John Wilson Education Society's
Wilson College (Autonomous)

Chowpatty, Mumbai-400007
RE-ACCREDITED 'A' grade by NAAC

Affiliated to the

UNIVERSITY OF MUMBAI

Syllabus for PG Second Year (S.Y.) under New Education Policy (NEP 2020)

Program: M.Sc. (Organic Chemistry)

Program Code: WSCHO (Organic Chemistry)

Choice Based Credit System (CBCS) with effect from

Academic year 2024–2025

PROGRAM OUTLINE 2024-2025

YEAR	Course	COURSE CODE	COURSE TITLE	CREDITS
M.Sc. II SEM-III	Mandatory Course -I	WSCHOMT631	Theoretical Organic Chemistry -I	04
	Mandatory Course -II	WSCHOMT632	Synthetic Organic Chemistry -I	04
	Mandatory Course -III	WSCHOMP631	Organic Chemistry Practical-I & II	04
	Mandatory Course -IV	WSCHOMT633	Advanced Spectroscopic technique	02
	Elective theory	WSCHOET631 **OR** WSCHOET632	Drug discovery, design, development and synthesis **OR** Medicinal, Biogenesis and green chemistry	02
	Elective practical	WSCHOEP5631	Advanced Organic Chemistry Practical-I	02
	Project	WSCHORP631	Research Project	04
M.Sc. II SEM-IV	Mandatory Course -I	WSCHOMT641	Theoretical Organic Chemistry -II	04
	Mandatory Course -II	WSCHOMT642	Synthetic Organic Chemistry -II	04
	Mandatory Course -III	WSCHOMP5641	Organic Chemistry Practical-III & IV	04
	Elective theory	WSCHOET641 **OR** WSCHOET642	Intellectual Property Rights **OR** Heterocyclic Chemistry	02
	Elective practical	WSCHOEP641	Advanced Organic Chemistry Practical-II	02
	Project	WSCHORP641	Dissertation	06

PROGRAMME SPECIFIC OUTCOME (PSOs)

1. Gain knowledge of the advanced concepts in the branch of chemistry, scrutinize and accomplish a solution to problems encountered in the field of research and analysis.
2. Apply the basic knowledge of chemistry to perform various tasks assigned to them at the workplace in industry and academia to meet the global standards.
3. Deduce qualitative and quantitative information of chemical compounds using advanced spectroscopic methods which can further be analyzed using practical skills inculcated in them during the course.
4. Imbibe the attitude as well as aptitude of a scientific approach along with analytical reasoning with respect to the novel techniques actually implemented in the Industry.
5. Use the subject knowledge, communication and ICT skills to become an effective team leader/team member in the interdisciplinary fields.
6. Understand, Manage and contribute to solve basic societal issues and environmental concerns ethically based on principles of scientific knowledge gained.
7. Exhibit professional work ethics and norms of scientific development.

PREAMBLE:

Master of Science (M.Sc.) in Chemistry is an postgraduate course of Department of Chemistry, Wilson College, Chowpatty, Mumbai (Autonomous). The Choice Based Credit System to be implemented through this curriculum would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities.

This syllabus is prepared to give the sound knowledge and understanding of chemistry to undergraduate students in the first year of the M.Sc. degree course. The goal of the syllabus is to make the study of Chemistry as stimulating, interesting and relevant as possible. The syllabus is prepared by keeping in mind the aim to make students capable of studying Chemistry in academic and industrial courses. Also, to expose the students and to develop interest in them in various fields of Chemistry.

The new and updated syllabus is based on a interdisciplinary approach with vigour and depth taking care that the syllabus is not heavy at the same time it is comparable to the syllabi of other universities at the same level. The students pursuing this course would have to develop an understanding of various aspects of chemistry. The conceptual understanding, development of experimental skills, developing the aptitude for academic and professional skills, obtaining basic ideas and understanding of hyphenated techniques, understanding the fundamental chemical processes and rationale towards application of knowledge are among such important aspects.

PROGRAM(s): M.Sc.-II		**SEMESTER: III**			
Course: I		**Course Code: WSCHOMT631** **Course Title: Theoretical organic chemistry-I**			
Teaching Scheme				**Evaluation Scheme**	
Lectures (Hour per week)	**Practical (Hour per week)**	**Tutorial (Hour per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 40)**	**Semester End Examination (Marks- 60)**
04	**NA**	–	**04**	**40**	**60**

Learning Objectives:

1. To gain knowledge of the advanced concepts in Organic Chemistry such as reaction mechanisms, stereochemistry, pericyclic, and photochemistry
2. To get familiar with FMO approach, reactive intermediates and their applications in solving organic reaction mechanisms.
3. To introduce the pericyclic reactions, their types, and further applications in organic chemistry.
4. To learn strains, conformations, the stereochemistry of the medium-sized rings, and the stereochemical reactions.
5. To understand the application of photochemistry in organic transformations.

Course Outcomes: At the end of the Course student will be able to-

1. explain FMO approach, and reactive intermediates and will be able to apply knowledge to solve organic reaction mechanism problems.
2. identify, classify, and solve the problems of pericyclic chemistry.
3. develop a skill to apply knowledge in predicting the stereochemistry of products based on learnings about medium-sized ring conformations and the strain involved.
4. apply concept of photochemistry to organic reactions.

Detailed Syllabus

Theoretical Organic Chemistry-I

Course Code:-	**Unit**	**Course/ Unit Title** **Theoretical organic chemistry-I**	**04 Credits/ 60 Lectures**
WSCHOMT631	**I**	**Organic reaction mechanisms**	**15 L**
	1.1	Organic reactive intermediates, methods of generation, structure, stability and important reactions involving carbocations, nitrenes, carbenes, arynes and ketenes.	**5 L**
	1.2	Neighboring group participation: Mechanism and effects of anchimeric assistance, NGP by unshared/ lone pair electrons, π-electrons, aromatic rings, σ- bonds with special reference to norbornyl and bicyclo[2.2.2]octyl cation systems (formation of non-classical carbocation)	**3 L**
	1.3	Role of FMOs in organic reactivity: Reactions involving hard and soft electrophiles and nucleophiles, ambident nucleophiles, ambident electrophiles, the α effect.	**2 L**

	1.4	Pericyclic reactions: Classification of pericyclic reactions; thermal and photochemical reactions. Three approaches: Evidence for the concertedness of bond making and breaking Symmetry-Allowed and Symmetry-Forbidden Reactions – -The Woodward-Hoffmann Rules-Class by Class -The generalised Woodward-Hoffmann Rule Explanations for Woodward-Hoffmann Rules -The Aromatic Transition structures [Huckel and Mobius] -Frontier Orbitals - Correlation Diagrams, FMO and PMO approach Molecular orbital symmetry, Frontier orbital of ethylene, 1,3 butadiene, 1,3,5 hexatriene and allyl system.	**5 L**
	II	**Pericyclic reactions**	**15 L**
	2.1	Cycloaddition reactions: Supra and antarafacial additions, 4n and 4n+2 systems, 2+2 additions of ketenes. Diels-Alder reactions, 1, 3-Dipolar cycloaddition and cheletropic reactions, ene reaction, retro-Diels-Alder reaction, regioselectivity, periselectivity, torquoselectivity, site selectivity and effect of substituents in Diels-Alder reactions. Other Cycloaddition Reactions- [4+6] Cycloadditions, Ketene Cycloaddition, Allene Cycloadditions, Carbene Cycloaddition, Epoxidation and Related Cycloadditions. Other Pericyclic reactions: Sigmatropic Rearrangements, Electrocyclic Reactions, Alder 'Ene' Reactions.	**7 L**
	2.2	Electrocyclic reactions: Conrotatory and disrotatory motions, 4nπ and (4n+2)π electron and allyl systems.	**3 L**
	2.3	Sigmatropic rearrangements: H-shifts and C-shifts, supra and antarafacial migrations, retention and inversion of configurations. Cope (including oxyCope and aza-Cope) and Claisen rearrangements. Formation of Vitamin D from 7-dehydrocholesterol, synthesis of citral using pericyclic reaction, conversion of Endiandric acid E to Endiandric acid A.	**5 L**
	III	**Stereochemistry-I**	**15 L**
	3.1	Classification of point groups based on symmetry elements with examples (nonmathematical treatment).	**2 L**
	3.2	Conformational analysis of medium rings: Eight to ten membered rings and their unusual properties, I-strain, transannular reactions.	**3 L**
	3.3	Stereochemistry of fused ring and bridged ring compounds: decalins, hydrindanes, perhydroanthracenes, steroids, and Bredt's rule.	**5 L**

