsch pyridine synthesis 21. Ugi Reaction 22. Biginelli reaction 23. Gewald reaction 24. Dess-Martin Oxidation: Oxidation of benzyl alcohol to benzaldehyde 25. Synthesis of benzil from deoxybenzoin using SeO_2 reagent **(Note: Other suitable experiments may be added)**

	DSE-3A P: Organic Ternary Mixtures **(Credit: 02, Practical: 60 Periods, Marks: 50)**
	Separation, purification and identification of organic compounds (Three components mixtures) by chemical tests, derivatives etc. using microscale technique. IR spectra to be used for functional group identification. Purification of separated compounds by TLC and Column Chromatography.

	DSE-3B P: Applied Organic Chemistry **(Credit: 02, Practical: 60 Periods, Marks: 50)**
	List of Practicals
1.	Microwave-assisted ammonium format-mediated Knoevenagel reaction
2.	Radical coupling reaction (Preparation of 1, 1-bis-2-naphthol) by green synthesis method grinding at room temperature.
3.	Preparation of benzopinacolone
4.	Bromination of acetanilide by using CAN as a catalyst
5.	Pechman condensation (Clay catalyzed solid state synthesis of 7-hydroxy-4-methylcoumarin)
6.	Benzil Benzilic acid rearrangement
	(Note: Other suitable experiments may be added)

M. Sc. II, Semester-IV (Organic Chemistry)

	DSC-7: Modern Organic Chemistry **(Credit: 04, Theory: 60 Periods, Marks: 100)**
	Course Objectives:
●	To explain the basic concepts and terms involved in stereochemistry.
●	To learn about stereo chemical notations.
●	To describe the stereochemistry of substitution reaction
●	To describe about chiral reagents and catalysts
●	To learn about asymmetric synthesis
Unit 1:	**Conformational Analysis and Reactivity [15]**
	Differences in the stability of Diastereomers, Relative reactivity of Diastereomers in ionic elimination, Intramolecular rearrangement, Neighboring Group Participation (NGP), Molecular elimination. Curtin- Hammett principle, Conformational stability and Reactivity of cyclohexane six membered ring system.
Unit 2:	**Fused and Bridged rings (15)**
	Introduction, Nomenclature of bicyclic systems, cis- and trans-decalins and nine methyl decalins, perhydroanthracene, perhydraphenanthrene, Bridged rings systems and its reactivity, Bredts rule and stereo chemical restrictions
Unit 3:	**Asymmetric synthesis-I (15)**
	Introduction to Stereoselective and stereospecific reactions **Chiral Pool**: [α-hydroxy acids and α-amino acids] **Chiral auxiliary**: SAMP/RAMP, Mayers Oxazolines, Evans Oxazolidinones, L-valine (Schollkopf Bislactimethers), Seebach Imidazolens from (S)-mandelic acid, Seebach α-hydroxy acids i.e. (*S)*-lactic acids, Cyclic hydrazones. **Chiral reagent**: BINAL, BINAP; Hydroboration- Ipc_2BH, $IpcBH_2$, R/S-Alpine borane, DIP-Cl (diisopinocamphylborone chloride), Misamane's Ligand (2,5-dimethylborolane); **Chiral catalyst**: CBS, NADH, baker's yeast. Asymmetric epoxidation: Sharpless epoxidation, Jacobson
Unit 4:	**Asymmetric synthesis-II [15]**

