Sir P. T. Sarvajanik College of Science

Autonomous

Affiliated to Veer Narmad South Gujarat University, Surat

Re-Accredited 'A+' with CGPA 3.35

SYLLABUS

FOR

SEM III

Program: M. Sc.

Course: Organic Chemistry

For

Academic year

2025-26

(NEP-2020)

(To be effective from June, 2025)

M. Sc. (CHEMISTRY) SEMESTER III

Core Course 7

COURSE NAME: Advance Organic Chemistry

COURSE CODE: CHEMSC-S3P7-4CR25 [CREDITS - 04]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. Comprehend the step- by-step mechanisms involved in each reaction, including bond formation, bond breaking, and electron movement. 2. Apply the above knowledge to design efficient synthetic routes to target molecules by strategically selecting appropriate starting materials and reaction conditions. 3. Explain the role of various oxidizing agents in organic chemistry, differentiate between oxidation processes and predict the outcomes of reactions, Illustrate the mechanism of oxidation and reduction in different organic compounds. 4. Describe the different reduction processes used in alkanes, alkenes and aromatic rings, explain method of preparation and applications of important reagents used in reduction process, Discuss reaction mechanism and applications of Birch reduction and Shapiro reduction. 5. Describe the method of preparation and application of organometallic compounds in organic synthesis. 6. Discuss the mechanism of hydroboration-oxidation reaction and its applications. 7. Identify and classify molecular rearrangements based on electron migration, Describe the significance of rearrangement reactions in organic synthesis, solve reaction mechanisms involving oxidation, reduction, and molecular rearrangements. 8. Predict the products of different rearrangement reactions, such as Favorskii, Benzil-Benzilic acid, and Fries rearrangement, apply rearrangement principles in designing novel organic molecules with improved properties and functionalities.Discuss reaction mechanism and applications of Birch reduction and Shapiro reduction.Describe the different reduction processes used in alkanes, alkenes and aromatic rings.

Module 1	NAME REACTIONS	[15L]

Learning Objectives:

This module is intended to

- Learn general nature, mechanism and synthetic application of various name reactions.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Comprehend the step- by-step mechanisms involved in each reaction, including bond formation, bond breaking, and electron movement.
2. Apply the above knowledge to design efficient synthetic routes to target molecules by strategically selecting appropriate starting materials and reaction conditions.

1.1	General nature, method, mechanism and synthetic applications of the following reactions; (1) Ugi reaction (2) Noyori reaction (3) Wittig reaction (4) Peterson olefination reaction (5) Mannich reaction (6) Stille reaction (7) Staudinger reaction (8) Corey-Fuchs reaction (9) Ritter reaction (10) Michael addition	
Module 2	**OXIDATION AND REDUCTION**	**[15L]**

Learning Objectives:

This module is intended to

- Introduce fundamental concepts of oxidation reactions in organic chemistry, emphasizing various reagents and their selectivity, Explain the mechanistic aspects of oxidation including their applications in organic synthesis.
- Analyze oxidation mechanisms: Students will learn the oxidation of hydrocarbons, aldehydes, and ketones using different oxidizing agents like Cr(VI), Mn(VII), OsO_4, and periodic acid.
- Understand the concepts of reduction and its different processes.
- Learn method of preparation of important reagents and their application in reduction.

Learning Outcome:

After completing this course, students will be able to:

1. Explain the role of various oxidizing agents in organic chemistry, differentiate between oxidation processes and predict the outcomes of reactions, Illustrate the mechanism of oxidation and reduction in different organic compounds.
2. Describe the different reduction processes used in alkanes, alkenes and aromatic rings, explain method of preparation and applications of important reagents used in reduction process, Discuss reaction mechanism and applications of Birch reduction and Shapiro reduction.

2.1	**(A) Oxidation:** Introduction, Oxidation with Cr(VI), Mn(VII), Mn(IV), OsO_4, Periodic acid. Peroxy acid. Oxidation of hydrocarbons- alkenes, aromatic rings, saturated C-H group (activated and unactivated), aldehyde and ketones **(B) Reduction:** Introduction, different reductive processes, hydrocarbons- alkenes, alkynes and aromatic rings, Carbonyl compounds- aldehydes, ketones, ($LiAlH_4$, $NaBH_4$ only for aldehyde and ketone, Aluminium Isopropoxide, Sn/HCl and Zn/HCl) acids and their derivatives, epoxides, nitro, nitroso, azo and oxime groups, Birch reduction, Shapiro reduction.	

Module 3	ORGANOMETALLIC COMPOUNDS AND THEIR APPLICATIONS	[15L]

Learning Objectives:

This module is intended to make the students

- Study method of preparation and application of organometallic compounds in organic synthesis.
- Study the mechanism of hydroboration-oxidation reaction and its applications.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Describe the method of preparation and application of organometallic compounds in organic synthesis.
2. Discuss the mechanism of hydroboration-oxidation reaction and its applications.