	3.4	Anancomeric systems, Effect of conformation on reactivity of cyclohexane derivatives in the following reactions (including mechanism): electrophilic addition, elimination, molecular rearrangements, reduction of cyclohexanones (with LiAlH4, selectride and MPV reduction) and oxidation of cyclohexanols.	**5 L**
	IV	**Photochemistry**	**15 L**
	4.1	Principles of photochemistry: quantum yield, electronic states and transitions, selection rules, modes of dissipation of energy (Jablonski diagram), electronic energy transfer: photosensitization and quenching process.	**3 L**
	4.2	Photochemistry of carbonyl compounds:$\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ transitions, Norrish- I and Norrish-II cleavages, Paterno-Buchi reaction. Photoreduction, calculation of quantum yield, photochemistry of enones, photochemical rearrangements of α, β-unsaturated ketones and cyclohexadienones. Photo Fries rearrangement, Barton reaction.	**8 L**
	4.3	Photochemistry of olefins: cis-trans isomerizations, dimerizations, hydrogen abstraction, addition and Di- π- methane rearrangement including aza-di- π -methane. Photochemical Cross-Coupling of Alkenes, Photodimerisation of alkenes.	**2 L**
	4.4	Photochemistry of arenes: 1, 2- , 1, 3- and 1, 4- additions. Photocycloadditions of aromatic Rings.	**1 L**
	4.5	Singlet oxygen and photo-oxygenation reactions. Photochemically induced Radical Reactions. Chemiluminescence.	**1 L**

References:

Unit I

1. March's Advanced Organic Chemistry, Jerry March, sixth edition, 2007, John Wiley and sons.
2. A guide to mechanism in Organic Chemistry, 6th edition, 2009, Peter Sykes, Pearson education, New Delhi.
3. Advanced Organic Chemistry: Reaction Mechanisms, R. Bruckner, Academic Press (2002).
4. Mechanism and theory in Organic Chemistry, T. H. Lowry and K. C. Richardson, Harper and Row.
5. Organic Reaction Mechanism, 4th edition, V. K. Ahluvalia, R. K. Parashar, Narosa Publication.
6. Reaction Mechanism in Organic Chemistry, S.M. Mukherji, S.P. Singh, Macmillan Publishers, India.
7. Organic Chemistry, Part A and B, Fifth edition,2007, Francis A. Carey and Richard J. Sundberg, Springer.
8. Carbenes, Nitrenes and Arynes. Von T. L. Gilchrist, C. W. Rees. Th. Nelson and Sons Ltd., London 1969.
9. Organic reactive intermediates, Samuel P. MacManus, Academic Press.
10. Organic Chemistry, J. Clayden, S. Warren, N. Greeves, P. Wothers,1st Edition, Oxford University Press (2001).
11. Organic Chemistry, Seventh Edition, R.T. Morrison, R. N. Boyd & S. K. Bhattacharjee, Pearson.
12. Advanced Organic Chemistry: Reactions & Mechanisms, second edition, B. Miller and R. Prasad, Pearson.
13. Organic reactions & their mechanisms, third revised edition, P.S. Kalsi, New Age International Publishers.
14. Organic Chemistry: Structure and Function, P. Volhardt and N. Schore, 5th Edition, 2012
15. Organic Chemistry, W. G. Solomons, C. B. Fryhle, , 9th Edition, Wiley India Pvt. Ltd.,2009.

Unit II

1. Pericyclic Reactions, S. Sankararaman, Wiley VCH, 2005.
2. Advanced organic chemistry, Jagdamba Singh L. D. S. Yadav, Pragati Prakashan, 2011
3. Pericyclic reactions, Ian Fleming, Oxford university press, 1999.
4. Pericyclic reactions-A mechanistic approach, S. M. Mukherji, Macmillan Co. of India 1979.
5. Organic chemistry, 8th edition, John McMurry
6. Modern methods of Organic Synthesis, 4th Edition W. Carruthers and Iain Coldham, Cambridge University Press 2004

7. Modern physical chemistry, Eric V Anslyn, Dennis A. Dougherty, University science books,2006
8. Physical Organic Chemistry, N. S. Isaacs, ELBS/Longman

Unit III

1. Stereochemistry of Carbon Compounds: Principles and Applications, D, Nasipuri, 3**rd** edition, New Age International Ltd.
2. Stereochemistry of Organic Compounds, Ernest L. Eliel and Samuel H. Wilen, Wiley-India edit
3. Stereochemistry, P. S. Kalsi, 4th edition, New Age International Ltd
4. Organic Stereochemistry, M. J. T. Robinson, Oxford University Press, New Delhi, India edition, 2005
5. Bioorganic, Bioinorganic and Supramolecular chemistry, P.S. Kalsi and J.P. Kalsi. New Age International Publishers
6. Supramolecular Chemistry; Concepts and Perspectives, J. M. Lehn, VCH.
7. Crown ethers and analogous compounds, M. Hiraoka, Elsevier, 1992.
8. Large ring compounds, J.A.Semlyen, Wiley-VCH, 1997.

Unit IV

1. Fundamentals of Photochemistry, K. K. Rohtagi-Mukherji, Wiley- Eastern
2. Essentials of Molecular Photochemistry, A. Gilbert and J. Baggott, Blackwell Sciertific Publication.
3. Molecular Photochemistry, N. J. Turro, W. A. Benjamin.
4. Introductory Photochemistry, A. Cox and T. Camp, McGraw-Hill
5. Photochemistry, R. P. Kundall and A. Gilbert, Thomson Nelson.
6. Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press.
7. Molecular Orbitals and Organic Chemical Reactions by Ian Fleming (Wiley – A john Wiley and Sons, Ltd., Publication)

PROGRAM(s): M.Sc. II		**SEMESTER: III**			
Course:II		**Course Code: WSCHOMT632** **Course Title: Synthetic Organic Chemistry-I**			
Teaching Scheme				**Evaluation Scheme**	
Lectures (Hour per week)	**Practical (Hour per week)**	**Tutorial (Hour per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 40)**	**Semester End Examination (Marks- 60)**
04	**NA**	–	**04**	**40**	**60**

Learning Objectives:

1. To Gain knowledge of the advanced concepts in organic chemistry such as modern name reactions, organic radical chemistry, the chemistry of enamines, ylides, and the role of metals and nonmetals in modern organic transformations.

Course Outcomes: At the end of the Course student will be able to-

1. describe modern name reactions as well as multicomponent reactions for the synthesis of heterocycles of pharmaceutical importance.
2. identify free radical generation, their stability, and their applications in modern organic synthesis.
3. explain new routes for organic transformations involving ylides, enamines, etc. along with the stereochemical aspects.
4. predict applications of metals (Sn, Hg), Semimetals (B), nonmetal (Se), etc. in organic synthesis.

Detailed Syllabus

Synthetic Organic Chemistry-I

Course Code	**Unit**	**Course/ Unit Title** **Synthetic Organic Chemistry-I**	**04 Credits/ 60 Lectures**
WSCHOMT632	**I**	**Name reactions with mechanism and application**	**15 L**
	1.1	Mukaiyama esterification, Mitsonobu reaction, Darzen's Glycidic Ester synthesis, Ritter reaction, Yamaguchi esterification, Peterson olefination.	**5 L**
	1.2	Domino reactions: Characteristics; Nazerov cyclization	**3 L**
	1.3	Multicomponent reactions: Strecker Synthesis, Ugi 4CC, Biginelli synthesis, Hantzsch synthesis, Pictet-Spengler synthesis	**5 L**
	1.4	Click Reactions: Characteristics; Huisgen 1,3-Dipolar Cycloaddition	**2 L**
	II	**Radicals in organic synthesis**	**15 L**
	2.1	Introduction: Generation, stability, reactivity and structural and stereochemical properties of free radicals, Persistent and charged radicals, Electrophilic and nucleophilic radicals.	**3 L**
	2.2	Radical Initiators: azobisisobutyronitrile (AIBN) and dibenzoyl peroxide.	**1 L**
	2.3	Characteristic reactions - Free radical substitution, addition to multiple bonds. Radical chain reactions, Radical halogenation of hydrocarbons (Regioselectivity),radical cyclizations, autoxidations: synthesis of cumene hydroperoxide from cumene.	**4 L**