	Acyclic Stereocontrol – attack on aldehydes and ketones with α-stereocentres (Crams Model, Felkin-Anh model, Cram-Chelate model); Diastereoselective enolate alkylation, Diastereoselectivity of aldol reactions (Zimmerman-Traxler transition state model), Diastereoselective enolate alkylation by Evans oxazolidinone auxiliaries; Diastereoselective allylation reactions of crotyl boronates and chiral allyl boron reagents; Proline catalyzed asymmetric aldol reactions, mannich reactions; Diastereoselective Reduction; Diastereoselective reduction (Evans-Saksena and Evans-Tishenko); Stereocontrol– attack on alkenes with α-stereocentres in hydroboration and epoxidation reaction.
	Course Outcomes: After completion of course students will be able to
●	Relate the structure and medicinal properties of drugs..
●	Differentiate between different types of stereoisomers, including enantiomers and diastereomers
●	Predict the accurate stereochemistry of products of asymmetric synthesis
	Reference books:
	1) (Topics in Heterocyclic Chemistry 25) Géraldine Masson, Luc Neuville (auth.), Romano V. A. Orru, Eelco Ruijter (eds.) - Synthesis of Heterocycles via Multicomponent Reactions II-Springer-Verlag Berlin 2) Jieping Zhu, Qian Wang, Meixiang Wang - Multicomponent Reactions in Organic Synthesis-Wiley-VCH (2015) 3) K.L. Ameta Ph.D., Anshu Dandia - Multicomponent Reactions_ Synthesis of Bioactive Heterocycles-CRC Press (2017) 4) Zhu J., Bienhame H. (eds.) - Multicomponent Reactions-Wiley-VCH (2005) 5) Raquel P. Herrera, Eugenia Marqués-L_pez - Multicomponent Reactions_ Concepts and Applications for Design and Synthesis-Wiley (2015) 6) Majid M. Heravi, Vahideh Zadsirjan - Recent Advances in Applications of Name Reactions in Multicomponent Reactions-Elsevier (2020) 7) Stereochemistry of Organic Compounds (Principle and application): D. Nasipuri 8) Stereochemistry : Conformation and Mechanism: P. S. Kalsi

	9) Stereochemistry of Organic compounds: Ernest L. Eliel / Samuel H. Wilen 10) Advanced Organic Chemistry; Part A and B: F. A. Carey & R. J. Sundberg 11) Organic Chemistry: Clayden, Greeves, Warren and Wothers 12) Organic Synthesis: M. B. Smith 13) Lukehart, Charles M. MacGillivray, Leonard R - Metal-Organic Framework Materials-Wiley (2014) 14) Xian-He Bu, Michael J. Zaworotko, Zhenjie Zhang - Metal-Organic Framework-From Design to Applications-Springer International Publishing_Springer (2020) 15) Wei Xia- Fabrication of Metal–Organic Framework Derived Nanomaterials and Their Electrochemical Applications-Springer Singapore (2018)

	DSC- 8: Chemistry of Bioactive Heterocycles **(Credit: 04, Theory: 60 Periods, Marks: 100)**
	Course Objectives: Upon completion of the course student shall be able to
●	To understand chemistry of three and four membered heterocycles.
●	To understand synthesis and reactions of five membered heterocycles.
●	To understand chemistry of six membered heterocycle, their synthesis and applications.
●	To understand synthesis and applications of benzofused heterocycles.
Unit 1:	**Three and Four membered heterocycles** **[15]**
	Baldwin ring closure rules, formation of 3, 4, 5 and 6 membered rings 3-membered rings: Aziridines, Oxiranes, Thiiranes, 4-membered rings: Azetidines, Oxitanes and Thietanes
Unit 2:	**Five-membered heterocycles** **[15]**
	Five-membered rings with one heteroatom: Pyrrollidine, Furan, Pyrrole and Thiophene Five-membered rings with two heteroatoms: Imidazole, Pyrazole, Oxazole,

	Isoxazole, Thiazole, Isothiazole. Five-membered rings with three heteroatoms: Triazoles, Oxadiazole, Thiadiazole, Tetrazole.
Unit 3:	**Six-membered heterocycles** **[15]**
	Six-membered rings with one heteroatom: Pyran, Pyridine Six-membered rings with two heteroatoms: Piperazine, Morphine, Thiomorphine, 10 Pyridazines, pyrimidines, pyrazines, Six-membered rings with three heteroatoms: Hexahydro-1,3,5-triazine Six-membered rings with three heteroatoms: Tetrazine
Unit 4:	**Benzofused heterocycles:** **[15]**
	Benzofused heterocycles: Benzopyrroles, Benzofuran, Indole, Benzothiophene, Benzoxazole, benzthiazole, Benzimidazole, Quinolines, Isoquinoline, Quinazolines, Coumarins and Chromones, Purines and Pteridines
	Course Outcomes:
●	Students will be able to understand synthesis of different heterocycles.
●	Students will be able to understand applications of different heterocycles.
●	Students will be able to understand various chemical reactions of heterocycles.
	Reference books:
	1) R. M. Acheson: An introduction to chemistry of heterocyclic compounds (Interscience) 2) Joule and Smith: Heterocyclic chemistry (Van Nossstrand) 3) R.K. BANSAL: Heterocyclic chemistry (Wiley E) 4) L.A. Paquitte: Principals of modern heterocyclic chemistry 5) M.H. Palamer: The structure and reactions of heterocyclic compounds. 6) A.R. Katrtzhy and A.V. Bootton: Advances in Heterocyclic chemistry (A.P.) 7) Finar: Organic chemistry (Vol. 1 and 2) 8) Conn and Stumf: Outline of Biochemistry 9) Williams, Introduction to the chemistry of enzyme action. 10) The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman AcademicPress. 11) Stralegies for Organic Drug Synthesis and Design. D. Lednicer, John