3.1	(i) Carbon-metal bonds in organometallic compounds, Synthesis and applications of Organolithium, Organozinc and Lithium diorganocuprate. (ii) Basic concept of organoboranes, Preparation of organoboranes, Stereochemistry of hydroboration, Mechanism of hydroboration – oxidation, Synthetic applications.	

Module 4	MOLECULAR REARRANGEMENTS	[15L]

Learning Objectives:

This module is intended to

- Apply molecular rearrangement principles: Students will explore different molecular rearrangement reactions.
- Explore molecular rearrangement reactions involving electron-deficient and electron-rich migrations to understand their synthetic utility.
- Interpret aromatic rearrangements: Students will examine the migration of functional groups within the aromatic nucleus and side chains, understanding their significance in synthetic chemistry.
- Examine aromatic rearrangements and their impact on the stability and reactivity of organic molecules.
- Develop problem-solving skills in reaction mechanisms, allowing students to predict and design chemical transformations.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Identify and classify molecular rearrangements based on electron migration, Describe the significance of rearrangement reactions in organic synthesis, solve reaction mechanisms involving oxidation, reduction, and molecular rearrangements.
2. Predict the products of different rearrangement reactions, such as Favorskii, Benzil-Benzilic acid, and Fries rearrangement, apply rearrangement principles in designing novel organic molecules with improved properties and functionalities.

4.1	**(A) Rearrangement involving migration to electron deficient carbon:** (i) Expansion and contraction of rings/Demajnov rearrangement (ii) Benzil-benzilic acid rearrangement **(B) Rearrangement involving migration to electron rich carbon:** (i) Favorskii rearrangement (ii) Sommelet-Hauser rearrangement (iii) Neber rearrangement **(C) Rearrangement involving migration to electron deficient nitrogen:** (i) Schmidt rearrangement (ii) Curtius rearrangement **(D) Aromatic rearrangements:** (i) Migration around the aromatic nucleus: Jacobsen rearrangement (ii) Migration of group from the side chain to the nucleus: Orton rearrangement, Hoffmann-Martius rearrangement, Rearrangement of N-nitrosoanilines (Fischer-Hepp rearrangement). **(E) Rearrangement involving migration from oxygen to ring:** (i) Fries rearrangement (ii) Claisen rearrangement	

Reference Books Recommended:

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (McMillan India Ltd., 1976).
3. Organic Chemistry (3/e) by J. B. Hendrickson, Donald J. Crem and George S. Rammond (McGraw-Hill Book Co. & Kogekusha Co. Ltd., 1970).
4. Organic Chemistry (5/e) by Morrison & Boyd (Prentice Hall).
5. Advanced Organic Chemistry by Carey & Sundberg (3rd edition).
6. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
7. Name Reactions by A. R. Parikh & H. A. Parikh
8. Name reaction: A collection of detailed reaction mechanism by Jie Jack Li
9. Reaction Mechanism and Reagents in Organic Chemistry by C. R. Chatwal (Himalaya Publishing House, Bombay, 1987).
10. Organic Chemistry-Reactions and Mechanism by P S Kalsi
11. Advanced Organic Chemistry: Reactions and Mechanisms by M. S. Singh
12. Advance Organic Chemistry By Dr. Jagdamba singh and Dr. L.D.S. Yadav (Pragati Edition)
13. Organic synthesis using transition metals-Roderick Bates (Wiley)
14. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press)
15. Some modern methods of organic synthesis – W. Carruthers (Cambridge)
16. Organic synthesis – Michael B. Smith
17. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition (2007)

18. Guidebook to organic synthesis-R K Meckie, D M Smith and R A Atken
19. Organic synthesis- Robert E Ireland
20. Strategic Applications of named reactions in organic synthesis-Laszlo Kurti and Barbara Czako
21. Organic Synthesis, Jagdamba Singh & L.D.S. Yadav, 6th edition, Pragati Prakashan (2010).
22. Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (McMillan India Ltd., 1976)
23. Advance Organic Chemistry, Reaction Mechanism and Structure by Jerry March, 4th ed. John Wiley & Sons, 1992
24. Organometallic Chemistry by P. L. Pauson (Edward Arnold, 1968).
25. Principles of Organometallic Chemistry by Coats, Green, Powell & Wade (Chapman and Hall, 1977).

e-Resources:

1. **https://archive.nptel.ac.in/courses/104/103/104103111/**
2. **https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000664/M010526/ET/1456900203CHE_P9_M16_e-Text.pdf**
3. **https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Supplemental_Modules_(Organic_Chemistry)/Aldehydes_and_Ketones/Reactivity_of_Aldehydes_and_Ketones/Reduction_of_Carbonyls_to_Alcohols_Using_Metal_Hydrides**
4. **https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=13G8VouhmrFfuhs6rkiyTA==**
5. **https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=13G8VouhmrFfuhs6rkiyTA==**
6. **https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000669/M026482/ET/1515666955CHE_P14_M9_etext.pdf**
7. **https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/organic_chemistry_iii/10.hydroboration_reaction/et/4814_et_et.pdf**
8. **https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000664/M010524/ET/1455785587CHE_P9_M14_etext.pdf**
9. **https://archive.nptel.ac.in/courses/104/103/104103110/**
10. **https://archive.nptel.ac.in/courses/104/103/104103023/**
11. **https://youtu.be/8l1qDWElyTs?si=fDYgOY58dgqC9eNw**
12. **https://youtu.be/1bFQEc6CoNA?si=RjbloqHi7TqfoDOs**
13. **https://archive.nptel.ac.in/content/storage2/courses/104103022/download/module8.pdf**
14. **https://archive.nptel.ac.in/courses/104/103/104103110/**
15. **https://enine.digimat.in/nptel/courses/video/104106131/L13.html**

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
1.	√	√	√		√	√	√				
2.	√	√	√								
3.	√		√	√							
4.	√	√	√								
5.		√			√	√		√			
6.	√	√	√								
7.	√		√	√							
8.	√		√					√			

M. Sc. (CHEMISTRY) SEMESTER III

Core Course 8

COURSE NAME: Selected Topics in Organic Chemistry I

COURSE CODE: CHEMSC-S3P8-4CR25 [CREDITS - 04]

Course Learning Outcome
1. Understand the fundamental principles and instrumentation of mass spectrometry, differentiate between various ionization techniques, Interpret low- and high-resolution mass spectra for molecular weight and molecular formula determination, 2. Apply concepts like the nitrogen rule, ring rule, and different ion peaks in mass spectral analysis, Comprehend the rules governing fragmentation patterns and apply them to identify unknown compounds. 3. Define types of reaction mechanisms, transition state structures, Hammond's postulate, Curtin-Hammett principle, reaction coordinate diagrams, and fundamental concepts of thermodynamics and kinetics in chemical reactions. 4. Explain the Hammett and Taft equations, discuss substituent and reaction constants, and describe deviations from the Hammett equation along with methods for determining reaction mechanisms, discuss kinetic isotope effects and quantitative structure-reactivity relationships to predict reaction mechanisms and describe kinetic versus thermodynamic control in chemical transformations. 5. Apply the Hantzsch-Widman nomenclature system to name and draw the structure of various monocyclic, fused, and bridged heterocycles. 6. Discuss the synthesis and important chemical reactions of Five and six membered heterocycles with two hetero atoms and Condensed five membered heterocycles. 7. Describe method of preparation of important reagents for organic synthesis. 8. Discuss the applications of important reagents for organic synthesis.

Module 1	MASS SPECTROMETRY	[15L]

Learning Objectives:

This module is intended to

- Understand instrumentation of mass spectroscopy including different ionization technics.
- Determine molecule weight and molecular formula of the compounds.
- Analyze the fragmentation behavior of different organic compounds.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Understand the fundamental principles and instrumentation of mass spectrometry, differentiate between various ionization techniques, Interpret low- and high-resolution mass spectra for molecular weight and molecular formula determination,

2. Apply concepts like the nitrogen rule, ring rule, and different ion peaks in mass spectral analysis, Comprehend the rules governing fragmentation patterns and apply them to identify unknown compounds.		
1.1	Theory and principles of mass spectroscopy; Instrumentation; low and high resolution mass spectra; Ionization techniques – Electron Impact (EI) ionization, Chemical Ionization (CI), Field Desorption (FD), Fast Atom Bombardment (FAB), Electronspray Ionization (ESI); Determination of molecular weight and molecular formula, nitrogen rule, ring rule, detection of molecular ion peak, base peak, metastable ion peak, isotopic peak; Fragmentations – rules governing the fragmentations, McLafferty rearrangement; Fragmentation of compounds – saturated and unsaturated hydrocarbons, aromatic hydrocarbons, alcohols, ethers, ketones, aldehydes, carboxylic acids, amines, amides, compounds containing halogens, nitriles, esters and nitro compounds.	
Module 2	**STRUCTURE-REACTIVITY PRINCIPLES**	**[15L]**
Learning Objectives: This module is intended to • Understand reaction mechanisms, transition states, and kinetic and thermodynamic principles, explain structure-reactivity relationships using Hammett and Taft equations, and learn kinetic isotope effects and reaction coordinate factors to predict and differentiate chemical reaction pathways		
Learning Outcome: After the successful completion of the module, the learner will be able to 1. Define types of reaction mechanisms, transition state structures, Hammond's postulate, Curtin-Hammett principle, reaction coordinate diagrams, and fundamental concepts of thermodynamics and kinetics in chemical reactions. 2. Explain the Hammett and Taft equations, discuss substituent and reaction constants, and describe deviations from the Hammett equation along with methods for determining reaction mechanisms, discuss kinetic isotope effects and quantitative structure-reactivity relationships to predict reaction mechanisms and describe kinetic versus thermodynamic control in chemical transformations.		
2.1	Types of mechanisms, transition state structure, Hammonds postulate, Curtian-Hammet principle, reaction coordinate diagram, thermodynamic of reaction, kinetic of reaction, kinetic and thermodynamic control. Quantitative Relationships between Molecular structure and Chemical reactivity: The Hammet equation, substituent and reaction constants, positive and negative deviation from Hammet equation, Taft equation, methods of determining mechanisms, Kinetic isotope effects.	