	2.4	Radicals in synthesis: Inter and intra molecular C-C bond formation via mercuric hydride, tin hydride, thiol donors. Cleavage of C-X, C-Sn, C-Co, C-S, O-O bonds. Oxidative coupling, C-C bond formation in aromatics: SRNAr reactions.	**4 L**
	2.5	Hunsdiecker reaction, Pinacol coupling, McMurry coupling, Sandmeyer reaction, Acyloin condensation.	**3 L**
	III	**Enamines, Ylides and α-C-H functionalization**	**15 L**
	3.1	Enamines: Generation & application in organic synthesis with mechanistic pathways, Stork enamine reaction. Reactivity, comparison between enamines and enolates. Synthetic reactions of enamines including asymmetric reactions of chiral enamines derived from chiral secondary amines.	**4 L**
	3.2	Phosphorus, Sulfur and Nitrogen Ylides: Preparation and their synthetic applications along with their stereochemical aspects. Wittig reaction, Horner-Wadsworth-Emmons Reaction, Barton-Kellogg olefination.	**6 L**
	3.3	α-C-H functionalization: By nitro, sulfoxide, sulfone and phosphonate groups: generation of carbanions by strong bases (LDA/n-butyl lithium) and applications in C-C bond formation. Bamford-Stevens reaction, Julia olefination and its modification, Seyferth–Gilbert homologation, Steven's rearrangement.	**5 L**
	IV	**Metals / Non-metals in organic synthesis**	**15 L**
	4.1	Mercury in organic synthesis: Mechanism and regiochemistry of oxymercuration and demercuration of alkenes, mercuration of aromatics, transformation of aryl mercurials to aryl halides. Organomercurials as carbene transfer reagents.	**3 L**
	4.2	Organoboron compounds: Mechanism and regiochemistry of hydroboration of alkenes and alkynes, asymmetric hydroboration using chiral boron reagents, 9-BBN hydroboration, oxazaborolidine (CBS catalyst) and functional group reduction by diborane.	**3 L**
	4.3	Organosilicons: Salient features of silicon governing the reactivity of organosilicons, preparation and important bond-forming reactions of alkyl silanes, alkenyl silanes, aryl silanes and allyl silanes. β-silyl cations as intermediates. Iodotrimethylsilane in organic synthesis.	**3 L**
	4.4	Silyl enol ethers: Application: As nucleophiles (Michael reaction, Mukaiyama aldol reaction), in ring contraction reactions.	**2 L**
	4.5	Organotin compounds: Preparation of alkenyl and allyl tin compounds; application in C-C bond formation, in replacement of halogen by H at the same C atom.	**2 L**
	4.6	Selenium in organic synthesis: Preparation of selenols/selenoxide, selenoxide elimination to create unsaturation, selenoxide and seleno acetals as α-C-H activating groups	**2 L**

References:

Unit I

1. Strategic Applications of Name Reactions in Organic Synthesis, L. Kurti & B. Czako (2005), Elsevier Academic Press
2. Name Reactions and Reagents in Organic Synthesis, 2nd Edn.,
3. Bradford P. Mundy, Michael G. Ellard, and Frank Favoloro, Jr., Wiley-Interscience
4. Name Reactions, Jie Jack Lie, 3rd Edn., Springer

Unit II, III and IV

5. Advanced Organic Chemistry, Part A and Part B: Reaction and Synthesis, Francis A. Carey, Richard J. Sundberg, 5th Edition, Springer Verlag
6. Modern Methods of Organic Synthesis, 4th Edition, W. Carruthers and Iain Coldham, Cambridge University Press, 2004.
7. Chem.Rev. 2002, 102, 2227-2302, Rare Earth Metal Triflates in Organic Synthesis, S. Kobayashi, M. Sugiura, H. Kitagawa, and W.W.L. Lam.
8. Organic Chemistry, Clayden Greeves Warren and Wothers, Oxford Press (2001).
9. Modern Organic Synthesis: An Introduction, G.S. Zweifel and M.H. Nantz, W.H. Freeman and Company, (2007).
10. Advanced Organic Chemistry: Reaction Mechanism, R. Bruckner, Academic Press (2002).
11. Principles of Organic Synthesis, R.O.C. Norman & J. M. Coxon, 3rd Edn., Nelson Thornes
12. Organic Chemistry, 7th Edn, R. T .Morrison, R. N. Boyd, & S. K. Bhattacharjee, Pearson
13. Advanced Organic Chemistry: Reactions & Mechanisms, 2nd Edn., B. Miller & R. Prasad, Pearson
14. Organic Electrochemistry, H. Lund, and M. Baizer, 3rd Edn., Marcel Dekker.

PROGRAM(s): M.Sc. II		**SEMESTER: III**			
Course: III		**Course Code: WSCHOMP631** **Course Title: Organic Chemistry Practical- I and II**			
Teaching Scheme				**Evaluation Scheme**	
Lectures (Hour per week)	**Practical (Hour per week)**	**Tutorial (Hour per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 40)**	**Semester End Examination (Marks- 60)**
NA	**08**	**–**	**04**	**40**	**60**

Learning Objectives:

1. To prepare derivatives of separated individual components from an unknown mixture.
2. To get acquainted with various physical methods of purification of organic compounds.
3. To get hands-on experience in single step preparation of various organic compounds.

Course Outcomes: At the end of the Course student will be able to-

1. prepare derivatives of separated components.
2. explain purification of organic compounds using Steam distillation, Vacuum distillation, and Column chromatography.
3. synthesize organic compounds by using various organic reagents.

Detailed Syllabus

Course code	**Organic Chemistry Practical- I**	**02 Credits**
WSCHOMP631	**Major Practical:** **Separation of a solid ternary mixture using micro-scale technique (Any 10)** 1. Separation of solid components of a ternary mixture (water insoluble/water soluble) based upon differences in the physical and the chemical properties of the components. 2. Identification of the two components (indicated by the examiner) using micro-scale technique.	
	Organic Chemistry Practical- II	**02 Credits**
	Minor Practical: **Single step organic preparation(1.0 g scale) involving purification by Steam distillation / Vacuum distillation or Column chromatography.** 1. Preparation of acetanilide from aniline and acetic acid using Zn dust. 2. Preparation of 1-nitronaphthalene from naphthalene. 3. Preparation of acetyl ferrocene from ferrocene. 4. Preparation of 3-nitroaniline from 1,3-dinitrobenzene. 5. Preparation of benzyl alcohol from benzaldehyde. 6. Preparation of methyl salicylate from salicylic acid. 7. Preparation of 4-methylacetophenone from toluene. 8. Preparation of phenyl acetate from phenol. 9. Preparation of 2-chlorotoluene from *o*-toluidine. 10. Preparation of 4-nitrophenol from phenol. 11. Preparation of fluorenone from fluorene. 12. Preparation of dimethyl phthalate from phthalic anhydride. (**(any 8 experiments)** **Note:** 1. Students are expected to measure its mass or volume, recrystallize the crude product by recrystallization method, check the purity by TLC, determine physical constant and calculate percentage yield.	

References:

1. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis- V.K. Ahluwalia and Renu Aggarwal, Universities Press India Ltd., 2000
2. Advanced Practical Organic Chemistry – N. K. Vishnoi, Third Addition, Vikas Publishing House PVT Ltd
3. Systematic Laboratory Experiments in Organic Synthesis- A. Sethi, New Age International Publications
4. Systematic Identification of Organic compounds, 6th edition, R. L. Shriner, R. C. Fuson and D.Y. Curtin Wiley, New York.
5. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS
6. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall
7. Macro-scale and Micro-scale Organic Experiments, K. L. Williamson, D. C. Heath.
8. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
9. Handbook of Organic Analysis- Qualitative and Quantitative, H. Clark, Adward Arnold.
10. Vogel's Textbook of Practical Organic Chemistry, Fifth edition,2008, B.S.Furniss, A. J.Hannaford, P. W. G. Smith, A. R. Tatchell, Pearson Education.
11. Laboratory Manual of Organic Chemistry, Fifth edition, R K Bansal, New Age Publishers.
12. Organic structures from spectra, L. D. Field, S. Sternhell, John R.Kalman, Wiley, 4th ed., 2011.

PROGRAM(s): M.Sc-II		**SEMESTER: III**			
Course: IV		**Course Code: WSCHOMT633** **Course Title: Advanced spectroscopic techniques**			
Teaching Scheme				**Evaluation Scheme**	
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 20)**	**Semester End Examination (Marks- 30)**
02	**–**	**–**	**02**	**20**	**30**

Learning Objectives:

1. To understand the occurrence, importance and the synthesis of natural products such as carbohydrates, insect pheromones, alkaloids and pigments
2. To learn multistep synthesis of selected natural products
3. To understand structural elucidation of organic compounds using spectroscopic methods.

Course Outcomes: At the end of the Course student will be able to-

1. give examples of natural products and their importance and will be able to draw their structures and synthesis.
2. solve problems on structural elucidation using spectroscopic techniques such as FTIR, NMR, Mass spectrometry, etc.