	Wiley. 12) Heterocyclic Chemistry Vol. 1-3, R. R. Gupta, M. Kumar, and V. Gupta, SpringerVerlag. 13) The Chemistry of Heterocycles, T Eicher and S. Hauptmann, Thieme. 14) Heterocyclic Chemistry, J. A. Joule, K. Mills and G. F. Smith, Chapman ans Hall. 15) Heterocyclic Chemistry, T. L. Gilchrist, Longman ScietificTechinal 16) Contemporary Heterocyclic Chemistry, G. R. Newkome and W. W. Poudler,Wiley. 17) An Introduction to the Heterocyclic Compounds, R. M. Acheson, John Wiley. 18) Comprehensive Heterocyclic Chemistry, A. R. Katrizky and C. W. Rees, eds, Pergamon Press

	DSE-4A: Retrosynthesis and Disconnection Approach **(Credit: 04, Theory: 60 Periods, Marks: 100)**
	Course Objectives:
•	To know the various protecting groups and use of metal complexes.
•	To understand the basic concepts used in retrosynthesis.
•	To get knowledge of C-C disconnection in organic molecules and retrosynthesis.
•	To know real application of disconnection in organic synthesis.
Unit 1:	**Protecting groups and Metal Complexes** **[15]**
	Part- I Protecting Groups [08] Protection of NH Groups, Protection of OH Croups of Alcohols, Protection of Diols as Acetals, Protection of Carbonyl Groups in Aldehydes and Ketones, Protection of the Carboxyl Group, Protection of Double Bonds, Protection of Triple Bonds. Part- II Transitional metals complexes in organic synthesis [07] Iron:- Reactions of Iron carbonyls, ferrocenes, Fe-cyclopentadiene complex, protection ofdienes, isomerization Mn& Co:-Manganese and Co-carbonyls in hydroformylation, carboxylations, synthesis of silane complexes and their applications Pausal-khand reactions and

	its applications protection of alkynes by Co_2CO_8
Unit 2:	**Disconnection Approach-I [15]**
	Introduction to: Grounding of organic chemistry for understanding retrosynthesis; Retrosynthetic analysis and designing of the synthesis; Disconnection approach: An introduction to synthons, synthetic equivalents, disconnection approach, functional group Interconversions, importance of order of events in organic synthesis, one and two group C-X disconnections, selective organic transformations: chemoselectivity, regioselectivity, stereoselectivity, enentioselectivity, Reversal of polarity, cyclization reactions, amine synthesis
Unit 3:	**Disconnection Approach-II: [15]**
	i) One group C-C Disconnections: Alcohols (including stereoslectivity), carbonyls (including regioselectivity), Alkene, Synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis ii) Two group C-C Disconnections:Diels-Alder reactions, 1,3-difunctionalized compounds and α, β-unsaturated compounds,Control in carbonyl condensations, 1,5-difunctionalized compounds, Michael addition andRobbinson annulation,1-2 Difunctionalised Compounds, Radical Reaction In Synthesis, 1-4 Difunctionalised Compounds, Reconnection, 1-6 Dicarbonyl Compounds, Strategy of Carbonyl Disconnections, Introduction to Synthesis: Saturated heterocycles
Unit 4:	**Disconnection Approach-III [15]**
	Three-membered rings, Rearrangements in Synthesis, Four-membered rings, Photochemistry in synthesis, The use of ketene in synthesis, Five-membered rings, Pericyclic reactions in synthesis: Special methods of five membered rings, six-membered rings, strategy of ring synthesis, Stereoselectivity B, Aromatic heterocycles. Retrosynthesis of reserpine, taxol, strychnine, misoprostol.
	Course Outcomes:
●	The students will be able to apply use of various protecting groups and organoborane compounds.
●	The student will get basic idea about retrosynthesis.
●	The student will be able to do disconnection of various C-C compounds.
●	The student will be able to use various metal complexes in organic synthesis.