Module 3	HETEROCYCLIC CHEMISTRY-I	[15L]

Learning Objectives:

This module is intended to

- Study Hantzsch-Widman nomenclature system and its application.
- Study the synthesis and important chemical reactions of Five and six membered heterocycles with two hetero atoms and Condensed five membered heterocycles.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Apply the Hantzsch-Widman nomenclature system to name and draw the structure of various monocyclic, fused, and bridged heterocycles.
2. Discuss the synthesis and important chemical reactions of Five and six membered heterocycles with two hetero atoms and Condensed five membered heterocycles.

3.1	(A) Nomenclature of Heterocycles: Hantzsch-Widman nomenclature systems for monocyclic and fused heterocycles and bridged heterocycles (B) Five and six membered heterocycles with two hetero atoms: Synthesis, reactivity, aromatic character and importance of following heterocyclic rings: Oxazole, Thiazole, Pyrazole, Imidazole, Pyridazine, Pyrimidine, Pyrazine (C) Condensed five membered heterocycles: Synthesis, reactivity, aromatic character and importance of following heterocyclic Rings: Benzoxazole, Benzthiazole, Benzopyrazole, Benzimidazole.	

Module 4	REAGENTS FOR ORGANIC SYNTHESIS	[15L]

Learning Objectives:

This module is intended to

- Understand Concepts, Preparation and Industrial Applications of important Reagents in Organic Synthesis.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Describe method of preparation of important reagents for organic synthesis.
2. Discuss the applications of important reagents for organic synthesis.

4.1	Introduction, Preparation and Industrial Applications of the following: (1) N-Bromosuccinimide (NBS) (2) Umpolung reagent (1,3-dithiane) (3) Dess martin periodinane (4) DDQ (5) Di-isobutyl aluminum hydride (DIBAL-H)	

	(6) Wilkinson's Catalyst (7) N, N-dicyclohexylcarbodiimide (DCC) (8) Lead tetra-acetate (LTA) (9) Diazomethane (10) Polyphosphoric acid	

References:

1. Spectroscopic Identification of Organic Compounds, R. M. Silverstein and F. X. Webster, 6th edition (John Wiley & Sons)
2. Introduction to Spectroscopy, D. L. Pavia, G. M. Lampman and G. S. Kriz, 3rdedition (Thomson Brooks/Cole)
3. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, 4thedition (Mcgraw – Hill Book Company)
4. Organic Spectroscopy, William Kemp, 3rd edition (Palgrave)
5. Organic Spectroscopy – Principles and Applications, Jag Mohan, 2nd edition (Narosa Publishing House)
6. Spectroscopy of Organic Compounds, P. S. Kalsi, 5th edition (New Age International Publishers)
7. Elementary Organic Spectroscopy: Principles and Chemical applications (revised edition), Y. R. Sharma (S. Chand Publishing).
8. Organic Chemistry by Francis A. Carey (McGraw-Hill Book Co., 1987).
9. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell Uni.Press.
10. Principles of Organic Synthesis, R.O.C. Norman and J. M. Coxon, Blackie Academic and Professional.
11. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.
12. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers
13. An introduction to the chemistry of heterocyclic compounds-R M Acheso
14. Heterocyclic Chemistry- J A Joule and Smith
15. Heterocyclic Chemistry-II- R R Gupta, M Kumar, V Gupta, Springer (India) pvt
16. Heterocyclic Chemistry, 4th Edition by J. A. Joule & K. Mills, Published by Chapman & Hall (1995)
17. Principles of modern heterocyclic chemistry, Edited by Leo A. Paquette, Published by Pearson Benjamin Cummings (1968)
18. Heterocyclic Chemistry, 3rd Edition by Thomas L. Gilchrist, Published by Prentice Hall (1997)
19. The Structure & Reactions of Heterocyclic Compounds, Edited by Michael Henry Palmer, Published by Edward Arnold (1967)
20. Heterocyclic chemistry by V. K. Ahluwalia, Narosa publishing house.
21. Organic synthesis using transition metals-Roderick Bates (Wiley).
22. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press).
23. Advanced organic chemistry, Part B - F. A Carey and R. J. Sundberg, 5th edition (2007).
24. Guidebook to organic synthesis-R K Meckie, D M Smith and R A Atken.
25. Organic reactions, reagents and molecular rearrangement by Dr. M. D. Ankhiwala and Dr. Nimeshkumar R. Kamdar, University Granthnirman board, Gujarat rajya, Ahemdabad.

e-Resources:

1. https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Instrumentation_and_Analysis/Mass_Spectrometry
2. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000667/M009442/ET/1455786764CHE_P12_M24_e-Text.pdf
3. https://onlinecourses.nptel.ac.in/noc22_cy08/preview
4. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000656/M014940/ET/1515565889CHE_P1_M34_etext.pdf
5. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000656/M014938/ET/1515565863CHE_P1_M33_etext.pdf
6. https://archive.nptel.ac.in/courses/104/105/104105034/
7. https://nptel.ac.in/courses/102101050
8. https://www.youtube.com/watch?v=_9ZksU4NHxo
9. https://onlinecourses.nptel.ac.in/noc22_cy55/preview
10. https://www.chem.gla.ac.uk/staff/stephenc/teaching/HeterocycleLectures2011_2C12.pdf
11. https://www.uou.ac.in/lecturenotes/science/MSCCH17/CHEMISTRY%20LN.%203%20HETEROCYCLIC%20COMPOUNDS-converted%20(1).pdf
12. https://archive.nptel.ac.in/courses/104/103/104103023/#

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
1.	√	√					√				
2.	√	√	√				√				
3.	√	√	√				√				
4.	√	√	√								
5.			√				√				
6.		√	√				√				
7.		√	√				√		√		
8.	√	√	√				√				

M. Sc. (CHEMISTRY) SEMESTER III

Core Course 9

COURSE NAME: Selected Topics in Organic Chemistry II

COURSE CODE: CHEMSC-S3P9-4CR25 [CREDITS - 04]

Course Learning Outcome
1. Define protecting groups and explain their role in organic synthesis, Describe the need, importance and application of protecting groups in organic synthesis. 2. Explain transformations using appropriate protecting groups and the concept of umpolung and how it reverses the usual reactivity of functional groups. Discuss the applications of concept of umpolung in organic synthesis. 3. Explain the concept of disconnection and how it is used to break down molecules into simpler, synthesize-able fragments, identify the best disconnection strategy for a molecule. 4. Apply the disconnection approach to design a retrosynthetic route for molecule, explain the importance of disconnection approach in various name reactions. 5. Define and differentiate between dyes and pigments, explain the process of visible light absorption and its relation to colour and the concept of complementary colors, describe and apply the major theories of color and chemical structure 6. Define and explain fastness properties of dyes, explain the concepts of exhaustion and fixation properties of dyes, classify dyes based on their chemical structure and their mode of application to fibers. 7. Explain the methods of preparation of different organic compounds, apply the knowledge of unit process & unit operation to synthesize organic compounds. 8. Explain the general method of preparation and reaction of each Deri. & its application.

Module 1	**PROTECTION-DEPROTECTION AND UMPOLUNG CHEMISTRY**	**[15L]**

Learning Objectives:

This module is intended to

- Understand protecting group used in organic synthesis and the concept of selective functional group protection.
- Study the concept of umpolung and its application in organic synthesis.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Define protecting groups and explain their role in organic synthesis, Describe the need, importance and application of protecting groups in organic synthesis.
2. Explain transformations using appropriate protecting groups and the concept of umpolung and how it reverses the usual reactivity of functional groups. Discuss the applications of concept of umpolung in organic synthesis.

1.1	Need of protecting groups – Protection of alcohols, Carbonyl, Carboxylic acid and amino groups, Synthetic equivalent groups and examples on transformations. Concepts of umpolung, generation of acyl anion, equivalent using 1,3-Dithianes, epoxides, terbutyl hydrazone, cyanide ions, cyanohydrine ether, nitro compounds and alkynes.	
Module 2	**DISCONNECTION APPROACH**	**[15L]**

Learning Objectives:

This module is intended to

- Study basic concept of disconnection approach and retrosynthesis in organic synthesis.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Explain the concept of disconnection and how it is used to break down molecules into simpler, synthesize-able fragments, identify the best disconnection strategy for a molecule.
2. Apply the disconnection approach to design a retrosynthetic route for molecule, explain the importance of disconnection approach in various name reactions.

2.1	Introduction to disconnection, Concept of synthon, Synthetic equivalent, Functional group interconversion **(i) One group disconnection:** Disconnection and synthesis of alcohols, olefins, simple ketones, acids and its derivatives **(ii) Two groups disconnection:** Disconnections in 1,3-dioxygenated skeletons, preparation of β-hydroxy carbonyl compounds, α,β-unsaturated carbonyl compounds, 1,3-dicarbonyls, 1,5- dicarbonyls and use of Mannich reaction **(iii) Pericyclic reactions:** Disconnections based on Diels-Alder reaction and electrocyclic reaction: Its use in organic synthesis	
Module 3	**BASIC CONCEPTS OF DYE AND DYE INTERMEDIATES**	**[15L]**

Learning Objectives:

This module is intended to

- Define dyes and pigments and distinguish between them.
- Explain the relationship between visible light absorption and the perceived colour of a substance.
- Identify the complementary colour of a given colour.
- Apply Witt's theory to identify chromophores and auxochromes in a given dye molecule.
- Explain Armstrong's, Nietzki's, valence bond, and molecular orbital theories in relation to colour.
- Classify dyes based on their chemical structure (e.g., azo, anthraquinone) and provide examples of each class.