Detailed Syllabus

Advanced spectroscopic techniques

Course Code:	**Unit**	**Course/ Unit Title** **Advanced spectroscopic techniques**	**02 Credits/ 30 Lectures (L)**
WSCHOMT633	**I**	**Advanced spectroscopic techniques-I**	**15 L**
	1.1	Proton NMR spectroscopy: Recapitulation, chemical and magnetic equivalence of protons, First order, second order, Spin system notations (A2, AB, AX, AB2, AX2, AMX and A2B2-A2X2 spin systems with suitable examples). Long range coupling (Allylic coupling, 'W' coupling and Coupling in aromatic and heteroaromatic systems), Temperature effects, Simplification of complex spectra, nuclear magnetic double resonance, chemical shift reagents.	**7 L**
	1.2	13C –NMR spectroscopy: Recapitulation, equivalent and non-equivalent carbons (examples of aliphatic and aromatic compounds), 13C- chemical shifts, calculation of 13C- chemical shifts of aromatic carbons, heteronuclear coupling of carbon to 19F and 31P.	**4 L**
	1.3	Spectral problems based on UV, IR, 1H NMR and 13C NMR and Mass spectroscopy.	**4 L**
	II	**Advanced spectroscopic techniques-II**	**15 L**
	2.1	Advanced NMR techniques: DEPT experiment, determining number of attached hydrogens (Methyl/methylene/methine and quaternary carbons), two dimensional spectroscopic techniques, (a)Homonuclear: COSY and HETCOR spectra, NOE and NOESY techniques. b)Heteronuclear:HSQC, HMQC,HMBC	**10 L**
	2.2	Spectral problems based on UV, IR, 1H NMR, 13C NMR (Including 2D technique) and Mass spectroscopy	**5 L**

Reference

Unit I and II

1. Spectroscopy of Organic compounds, P.S. Kalsi, New Age International Pub. Ltd. And Wiley Eastern Ltd., Second edition, 1995.
2. Applications of Absorption Spectroscopy of Organic compounds, J. R. Dyer, Prentice Hall of India, 1987.
3. Spectrometric Identification of Organic compounds, R.M. Silverstein and others, John Wiley and Sons Inc., 5th ed., 1991
4. Absorption spectroscopy of organic Molecules, V.M. Parikh, 1974.
5. Spectroscopic methods in organic chemistry, Williams and Fleming, Tata McGraw Hill, 4th ed, 1989.
6. Organic spectroscopy, William Kemp, ELBS, 3rd ed., 1987.
7. 42. Organic structures from spectra, L. D. Field, S. Sternhell, John R. Kalman, Wiley, 4th ed., . 3122
8. Introduction to spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, James R. Vyvyan, 4th ed., 2009.
9. Organic spectroscopic structure determination: a problem-based learning approach Douglass F. Taber, Oxford University Press, 17-Sep-2007.
10. Organic Spectroscopy: Principles And Applications, Jag Mohan, Alpha Science International Ltd., 30-Mar-2004

PROGRAM(s): M.Sc. II		**SEMESTER: III**			
Course: V (Elective I)		**Course Code: WSCHOET631** **Course Title: Drug discovery, design, development and synthesis**			
Teaching Scheme				**Evaluation Scheme**	
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 20)**	**Semester End Examination (Marks- 30)**
02	**–**	**–**	**02**	**20**	**30**

Learning Objectives:
1. To introduce learners to drug discovery and design.
2. To get knowledge of computer aided molecular graphics in drug design and their synthesis.

Course outcomes: At the end of the Course student will be able to-
1. explain the basics of drug discovery and designing.
2. apply the concept of computer aided molecular graphics in drug designing.

Detailed Syllabus

Elective I: Drug discovery, design, development and synthesis

Course Code:	**Unit**	**Course/ Unit Title** **Drug discovery, design, development and synthesis**	**02 Credits/ 30 Lectures**
WSCHOET631	**I**	**Drug discovery, design and development**	**15 L**
	1.1	Introduction, important terms used in medicinal chemistry: receptor, therapeutic index, bioavailability, drug assay and drug potency. General idea of factors affecting bioactivity: Resonance, inductive effect, bioisosterism, spatial considerations. Basic pharmacokinetics: drug absorption, distribution, metabolism (biotransformation) and elimination. Physical and chemical parameters like solubility, lipophilicity, ionization, pH, redox potential, H-bonding, partition coefficient and isomerism in drug distribution and drug-receptor binding.	**7 L**
	1.2	Procedures in drug design: Drug discovery without a lead: Penicillin, Librium. Lead discovery: random screening, non-random (or targeted) screening. Lead modification: Identification of the pharmacophore, Functional group modification. Structure-activity relationship, Structure modification to increase potency and therapeutic index: Homologation, chain branching, ring-chain transformation, bioisosterism, combinatorial synthesis (basic idea).	**8 L**
	II	**Drug design, development and synthesis**	**15 L**
	2.1	Introduction to quantitative structure activity relationship studies. QSAR parameters: - steric effects: The Taft and other equations; Methods used to correlate regression parameters with biological activity: Hansch analysis- A linear multiple regression analysis.	**5 L**
	2.2	Introduction to modern methods of drug design and synthesis- computer aided molecular graphics based drug design, drug design via enzyme inhibition (reversible and irreversible), bioinformatics and drug design.	**3 L**

	2.3	Concept of prodrugs and soft drugs. (a) Prodrugs: Prodrug design, types of prodrugs, functional groups in prodrugs, advantages of prodrug use. (b) Soft drugs: concept and properties.	**3 L**
	2.4	Synthesis and application of the following drugs: Fluoxetine, cetrizine, esomeprazole, fluconazole, zidovudine, methotrexate, diclofenac, labetalol, fenofibrate.	**4 L**

References:

Unit I and II

1. Natural product chemistry, A mechanistic, biosynthetic and ecological approach, Kurt B.G. Torssell, Apotekarsocieteten – Swedish Pharmaceutical Press.
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18. Introduction to Flavonoids, B.A. Bohm, Harwood Academic Publishers, 1998.
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20. Insecticides of Natural Origin, Sukh Dev, Harwood Academic Publishers.
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26. Total synthesis of Griseofulvin, Stork, G.; Tomasz, M. J. Am. Chem. Soc. 1962, 84, 310.
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37. Biotransformations in Organic Chemistry, 5thEdition, Kurt Faber, Springer
38. Structure Determination of Organic Compounds, EPretsch, P. Buhlmann, C.Affolter, Springer

PROGRAM(s): M.Sc. II		**SEMESTER: III**			
Course: V (Elective II)		**Course Code: WSCHOET632 Course Title: Medicinal, Biogenesis and green chemistry**			
Teaching Scheme				**Evaluation Scheme**	
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 20)**	**Semester End Examination (Marks- 30)**
02	**–**	**–**	**02**	**20**	**30**

Learning Objectives:
1. To understand biogenesis and biosynthesis of selected natural products.
2. To understand green chemistry in organic synthesis and solid phase synthesis.

Course outcomes: At the end of the Course student will be able to-
1. explain biogenesis and biosynthesis of selected natural products.
2. apply knowledge about solid phase synthesis and other aspects of green chemistry.

Detailed Syllabus

Elective II: Medicinal, Biogenesis and green chemistry

Course Code:	**Unit**	**Course/ Unit Title Medicinal , Biogenesis and green chemistry**	**04 Credits/ 60 Lectures**
WSCHOET632	**I**	**Biogenesis and biosynthesis of natural products**	**15 L**
	1.1	Primary and secondary metabolites and the building blocks, general pathway of amino acid biosynthesis.	**3 L**
	1.2	Acetate pathway: Biosynthesis of malonylCoA, saturated fatty acids, prostaglandins from arachidonic acid, aromatic polyketides.	**4 L**
	1.3	Shikimic Acid pathway: Biosynthesis of shikimic acid, aromatic amino acids, cinnamic acid and its derivatives, lignin and lignans, benzoic acid and its derivatives, flavonoids and isoflavonoids.	**4 L**
	1.4	Mevalonate pathway: Biosynthesis of mevalonic acid, monoterpenes – geranyl cation and its derivatives, sesquiterpenes – farnesyl cation and its derivatives and diterpenes.	**4 L**
	II	**Green chemistry**	**15L**
	2.1	Introduction, basic principles of green chemistry. Designing a green synthesis: Green starting materials, green reagents, green solvents and reaction conditions, green catalysts.	**1 L**