	Reference books:
	1) Organic Synthesis: The Disconnection Approach: Stuart Warren 2) Designing Organic Synthesis: Stuart Warren 3) Organic Synthesis: Strategy and Control: Paul Wyatt and Stuart Warren 4) The Logic of Chemical Synthesis: E. J. Corey and Xue-Min Chelg 5) Classics in Total Synthesis I, II and III: K. C. Nicolaou and others 6) Organic Synthesis Concepts, Methods, Starting Materials: J. Fuhrhop, G. Penzlin 7) Some Modern Methods of Organic Synthesis: W. Carruthers 8) Organic Synthesis: M. B. Smith 9) Principles of Organic Synthesis: R. Norman and J. M. Coxan 10) Advanced Organic Chemistry: Jerry March 11) Organic Chemistry: Clayden, Greeves, Warren and Wo

	DSE-4B: Medicinal Chemistry **(Credit: 04, Theory: 60 Periods, Marks: 100)**
	Course Objectives:
●	To understand synthetic strategies of different medicines.
●	To understand uses of different drugs.
●	To understand mechanism of action of various drug molecules.
●	To understand structure activity relationship of various drug molecules.
Unit 1:	**Definition, Classification, SAR, Mechanism of action and Synthesis* of drugs for following classes. [15]**
	Sulfonamides: Sulfisoxazole, Sulfapyridine, Sulfacetamide* and Sulfamethoxazole* **Antibiotics**: Penicillin: Ampicillin*, Amoxycillin. Cephalosporin: Cefazolin, Cefadroxil, Cefixime*, Tetracycline, Chloramphenicol*, Amino glycosides: Streptomycin Antimalerials: Chloroquine*
Unit 2:	**Definition, Classification, SAR, Mechanism of action and Synthesis* of drugs for following classes. [15]**
	Antiviral: Acyclovir, Remdesivir. Antifungal: Clotrimazole, Miconazole, Itraconazole NSAIDs: Aspirin*, Ibuprofen*, Paracetamol*, Diclofenac*, Aceclofenac, Indomethacin, Nimesulide and COX-II inhibitors

Unit 3:	**Definition, Classification, SAR, Mechanism of action and Synthesis* of drugs for following classes. [15]**
	Antianginal: Nitrates, Nifedipine, Propranolol* Anti-hypertensive Drugs: Verapamil, Captopril*, Atenolol Antidiabetics: Insulin, Tolbutamide, Glipizide, Metformin*, Pioglitazone Antihistamines: Diphenylhydramine*, Chlorpheniramine, Cetrizine
Unit 4:	**Definition, Classification, SAR, Mechanism of action and Synthesis* of drugs for following classes. [15]**
	Anaesthetics: Halothane, Lidocaine and Thiopental* Sedative and hypnotics: Phenobarbital, Diazepam*, Alprazolam **Anticonvulsant**: Phenytoin*, Carbamzepine, Valproic acid Antidepressant: Amitriptiline, Phenelzine* Antineoplastic: Alkylating agent, Antimetabolites
	Course Outcomes:
●	The students will be able to apply their knowledge about different drug molecules.
●	The students will understand mechanism of action of different drug molecules.
●	The students will be able to correlate structure of drug molecules with their activity.
●	The students will come to know various synthetic routes of different drug molecules.
	Reference books: 1) Medicinal chemistry-Burgers (Vol-I-VI) 2) Principles of medicinal chemistry-William O Foye 3) Textbook of medicinal chemistry- Vol-I&II- Surendra N Pandey 4) Principles of medicinal chemistry- S SKadam, K R Mahadik and K G Bothara 5) Introductory medicinal chemistry- Kennewell and Taylor 9 6) Wilson and Giswold`sText book of Organic medicinal and Pharmaceutical chemistryJaimes N Delgado and William A Remere 7) Fundamentals of microbiology- Forpischer 8) Genetics of antibiotics producing microorganisms- G Sermouti 9) Organic Chemistry: Clayden, Greeves, Warren and Wo

	10) Organic Synthesis: The Disconnection Approach: Stuart Warren 11) Designing Organic Synthesis: Stuart Warren 12) Comprehensive medicinal chemistry- Corwin and Hansch