- Classify dyes based on their mode of application to fibers (e.g., direct, mordant, vat) and explain the application process for each.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Define and differentiate between dyes and pigments, explain the process of visible light absorption and its relation to colour and the concept of complementary colors, describe and apply the major theories of color and chemical structure
2. Define and explain fastness properties of dyes, explain the concepts of exhaustion and fixation properties of dyes, Classify dyes based on their chemical structure and their mode of application to fibers.

3.1	Introduction of Dyes and Pigments, Absorption of visible light, colour of wavelength absorbed, complementary colour. Relation between color and chemical Constitution, Witt's theory, Armstrong's theory, Nietzki's theory, Valence bond theory, Molecular orbital theory, Fastness Properties, Exhaustion and fixation properties. Natural Dyes, Nomenclature of Dye Intermediates, Colour Index Classification of Dyes: Based on structure, based on mode of application to fibres, Non–Textile uses of dyes: Dyes in medicine, leather, paper, colour photography and electro photography, food, cosmetics, displays and laser dyes.	
Module 4	**UNIT PROCESSES**	**[15L]**

Learning Objectives:

This module is intended to

- This module is intended to understand Unit process and application in industry determination of various agents in unit process and their synthetic route.

Learning Outcome:

1. Explain the methods of preparation of different organic compounds, apply the knowledge of unit process & unit operation to synthesize organic compounds.
2. Explain the general method of preparation and reaction of each deri. & its application.

4.1	**(i) Nitration:** Nitrating agents. Mechanism of aromatic nitration. Industrial chemicals derived from Benzene, Naphthalene, Anthracene using Nitration. **(ii) Sulphonation and Sulfation:** Sulphonating and Sulfating agents. Mechanism of aromatic Sulphonation. Industrial chemicals derived from Benzene, Naphthalene, Anthracene using Sulphonation. **(iii) Amination:** Aminating agents, Amination by reduction, Amination by Ammonolysis. Industrial chemicals derived from Benzene using Amination. **(iv) Alkylation:** Alkylating agents. Industrial important alkyl compounds derived by various routs **(v) Halogenation:** Halogenating agents. Industrial important halogenated compounds derived by various routs.	

Reference Books Recommended:

1. Organic synthesis using transition metals-Roderick Bates (Wiley).
2. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press).
3. Some modern methods of organic synthesis – W. Carruthers (Cambridge)
4. Organic synthesis – Michael B. Smith.
5. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition (2007).
6. Guidebook to organic synthesis-R K Meckie, D M Smith and R A Atken.
7. Organic synthesis- Robert E Ireland.
8. Strategic Applications of named reactions in organic synthesis-Laszlo Kurti and Barbara Czako.
9. Organic Synthesis, Jagdamba Singh & L.D.S. Yadav, 6th edition, Pragati Prakashan (2010). Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (McMillan India Ltd., 1976).
10. Advance Organic Chemistry, Reaction Mechanism and Structure by Jerry March, 4th ed. John Wiley & Sons, 1992.
11. Designing Organic Synthesis – A Programmed Introduction to the Synthon Approach, Stuart Warren, John Wiley & Sons (1994).
12. Organic Synthesis: The disconnection approach, Stuart Warren, John Wiley & Sons (1994).
13. Selected Organic Synthesis, Ian Fleming, John Wiley & Sons (1977).
14. Principles of Organic Chemistry by R.O.C. Norman (Chapman and Hall, 1986).
15. The chemistry of synthetic Dyes, Vol. I to VII by Venkataraman, Academic Press, New York.
16. Chemistry of Synthetic Dyes & Pigments by Lubs.
17. Dyes and their intermediates by E. N. Abrahart.
18. Handbook of synthetic dyes and pigments, Vol. I & II by K. M. Shah.
19. Industrial Dyes by Klans Hunger, Germany by Wiley-VCH.
20. Development in the Chemistry and technology of Organic Dyes by J.Griffiths, Blackwell Sci. Pub., Oxford, London.
21. Principles of colour Technology by Fred W. Billmeyer and Max Saltzman, John Wiley & Sons.
22. Synthetic dyes- G.R. Chatwal Himalaya Publishing House
23. Unit processes in organic synthesis; P. H. Groggin's
24. Unit operations and unit processes-Vol-1 by Bhattacharya Narayanan.

e-Resources:

1. **https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000669/M026482/ET/1515666955CHE_P14_M9_etext.pdf**
2. **https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000669/M026480/LM/1515666902CHE_P14_M7_know_more.pdf**
3. **https://youtu.be/OM_EongrQTY?si=vtV6UdTN6khMFkD2**
4. **http://ddugu.ac.in/ePathshala_Attachments/E_PS365850@af830af5i.pdf**
5. **https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Basic_Principles_of_Organic_Chemistry_(Roberts_and_Caserio)/13%3A_Polyfunctional_Compounds_Alkadienes_and_Approaches_to_Organic_Synthesis/13.10%3A_Protecting_Groups_in_Organic_Synthesis**
6. **https://www.lkouniv.ac.in/site/writereaddata/siteContent/202004101314199439sangeeta_sriv_chem_Disconnection_Approach.pdf**
7. **https://youtu.be/9M0HqQEFL6k?si=rtyXf40GQdCoIbKA**

8. https://youtu.be/RjZJjneJ5fk?si=CZ2BKOll-c-oazQE
9. https://archive.nptel.ac.in/courses/104/105/104105087/
10. https://www.youtube.com/watch?v=f7evaz5011w
11. https://uou.ac.in/sites/default/files/slm/MSCCH-606.pdf

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
1.	√										
2.	√	√					√				
3.	√	√					√				
4.	√	√					√				
5.	√	√					√				
6.	√	√					√				
7.	√	√					√				
8.	√	√					√				

M. Sc. (CHEMISTRY) SEMESTER III

Elective Course 5

COURSE NAME: Medicinal Chemistry

COURSE CODE: CHEMSC-S3E5-4CR25 [CREDITS - 04]

Course Learning Outcome
After the successful completion of the Course, the learner will be able to: 1. Define key concepts in drug design and development, Describe the different phases of drug trials and their significance, Outline the essential steps in drug discovery and optimization and explain how lead compounds are modified for better therapeutic activity. 2. Discuss SAR data to predict drug effectiveness, differentiate between LD_{50}, ED_{50}, and the therapeutic index in assessing drug safety, Explain the concepts of drug-receptor interactions and the soft drug approach, Describe the pharmacokinetic and pharmacodynamic properties of drugs and compare different metabolic pathways and their role in drug elimination. 3. Define and explain drugs, their importance, and their classification based on chemical structure and therapeutic action, differentiate between proprietary and non-proprietary names, explain WHO guidelines for drug naming, and identify generic and brand names. 4. Discuss and explain various drug action theories in pharmacology, describe biological and chemical defense mechanisms against drug action, explain different routes of drug administration and factors influencing drug absorption, explain the significance of solubility, partition coefficients, ionization constant, electronic effects, steric effects, and stereochemical considerations in drug activity and effectiveness. 5. Define and classify antibiotics, including β-lactam and non-lactam antibiotics, and describe their basic structures, mechanisms of action, and therapeutic significance. 6. Explain the Structural Activity Relationship (SAR) of penicillins, cephalosporins, tetracyclines, and other antibiotics, and describe structural variations affecting their pharmacological properties, illustrate the synthesis pathways and therapeutic applications of selected antibiotics. 7. Define and classify diuretics and antihypertensive agents, and describe their basic chemical structures and therapeutic significance, explain the Structure-Activity Relationship (SAR) of thiazide diuretics, β-adrenergic blockers, dihydropyridines, and ACE inhibitors, and describe their mechanisms of action. 8. Discuss and illustrate the synthesis pathways and therapeutic uses of selected diuretics and antihypertensive agents, relating their chemical structures to their pharmacological effects.

Module 1	INTRODUCTION TO DRUGS AND DRUG DESIGN	[15L]

learning objectives:

This module is intended to

- Understand key concepts in drug design, development, and optimization, explain drug trials and safety assessment, analyze SAR data for drug effectiveness, evaluate drug-receptor interactions, and compare pharmacokinetic, pharmacodynamic properties, and metabolic pathways in drug elimination.

Learning Outcome:

After the successful completion of the module, the learner will be able to

- Define key concepts in drug design and development, Describe the different phases of drug trials and their significance, Outline the essential steps in drug discovery and optimization and explain how lead compounds are modified for better therapeutic activity
- Discuss SAR of various drugs, differentiate between LD_{50}, ED_{50}, and the therapeutic index in assessing drug safety, Explain the concepts of drug-receptor interactions and the soft drug approach, Describe the pharmacokinetic and pharmacodynamic properties of drugs.

1.1	Introduction to Drug discovery and Drug development. Pre-clinical and Clinical Trials: Phases I, II, III, and IV of human testing Drug Targets: Understanding biological targets of drugs. Procedure for Drug Design: Steps involved in designing a new drug. Lead Compounds and Lead Modification, Structure-Activity Relationship (SAR), Relationship between molecular structure and biological activity, Toxicity and Efficacy Parameters: LD_{50} (Lethal Dose 50%) ED_{50} (Effective Dose 50%) Therapeutic Index (Safety margin of drugs), Soft Drug concept, Prodrug concepts, basic introduction of Pharmacokinetics and Pharmacodynamics, Drug Metabolism: Phase-I Metabolism: Oxidation, reduction, hydrolysis reactions, Phase-II Metabolism: Conjugation reactions, Enzymes stimulation and enzyme inhibition, Introduction to Molecular Docking	