	2.2	Use of the following in green synthesis with suitable examples: a) Green reagents: dimethyl carbonate, polymer supported reagents. b) Green catalysts: Acid catalysts, oxidation catalysts, basic catalysts, phase transfer catalysts [Aliquat 336, benzyl trimethyl ammonium chloride (TMBA), Tetra-n-butyl ammonium chloride, crown ethers], biocatalysts. c) Green solvents: water, ionic liquids, deep eutectic solvents, supercritical carbon dioxide. d) Solid state reactions: solid phase synthesis, solid supported synthesis e) Microwave assisted synthesis: reactions in water, reactions in organic solvents, solvent free reactions. f) Ultrasound assisted reactions.	**9 L**
	2.3	Comparison of traditional processes versus green processes in the syntheses of ibuprofen, adipic acid, 4-aminodiphenylamine, p-bromotoluene and benzimidazole.	**3 L**
	2.4	Green Catalysts : Nanocatalyst, Types of nanocatalysts, Advantages and Disadvantages of Nanocatalysts, Idea of Magnetically separable nanocatalysts.	**2 L**

References

1. Spectroscopy of Organic compounds, P.S. Kalsi, New Age International Pub. Ltd. And Wiley Eastern Ltd., Second edition, 1995.
2. Applications of Absorption Spectroscopy of Organic compounds, J. R. Dyer, Prentice Hall of India, 1987.
3. Spectrometric Identification of Organic compounds, R.M. Silverstein and others, John Wiley and Sons Inc., 5th ed., 1991
4. Absorption spectroscopy of organic Molecules, V.M. Parikh, 1974.
5. Spectroscopic methods in organic chemistry, Williams and Fleming, Tata McGraw Hill, 4th ed, 1989.
6. Organic spectroscopy, William Kemp, ELBS, 3rd ed., 1987.
7. Organic structures from spectra, L. D. Field, S. Sternhell, John R. Kalman, Wiley, 4th ed., . 3122
8. Introduction to spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, James R. Vyvyan, 4th ed., 2009.

PROGRAM(s): M.Sc. II		**SEMESTER: III**			
Course: V **(Elective Practical)**		**Course Code: WSCHOEP631** **Course Title: Advanced Organic Chemistry Practical-I**			
Teaching Scheme				**Evaluation Scheme**	
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 20)**	**Semester End Examination (Marks- 30)**
-	**04**	**–**	**02**	**20**	**30**

Learning Objectives:
1. To introduce learners to estimation of drugs.
2. To get knowledge of essential components of natural products and its isolation.

Course outcomes: At the end of the Course student will be able to-
1. estimate the drug by using a particular estimation method.
2. show the method of isolation of natural products from medicinally important plants.

Detailed Syllabus

Course code	**Advanced Organic Chemistry Practical-I**	**02 Credits/ 30 Lectures**
WSCHOEP631	**Estimation of drugs** 1. Estimation of penicillin by iodometric titrations. 2. Estimation of streptomycin using uv-visible spectrophotometer. 3. Estimation of paracetamol by hydrolysis. 4. Estimation of aspirin in the given tablet using uv-visible spectrophotometer. 5. Estimation of diazepam by non-aqueous titrations. 6. Estimation of vitamin C by iodometric titrations. **Isolation of medicinally important component from the natural products (maximum 6)** Any medicinally important plants available in the local area. At least one natural product should be isolated by using column chromatographic techniques (Use micro columns to avoid excess use of solvents) Note: Students should be able to collect reasonable quantities of natural products to do the characterization (Physical Constant, solubility, Elemental analysis functional group test etc) and should also form the appropriate derivative. They are encouraged to study novel medicinal plants from their local area.	**02**

References:

1. Titrimetric Determination of Active Ingredient Content in Some Drugs Paperback – Import, 6 August 2015
2. by Nageswara Rao Tentu (Author), Tentu Srinivasarao (Author), Korupolu Raghubabu (Author)
3. Pharmaceutical Drug Analysis, Ashutosh Kar, New Age International, 2005 - Drugs
4. Spectrophotometric/Titrimetric Drug Analysis by Nagib Qarah and Ezzouhra El-Maaiden
5. Extraction Techniques - Natural Products from Medicinal Plants Paperback by Ranjana Jadhav , Amol Pawar , Monika Shelake

PROGRAM(s): M.Sc. II			**SEMESTER: III**			
Course: VI			**Course Code: WSCHORP631** **Course Title: Research Project**			
Teaching Scheme				**Evaluation Scheme**		
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Log book (Marks- 20%)**	**Report/Dissertation (Marks- 50%)**	**Viva-Voce (Marks- 30%)**
-	**08**	**–**	**04**	**20**	**50**	**30**

Learning Objectives:

1. To develop a research attitude in the learners.
2. To develop critical and logical thinking ability.
3. To apply foundational research skills to address a research question.
4. To know the importance of literature/referencing into designing/planning novel research work.
5. To design the new laboratory experiment.

Course Outcomes: At the end of the Course student will be able to-

1. understand the importance of a research project.
2. carry out a substantial research-based project.
3. differentiate a purpose statement, a research question or hypothesis, and a research objective.
4. analyze data critically and validate its applications.
5. Report research findings in written and verbal forms.

Detailed Syllabus

Course Code	**Research Projects**	**04 Credits**
WSCHORP631	1. Students should carry out a detailed research project. 2. This should make them familiar with i. Literature survey, research methodologies ii. Data Analysis iii. characterization techniques 3. Project report must be written and submitted in a proper format as follows; i)Certificate (Signed by Project guide and Head of the Department) ii) Certificates for Poster/Paper presented in conferences (if any) iii) Self declaration certificate for plagiarism iv) Introduction (not more than 6 pages) v) Experimental Section vi) Results and Discussions vii) Conclusion viii) References (Use ACS format) ix) Spectroscopic or other relevant supporting data x) Acknowledgement 4. Interdisciplinary projects shall be encouraged 5. Students should spend enough time for the project works (at least 8 hours per week) 6. If a student is performing a project in another institute, for such a student, an internal mentor must be allotted and he will be responsible for internal assessment of a student. In this case a student has to obtain a certificate from both external and internal mentors. 7. Systematic record of attendance of project students must be maintained by a mentor. 8.Project will be evaluated jointly by three examiners. 9. Astudent has to present his practical work, discuss results and conclusions in detail which will be followed by a question-answer session . 10. It is an open type of examination.	

PROGRAM(s): M.Sc.-II		**SEMESTER: IV**			
Course: I		**Course Code: WSCHOMT641** **Course Title: Theoretical organic chemistry-II**			
Teaching Scheme				**Evaluation Scheme**	
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 40)**	**Semester End Examination (Marks- 60)**
04	–	–	**04**	**40**	**60**

Learning Objectives:

1. To learn various physical aspects of an organic reaction.
2. To study the synthesis and various properties of few macromolecules.
3. To be able to resolve the Racemic mixture.
4. To learn asymmetric synthesis.

Course Outcomes:

At the end of the Course student will be able to-

1. identify the fundamental concepts of physical organic chemistry that governs various kinetic and thermodynamic aspects of organic reactions.
2. express the structure, properties, associations and organizations of organic macromolecules along with a typical synthesis of few of them.
3. predict the technique of resolution of racemates and to learn to determine the enantiomer and diastereomer composition
4. discuss principles involved in asymmetric synthesis and study of few selected similar organic name reactions

Detailed Syllabus

Theoretical Organic Chemistry-II

Course Code:- WSCHMTP641	**Unit**	**Course/ Unit Title** **Paper - I (Theoretical organic chemistry-II)**	**04 Credits/ 60 Lectures**
	I	**Physical organic chemistry**	**15 L**
	1.1	Structural effects and reactivity: Linear free energy relationship (LFER) in determination of organic reaction mechanism, The Hammett equation, substituent constants, theories of substituent effects, interpretation of σ values, reaction constants ρ, Yukawa- Tsuno equation.	**7L**
	1.2	Uses of Hammett equation, deviations from Hammett equation. Dual parameter correlations, Inductive substituent constants. The Taft model, σI and σR scales, steric parameters Es and β. Solvent effects, Okamoto-Brown equation, Swain-Scott equation, Edward and Ritchie correlations, Grunwald-Winstein equation, Dimroth's ET parameter, Solvatochromism Zscale, Spectroscopic Correlations, Thermodynamic Implications	**8L**