	RP: Research Project **(Credit: 06, Marks: 150)**
	Students are expected to work on assigned research project and submit the results at the end of the semester in the form a dissertation. Open defense of the student on his/her dissertation shall be arranged. This defense shall be in front of the panel of examiners. This will be valued for 60 marks. Students are required to work for a specific project under supervision of concerned faculty member. Project work involving organic synthesis/evaluation of biological studies or in-plant training in any of the pharmaceutical or chemical industry for at least 21 days will be considered. Project should be completed under the guidance of a faculty member in the same Department or Industry or research organization. In case of Industry/ research organization one member of that body can also be included as project guide. **Guidelines for Assessment** ➢ Quality of literature survey and novelty in the problem ➢ Clarity of problem definition and feasibility of problem solution ➢ Clarity of objective and scope ➢ Quality of work attempted ➢ Presentation skills

	DSC-7 P: Organic Chemistry **(Credit: 02, Practical: 60 Periods, Marks: 50)**
	List of Practicals:
	Isolation of following constituents from the natural sources: (Any five)
	1) Isolation of lycopene from tomato fruits 2) Isolation of limonene from citrus rinds 3) Isolation of β-carotene from carrots 4) Isolation of Eugenol from cloves 5) Isolation of Piperine from black pepper

	6) Isolation of Nicotine from tobacco 7) Isolation of Curcumin from turmeric 8) Isolation of capsaicinoids from peppers by Soxhlet extraction **(Note: Other suitable experiments may be added)**

	DSE-4A P: Synthesis of Heterocycles **(Credit: 02, Practical: 60 Periods, Marks: 50)**
	List of Practicals
1.	Organic synthesis / Molecular modeling: Synthesis of medicinally important compounds: (TLC Analysis is recommended) **(Any five)** 1. Benzocain 2. Coumarins 3. Benzimidazole 4. Paracetamol 5. Iodoform 6. Phenyl azo-2 naphthol 7. 2-Phenyl quinoline-4-carboxylic acid from benzaldehyde. **(Note: Other suitable experiments may be added)**

	DSE-4B P: Medicinal Chemistry **(Credit: 02, Practical: 60 Periods, Marks: 50)**
	List of Practicals
1.	Assay of Paracetamol Tablet
2.	Assay of Chloramphenicol Capsule
3.	Assay of Aspirin Tablet
4.	Assay of Vitamin-C
5.	Preparation and Evaluation of Tablet
6.	Draw Plant Layout of Tablet Unit
7.	Draw Process Flow chart of parenteral formulation
8.	Validation of UV-Visible spectroscopic analytical method
9.	Performance Qualification of IR
10.	Evaluation of Packaging Material (Glass/Plastic)
11.	Preparation of weak Iodine solution
12.	Preparation of Paracetamol Suspension

13.	Preparation of Castor Oil Emulsion
14.	Preparation of Simple Syrup IP
15.	Preparation of Lemon Syrup
16.	Preparation of Sodium chloride eye lotion
17.	Preparation of Methyl salicylate Ointment **(Note: Other suitable experiments may be added)**

Reference books for Practicals (Sem-III & IV):

1. A Textbook of Practical Organic Chemistry - A. I. Vogel.
2. Practical Organic Chemistry - Mann & Saunders.
3. A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke.
4. Organic Synthesis Collective Volumes by Blat.
5. Reagents in Organic Synthesis by Fieser and Fieser.
6. Organic Practicals by Ahluwalia.
7. Systematic Lab Experiments in Organic Chemistry by Arun Sethi. (New Age).
8. Advanced Practical Medicinal Chemistry by Ashutosh Kar
9. Practical Pharmaceutical Chemistry-part two by A.H.Beckett and J.B. Stenlake.
10. Practical Pharmaceutical Analysis by Dr.G. Devala Rao.
11. Laboratory Handbook of Instrumental Drug Analysis by B.G. Nagavi.
12. Spectrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004.
13. Principles of Instrumental Analysis - Doglas A Skoog, F. James Holler, Timothy A. Nieman, 5 th edition, Eastern press, Bangalore, 1998.
14. Instrumental methods of analysis – Willards, 7 th edition, CBS publishers.
15. Organic Spectroscopy - William Kemp, 3 rd edition, ELBS, 1991.
16. Quantitative analysis of pharmaceutical formulations by HPTLC - P D Sethi, CBS Publishers, New Delhi.
17. Quantitative Analysis of Drugs in Pharmaceutical formulation - P D Sethi, 3 rd Edition, CBS Publishers, New Delhi, 1997.
18. Pharmaceutical Analysis- Modern methods – Part B - J W Munson, Volume 11, Marcel Dekker Series.
19. Indian pharmacacopoeia.
20. ICH guidelines-(Q2) Analytical method validation.

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