	II	**Supramolecular chemistry**	**15 L**
	2.1	Principles of molecular associations and organizations as exemplified in biological macromolecules like nucleic acids, proteins and enzymes.	**3**
	2.2	Synthetic molecular receptors: receptors with molecular cleft, molecular tweezers, receptors with multiple hydrogen sites.	**3**
	2.3	Structures and properties of crown ethers, cryptands, cyclophanes, calixarenes, rotaxanes and cyclodextrins. Synthesis of crown ethers, cryptands and calixarenes.	**5**
	2.4	Molecular recognition and catalysis, molecular self assembly.Supramolecular Polymers, Gelsand Fibers.	**4**
	II	**Stereochemistry- II**	**15 L**
	3.1	Racemisation and resolution of racemates including conglomerates: Mechanism of racemisation, methods of resolution: mechanical, chemical, kinetic and equilibrium asymmetric transformation and through inclusion compounds.	**3**
	3.2	Determination of enantiomer and diastereomer composition: enzymatic method, chromatographic methods. Methods based on NMR spectroscopy: use of chiral derivatizing agents (CDA), chiral solvating agents (CSA) and Lanthanide shift reagents (LSR).	**3**
	3.3	Correlative method for configurational assignment: chemical, optical rotation, and NMR spectroscopy.	**4**
	3.4	Molecular dissymmetry and chiroptical properties: Linearly and circularly polarized light. Circular birefringence and circular dichroism. ORD and CD curves. Cotton effect and its applications. The octant rule and the axial α– haloketone rule with applications.	**5**
	IV	**Asymmetric synthesis**	**15 L**
	4.1	Principles of asymmetric synthesis: Introduction, the chiral pool in Nature, methods of asymmetric induction – substrate, reagent and catalyst controlled reactions.	**3**
	4.2	Synthesis of L-DOPA [Knowles's Mosanto process]. Asymmetric reactions with mechanism: Aldol and related reactions, Cram's rule, Felkin-Anh model, hydroxylation, aminohydroxylation, Diels- Alder reaction, reduction of prochiral carbonyl compounds and olefins.	**9**
	4.3	Use of chiral auxiliaries in diastereoselective reductions, asymmetric amplification. Use of chiral BINOLs, BINAPs and chiral oxazolines asymmetric transformations.	**3**

References:

1. March's Advanced Organic Chemistry, Jerry March, sixth edition, 2007, John Wiley and sons.
2. A guide to mechanism in Organic Chemistry, 6th edition, 2009, Peter Sykes, Pearson education, New Delhi.
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6. Reaction Mechanism in Organic Chemistry, S.M. Mukherji, S.P. Singh, Macmillan Publishers, India.
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9.Organic reactive intermediates, Samuel P. MacManus, Academic Press.

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11.Organic Chemistry, Seventh Edition, R.T. Morrison, R. N. Boyd & S. K. Bhattacharjee, Pearson.Advanced Organic Chemistry: Reactions & Mechanisms, second edition, B. Miller and R. Prasad, Pearson.
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28.Supramolecular Chemistry; Concepts and Perspectives, J. M. Lehn, VCH.
29.Crown ethers and analogous compounds, M. Hiraoka, Elsevier, 1992.
30.Large ring compounds, J.A.Semlyen, Wiley-VCH, 1997.
31.Fundamentals of Photochemistry, K. K. Rohtagi-Mukherji, WileyEastern
32.Essentials of Molecular Photochemistry, A. Gilbert and J. Baggott, Blackwell Sciertific Publication.
33.Molecular Photochemistry, N. J. Turro, W. A. Benjamin.
34.Introductory Photochemistry, A. Cox and T. Camp, McGraw-Hill
35.Photochemistry, R. P. Kundall and A. Gilbert, Thomson Nelson.
36.Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press.
37.Molecular Orbitals and Organic Chemical Reactions by Ian Fleming (Wiley – A john Wiley and Sons, Ltd., Publication)

PROGRAM(s): M.Sc. II		**SEMESTER: IV**			
Course: II		**Course Code: WSCHOMT642** **Course Title: Synthetic Organic Chemistry-II**			
Teaching Scheme				**Evaluation Scheme**	
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 40)**	**Semester End Examination (Marks- 60)**
04	**–**	**–**	**04**	**40**	**60**

Learning Objectives:

1. To learn the name reactions and their applications in various organic synthesis to give high yields of the reaction steps.
2. To learn retro synthesis.
3. To understand the different electrochemical reactions.
4. To learn the catalysis of various rare earth metals in organic synthesis.

Course Outcomes:

At the end of the Course student will be able to-

1. predict the possible pathways of organic synthesis of a target molecule by backward engineering based on comprehensive knowledge of reaction mechanisms.
2. develop well established organic name reactions by choosing appropriate starting material and designing high yielding steps for the required organic synthesis.
3. explain the role of various electrochemical organic conversions in the field of organic synthesis.
4. predict the possibilities of catalysis by different transition and rare earth metals and its compounds

Detailed Syllabus

Synthetic Organic Chemistry-II

Course Code WSCHOMT642	**Unit**	**Course/ Unit Title** **Synthetic organic chemistry-II**	**04 Credits/ 60 Lectures**
	I	**Designing Organic Synthesis-I**	**15 L**
	1.1	Protecting groups in Organic Synthesis: Protection and deprotection of the hydroxyl, carbonyl, amino and carboxyl functional groups and its applications.	**3**
	1.2	Concept of umpolung (Reversal of polarity): Generation of acyl anion equivalent using 1,3-dithianes, methyl (methylthio)methyl sulfoxide, cyanide ions, cyanohydrin ethers, nitro compounds and vinylated ethers.	**3**
	1.3	Introduction to Retrosynthetic analysis and synthetic planning: Linear and convergent synthesis; Disconnection approach: An introduction to synthons, synthetic equivalents, disconnection approach, functional group interconversions (FGI), functional group addition (FGA), functional group removal (FGR) importance of order of events in organic synthesis, one and two group C-X disconnections (1,1; 1,2; 1,3 difunctionalized compounds), selective organic transformations: chemoselectivity, regioselectivity, stereoselectivity, enantioselectivity.	**9**
	II	**Designing Organic Synthesis-II**	**15 L**
	2.1	General strategy: choosing a disconnection-simplification, symmetry, high yielding steps, and recognisable starting material.	**3**

	2.2	One group C-C Disconnections: Alcohols (including stereoselectivity), carbonyls (including regioselectivity), Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.	**6**
	2.3	Two group C-C Disconnections: 1,2- 1,3- 1,4- 1,5- and 1,6-difunctionalized compounds, Diels-Alder reactions, α, β-unsaturated compounds, control in carbonyl condensations, Michael addition and Robinson annulation.	**6**
	III	**Electro-organic chemistry and Selected methods of Organic synthesis**	**15 L**
	3.1	Electro-organic chemistry:	**7L**
	3.1.1	Introduction: Electrode potential, cell parameters, electrolyte, working electrode, choice of solvents, supporting electrolytes.	
	3.1.2	Cathodic reduction: Reduction of alkyl halides, aldehydes, ketones, nitro compounds, olefins, arenes, electro-dimerization.	
	3.1.3	Anodic oxidation: Oxidation of alkylbezene, Kolbe reaction, Non-Kolbe oxidation, Shono oxidation.	
	3.2	Selected Methods of Organic synthesis Applications of the following in organic synthesis:	**8L**
	3.2.1	Crown ethers, cryptands, micelles, cyclodextrins, catenanes.	
	3.2.2	Organocatalysts: Proline, Imidazolidinone.	
	3.2.3	Pd catalysed cycloaddition reactions: Stille reaction, Saeguse-Ito oxidation to enones, Negishi coupling.	
	3.2.4	Use of Sc(OTf)3, and Yb(OTf)3 as water tolerant Lewis acid catalyst in aldol condensation, Michael reaction, Diels-Alder reaction, Friedel – Crafts reaction.	
	IV	**Transition metal in Organic synthesis**	**15 L**
	4.1	Introduction to basic concepts: 18 electron rule, bonding in transition metal complexes, C-H activation, oxidative addition, reductive elimination, migratory insertion.	**3**
	4.2	Palladium in organic synthesis: π-bonding of Pd with olefins, applications in C-C bond formation, carbonylation, alkene isomerisation, cross-coupling of organometallics and halides. Representative examples: Heck reaction, Suzuki-Miayura coupling, Sonogashira reaction and Wacker oxidation. Heteroatom coupling for bond formation between aryl/vinyl groups and N, S, or P atoms.	**5**
	4.3	Olefin metathesis using Grubb's catalyst.	**1**
	4.4	Application of Ni, Co, Fe, Rh, and Cr carbonyls in organic synthesis.	**4**
	4.5	Application of samarium iodide including reduction of organic halides, aldehydes and ketones, α-functionalised carbonyl and nitro compounds.	**1**

	4.6	Application of Ce(IV) in synthesis of heterocyclic quinoxaline derivatives and its role as a de-protecting agent.	**1**

References:

Unit I

1. Strategic Applications of Name Reactions in Organic Synthesis, L. Kurti & B. Czako (2005), Elsevier Academic Press
2. Name Reactions and Reagents in Organic Synthesis, 2nd Edn.,
3. Bradford P. Mundy, Michael G. Ellard, and Frank Favoloro, Jr., Wiley-Interscience
4. Name Reactions, Jie Jack Lie, 3rd Edn., Springer

Unit II, III and IV

5. Advanced Organic Chemistry, Part A and Part B: Reaction and Synthesis, Francis A. Carey, Richard J. Sundberg, 5th Edition, Springer Verlag
6. Modern Methods of Organic Synthesis, 4th Edition, W. Carruthers and Iain Coldham, Cambridge University Press, 2004.
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14. Organic Electrochemistry, H. Lund, and M. Baizer, 3rd Edn., Marcel Dekker.

PROGRAM(s): M.Sc. II		**SEMESTER: IV**			
Course: III		**Course Code: WSCHOMP641** **Course Title: Organic Chemistry Practical- III & IV**			
Teaching Scheme				**Evaluation Scheme**	
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 40)**	**Semester End Examination (Marks- 60)**
-	**08**	**–**	**04**	**40**	**60**

Learning Objectives:

1. To prepare derivatives of separated individual components from an unknown mixture.
2. To get hands-on experience in two step preparation of various organic compounds.

Course Outcomes: At the end of the Course, Learners will be able to

1. prepare derivatives of separated components.
2. prepare organic compounds by using various organic reagents.

Detailed Syllabus

Course code	**Organic Chemistry Practical- III**	**02 Credits**
WSCHOMP641	**Major Experiment:** **Separation of a ternary mixture of organic compounds and identification including derivative preparations using micro-scale technique. (any 10)** 1. Separation of a ternary mixture (S-S-L, S-L-L and L-L-L) (for solid mixture: water insoluble/ soluble including carbohydrates) based upon differences in the physical and the chemical properties of the components. 2. Identification of the two components (indicated by the examiner) using micro-scale technique.	
	Organic Chemistry Practical- IV	**02 Credits**
	Minor Experiment: **Two steps preparations:** 1. 2-naphthol → 1-phenyl azo-2-naphthol → 1-amino-2-naphthol. 2. Hydroquinone → hydroquinone diacetate → 2,5dihydroxyacetophenone. 3. 4-nitrotoluene → 4-nitrobenzoic acid → 4-aminobenzoic acid. 4. Benzophenone → benzophenone oxime → benzanilide. 5. Benzoin → benzil → benzilic acid. 6. Phthalic acid → phthalimide → anthranilic acid. Note: 1. Students are expected to purify the product by recryllization, measure its mass or volume, check the purity by TLC, determine physical constant and calculate percentage yield.	

References:

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by A. I. Vogels, 3rd Ed. ELBS (1964)
2. Vogel's textbook of quantitative chemical analysis, Sixth Ed. Mendham, Denny, Barnes, Thomas, Pearson education
3. Standard methods of chemical analysis, F. J. Welcher
4. Standard Instrumental Methods of Chemical Analysis, F. J. Welcher
5. W.W.Scott."Standard methods of Chemical Analysis",Vol.I, Van Nostrand Company,Inc.,1939.
6. E.B.Sandell and H.Onishi,"Spectrophotometric Determination of Traces of Metals",Part II,4th Ed.,A Wiley Interscience Publication,New York,1978.

PROGRAM(s): M.Sc. II		**SEMESTER: IV**			
Course: IV (Elective I)		**Course Code: WSCHOET641**			
Teaching Scheme				**Evaluation Scheme**	
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 20)**	**Semester End Examination (Marks- 30)**
02	**–**	**–**	**02**	**20**	**30**

Learning Objectives:

1. To create awareness and understanding of terms like intellectual property, patents, copyright, industrial designs, trademarks, geographical indications etc.
2. To know trade secrets, IP infringement issues, economic value of intellectual property and study of various related international agreements.

Course Outcomes:

At the end of the Course student will be able-

1. describe the terms with their meaning such as intellectual property, patents, copyright, industrial designs, trademarks, geographical indications etc.
2. interpret various trades and their trade secrets.
3. summarize the different IP infringement issues, economic value of intellectual property.

Detailed Syllabus

Elective I: Intellectual Property Rights

Course Code:	**Unit**	**Course/ Unit Title** **Intellectual Property Rights**	**02Credits/ 30 Lectures**
WSCHOET641	**I**	**Intellectual Property Rights-I**	**15L**
		Introduction to Intellectual Property: Historical Perspective, Different types of IP, Importance of protecting IP.	2 L
		Patents: Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Health care-balancing promoting innovation with public health, Software patents and their importance for India.	5L
		Industrial Designs: Definition, How to obtain, features, International design registration. **Copyrights:** Introduction, How to obtain, Differences from Patents.	4L
		Trade Marks: Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, trade names etc. **Geographical Indications:** Definition, rules for registration, prevention of illegal exploitation, importance to India.	4L

	II	**Intellectual Property Rights-II**	**15L**
		Trade Secrets: Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection. **IP Infringement issue and enforcement**: Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. **Economic Value of Intellectual Property**: Intangible assests and their valuation, Intellectual Property in the Indian context – Various Laws in India Licensing and Technology transfer.	6 L
		Different International agreements: (a) World Trade Organization (WTO): (i) General Agreement on Tariffs and Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade Related Services (GATS) Madrid Protocol. (iii) Berne Convention (iv) Budapest Treaty (b) Paris Convention WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity	5L 4L

References:

1. Dr.G.B Reddy,"Intellectual Property Rights and Law", Gogia Law Agency.Hydrabad,Reprint edition2020
2. N.R. Subbaram.S.Viswanathan,"Hand book Indian Patent Law and Practice"Printers and publishers Pvt,Ltd,2008.
3. Cornish,"Intellectual Property Rights", Universal publications.
4. Dr.B.L.Wadehra,"Law Relating to Intellectual Property" 5thedition,Universal Law publishing Co, Dehli

PROGRAM(s): M.Sc. II		**SEMESTER: IV**			
Course: **IV** **(Elective II)**		**Course Code: WSCHOET642** **Course Title: Heterocyclic Chemistry**			
Teaching Scheme				**Evaluation Scheme**	
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 20)**	**Semester End Examination (Marks- 30)**
02	**–**	**–**	**02**	**20**	**30**

Learning Objectives:

1. To understand and study various heterocycles.
2. To learn the classification, labeling and preparation, reactivity of bi, tricyclic five and six membered heterocycles up to three heteroatoms.

Course Outcomes:

At the end of the Course student will be able

1. explain classification, nomenclature and synthesis of hetero monocyclic compounds.
2. analyze classification, labeling and preparation, reactivity of bi, tricyclic five and six membered heterocycles up to three heteroatoms.

Detailed Syllabus

Elective II: Heterocyclic Chemistry

Course Code:	**Unit**	**Course/ Unit Title:** **Heterocyclic chemistry**	**04 Credits/ 60 Lectures (L)**
WSCHOET642	**I**	Heterocyclic compounds-I	**15L**
		Heterocyclic compounds: Introduction, classification, Nomenclature of heterocyclic compounds of monocyclic (3-6 membered) (Common, systematic (Hantzsch-Widman) and replacement nomenclature) Structure, reactivity, synthesis and reactions of pyrazole, imidazole, oxazole, isoxazole, thiazole, isothiazole, pyridazines, pyrimidine, pyrazines and oxazines.	
	II	Heterocyclic compounds-II	**15L**
		Nomenclature of heterocyclic compounds of bicyclic/tricyclic (5-6 Membered) fused heterocycles (up to three hetero atoms). (Common, systematic (Hantzsch-Widman) and replacement nomenclature) Nucleophilic ring opening reactions of oxiranes, aziridines, oxetanes and azetidines. Structure, reactivity, synthesis and reactions of coumarins, quinoxalines, cinnolines, indole, benzimidazoles, benzoxazoles, benzothiazoles, Purines and acridines.	

References

1. Heterocyclic chemistry, 3rd edition, Thomas L. Gilchrist, Pearson Education, 2007.
2. Heterocyclic Chemistry, Synthesis, Reactions and Mechanisms, R. K. Bansal, Wiley Eastern Ltd., 1990.
3. Heterocyclic Chemistry, J. A. Joule and G. F. Smith, ELBS, 2nd edition, 1982.
4. The Conformational Analysis of Heterocyclic Compounds, F.G. Riddell, Academic Press,1980.
5. Principles of Modern Heterocyclic Chemistry, L.A. Paquette, W.B. Benjamin, Inc., 1978.
6. An Introduction to the Chemistry of Heterocyclic Compounds, 2nd edition, B.M. Acheson, 1975.
7. Organic Chemistry, Vol 2, I.L. Finar, ELBS, 6th edition, Pearson.

8. Stereoselective Synthesis: A Practical Approach, M. Nogradi, Wiley-VCH, 1995.
9. Absorption spectroscopy of organic Molecules, V.M. Parikh, 1974.
10. Spectroscopic methods in organic chemistry, Williams and Fleming, Tata McGraw Hill, 4th ed, 1989.
11. Organic spectroscopy, William Kemp, ELBS, 3rd ed., 1987.
12. Organic structures from spectra, L. D. Field, S. Sternhell, John R. Kalman, Wiley, 4th ed., .3122 43. Introduction to spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, James R. Vyvyan, 4th ed., 2009.
13. Organic spectroscopic structure determination: a problem-based learning approach Douglass F. Taber, Oxford University Press, 17- Sep-2007.
14. Organic Spectroscopy: Principles And Applications, Jag Mohan, Alpha Science International Ltd., 30-Mar-2004

WILSON COLLEGE (AUTONOMOUS) SYLLABUS FOR ORGANIC CHEMISTRY

PROGRAM(s): M.Sc. II		**SEMESTER: IV**			
Course: IV (Elective Practical)		**Course Code: WSCHOEP641** **Course Title: Advanced Organic Chemistry Practical-II**			
Teaching Scheme				**Evaluation Scheme**	
Lectures (per week)	**Practical (per week)**	**Tutorial (per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 20)**	**Semester End Examination (Marks- 30)**
-	**04**	**–**	**02**	**20**	**30**

Learning Objectives:

1. To get hands-on experience in two step preparation of various organic compounds.
2. To know the interpretation of various spectra and identification of unknown organic compound

Course Outcomes: At the end of the Course student will be able to-

1. prepare organic compounds by using various organic reagents.
2. identify unknown organic compound via spectroscopic techniques.

Detailed Syllabus

Course code	**Elective Practical-II**	**02 Credits/ 30 Lectures (L)**
WSCHOEP641	**Two step preparation of heterocyclic compounds:** 1. Acetophenone → Acetophenone phenyl hydrazine → 2-phenyl indole. 2. Cyclohexanone → cyclohexanone oxime → Caprolactam. 3. o-nitroaniline → o-phenylenediamine → Benzimidazole. 4. o-chlorobenzoic acid → N-phenyl anthranilic acid → acridone. 5. Resorcinol → 4-methyl-7-hydroxy coumarin → 4-methyl-7-acetoxy coumarin. 6. Anthracene → anthraquinone → anthrone. **Note: 1. Students are expected** to purify the product by recrystallization, measure its mass or volume, check the purity by TLC, determine physical constant and calculate percentage yield. **Combined spectral identification**: Interpretation of spectral data of organic compounds (UV, IR, PMR, CMR and Mass spectra). A student will be given UV, IR, PMR, CMR, and Mass spectra of a compound from which preliminary information should be reported within the first half an hour of the examination without referring to any book/reference material. The complete structure of the compound may then be elucidated by referring to any standard text-book/reference material etc (Minimum 10 spectral analysis).	**02**

References:

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by A. I. Vogels, 3 rd Ed. ELBS (1964)
2. Vogel 's textbook of quantitative chemical analysis, Sixth Ed. Mendham, Denny, Barnes, Thomas, Pearson education
3. Standard methods of chemical analysis, F. J. Welcher Standard Instrumental methods of Chemical Analysis, F. J. Welcher
5. W.W.Scott."Standard methods of Chemical Analysis ",Vol.I, Van Nostrand Company,Inc.,1939.
6. E.B.Sandell and H.Onishi,"Spectrophotometric Determination of Traces of Metals ",Part II,4th Ed.,A Wiley Interscience Publication,New York,1978.

PROGRAM(s): M.Sc. II			**SEMESTER: IV**			
Course: V			**Course Code: WSCHORP641** **Course Title: Dissertation**			
Teaching Scheme				**Evaluation Scheme**		
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Log book (Marks- 20%)**	**Report/Dissertation (Marks- 50%)**	**Viva-Voce (Marks- 30%)**
-	**12**	**–**	**06**	**30**	**75**	**45**

Learning Objectives:

1. To understand and discuss the new research topics in the field of chemistry.
2. To display, organize and represent correlation between different types of data.
3. To summarize and provide a concise summary of research projects carried out.
4. Demonstrate a capacity to communicate research results clearly and comprehensively.
5. Ability to demonstrate oral/poster presentation.

Course Outcomes: At the end of the Course student will be able to-

1. work and explain key research concepts and issues.
2. develop different experimental skills required for research.
3. read, comprehend and anticipate the solution of research problems in their project work.
4. analyze data critically and validate its applications.
5. Equip themselves with ethical issues related to Research and Publication.
6. communicate research findings in written and verbal forms.
7. develop a strong foundation for future research work in a systematic manner by applying notions of Research Methodology.

Detailed Syllabus

Course Code	**Dissertation**	**06 Credits**
WSCHORP641	1. Students should carry out a detailed research project. 2. This should make them familiar with i. Literature survey, research methodologies ii. Data Analysis iii. characterization techniques 3. Project report must be written and submitted in a proper format as follows; i)Certificate (Signed by Project guide and Head of the Department) ii) Certificates for Poster/Paper presented in conferences (if any) iii) Self declaration certificate for plagiarism iv) Introduction (not more than 6 pages) v) Experimental Section vi) Results and Discussions vii) Conclusion viii) References (Use ACS format) ix) Spectroscopic or other relevant supporting data x) Acknowledgement 4. Interdisciplinary projects shall be encouraged 5. Students should spend enough time for the project works (at least 12 hours per week) 6. If a student is performing a project in another institute, for such a student, an internal mentor must be allotted and he will be responsible for internal assessment of a student. In this case a student has to obtain a certificate from both external and internal mentors. 7. Systematic record of attendance of project students must be maintained by a	

	mentor. 8.Project will be evaluated jointly by three examiners. 9. Astudent has to present his practical work, discuss results and conclusions in detail which will be followed by a question-answer session . 10. It is an open type of examination.	

Modality of Assessment (4 credit)

Theory Examination Pattern:

A. **Internal Assessment- 40%- 40 Marks per paper**

Sr. No.	Evaluation Type	Marks
1	**Written Objective Examination**	**20**
2	**Assignment/ Case study/ field visit report/ presentation/ project**	**20**
	Total	**40**

B. **External Examination- 60%- 60 Marks per paper**

Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:
   a. There shall be 05 questions each of 15 marks on each unit.
   b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1	Sub Questions: 1A. 2 out of 4 1B. 1 out of 2	12	Unit I
Q.2	Sub Questions: 2A. 2 out of 4 2B. 1 out of 2	12	Unit II
Q.3	Sub Questions: 3A. 2 out of 4 3B. 1 out of 2	12	Unit III
Q.4	Sub Questions: 4A. 2 out of 4 4B. 1 out of 2	12	Unit IV
Q.5	4 out of 8	12	Units (I+II+III+IV)
	TOTAL	**60**	

Modality of Assessment (2 credit)

Theory Examination Pattern :

C. **Internal Assessment- 40%- 20 Marks per paper**

Sr. No.	Evaluation Type	Marks
1	**Written Objective Examination**	**10**
2	**Assignment/ Case study/ field visit report/ presentation/ project**	**10**
	Total	**20**

D. **External Examination- 60%- 30 Marks per paper**

Semester End Theory Examination:

1. Duration - These examinations shall be of **One hour** duration.
2. Theory question paper pattern:
   a. There shall be 03 questions each of 15 marks on each unit.
   b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1	Sub Questions: 1A. 2 out of 4 1B. 1 out of 2	12	Unit I
Q.2	Sub Questions: 2A. 2 out of 4 2B. 1 out of 2	12	Unit II
Q.3	2 out of 4	06	Units (I+II)
	TOTAL	**30**	

Practical Examination Pattern

A. **Internal Examination: 40%**

Particulars	Mandatory Practical (4 credit)	Elective Practical (2 credit)
Journal	10	05
Experimental tasks	20	10
Participation	10	05
Total	**40**	**20**

B. **External Examination: 60%**
Semester End Practical Examination:

Particulars	**Mandatory Practical (4 credit)**	**Elective Practical (2 credit)**
Laboratory work	50	25
Viva	10	05
Total	**60**	**30**

Research Project Evaluation

Semester III (4 Credit)			**Semester IV (6 Credit)**		
Log book (Marks- 20%)	**Report/Dissertation (Marks- 50%)**	**Viva-Voce (Marks- 30%)**	**Log book (Marks- 20%)**	**Report/Dissertation (Marks- 50%)**	**Viva-Voce (Marks- 30%)**
20	**50**	**30**	**30**	**75**	**45**

PRACTICAL BOOK/JOURNAL

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.