Module 2	FUNDAMENTALS OF DRUGS AND PHARMACODYNAMIC	[15L]

Learning objectives:

This module is intended to

- Understand the classification, naming conventions, and significance of drugs, explain drug action theories and defense mechanisms, describe drug administration routes and absorption factors, and analyze the impact of physicochemical properties on drug activity and effectiveness.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Define and explain drugs, their importance, and their classification based on chemical structure and therapeutic action, differentiate between proprietary and non-proprietary names, explain WHO guidelines for drug naming, and identify generic and brand names.
2. Discuss and explain various drug action theories in pharmacology, describe biological and chemical defense mechanisms against drug action, explain different routes of drug administration and factors influencing drug absorption, explain the significance of solubility, partition coefficients, ionization constant, electronic effects, steric effects, and stereochemical considerations in drug activity and effectiveness.

2.1	Introduction, Classifications: On the basis of their chemical structure and therapeutic action, Nomenclature: Proprietary and Non-proprietary name, Nomenclature of new drugs by WHO, Names of drugs: Generic and brand names, Basic concepts of drug receptors Theories of drug action: Occupancy theory, Rate theory and induced fit theory, Biological defence, chemical defences, Furguson principle, Absorption of drugs: Routes of drug administration, factors that effect on absorption Physico chemical properties: Solubility, Partition coefficients, Ionization constant, Electronic effect, Steric effect, Stereochemical consideration	
Module 3	**ANTIBIOTICS**	**[15L]**

Learning Objectives:

This module is intended to

- Understand the classification, structure, mechanism of action, and therapeutic significance of antibiotics, explain the SAR and structural variations of key antibiotic classes, and illustrate their synthesis pathways and pharmacological applications.

After the successful completion of the module, the learner will be able to

1. Define and classify antibiotics, including β-lactam and non-lactam antibiotics, and describe their basic structures, mechanisms of action, and therapeutic significance.
2. Explain the Structural Activity Relationship (SAR) of penicillins, cephalosporins, tetracyclines, and other antibiotics, and describe structural variations affecting their pharmacological properties, illustrate the synthesis pathways and therapeutic applications of selected antibiotics.

3.1	General introduction and classification of antibiotics **(i) β-lactam antibiotics**: Mechanism of β-lactam antibiotics, General introduction and classification of Penicillin, Chemical reactions of Penicillins, Structural variations in Penicillins & Ampicillin, Structural Activity Relation of Penicillins General introduction and classification of Cephalosporins, Structural variations in Cephalosporins. Synthesis and therapeutic uses of only the following: Penicillin-V, Methicillin, Ampicillin, Cephalexin **(ii) Non-lactam antibiotics**: Structural variations and Structural Activity Relation of Tetracyclins,	

	Structures and medicinal importance/ clinical uses/ pharmacological applications of the following antibiotics: Macrolide Antibiotics (Erythromycin, Azithromycin) **Miscellaneous Antibiotics** (Chloramphenicol, Nalidixic acid, Norfloxacin, Ciprofloxacin. Lincomycin) Synthesis and therapeutic uses of only the following: Methacyline, Azithromycin, Chloramphenicol, Ciprofloxacin	
Module 4	**DIURETICS AND CARDIOVASCULAR DRUGS**	**[15L]**
Learning Objectives: This module is intended to • Understand the classification, structure, and SAR of diuretics and antihypertensive agents, explain their mechanisms of action, and illustrate the synthesis pathways and therapeutic applications of selected drugs by relating their chemical structures to pharmacological effects		
Learning Outcome: After the successful completion of the module, the learner will be able to • Define and classify diuretics and antihypertensive agents, and describe their basic chemical structures and therapeutic significance, explain the Structure-Activity Relationship (SAR) of thiazide diuretics, β-adrenergic blockers, dihydropyridines, and ACE inhibitors, and describe their mechanisms of action. • Discuss and illustrate the synthesis pathways and therapeutic uses of selected diuretics and antihypertensive agents, relating their chemical structures to their pharmacological effects.		
4.1	**(A) Diuretics**: General classification (Mercurial and non-mercurial diuretics), Structural variation and SAR of Thiazide Diuretics, Synthesis and therapeutic uses of only the following: Meralluride, Chlorothiazide, Acetazolamide, Furosemide, Ethacrynic acid, Triamterene **(B) Antihypertensive Agents:** General introduction of cardiovascular drugs, classification of Antihypertensive Agents, Structure variation in ß-adrenergic blockers and Dihydropyridines, Structure – Activity Relationship of Angiotensin Converting Enzyme (ACE) Inhibitors, Synthesis and therapeutic uses of only the following: Verapamil, Methyldopa, Atenolol, Lisinopril, Losartan	

Reference Books Recommended

1. Burger's Medicinal Chemistry and Drug Discovery (5/e), 1997, Vol. 1, 2, 3, 4,5, Edited by ManFred E. Wolff (John Wiley & Sons, inc., New York).
2. Principles of Medicinal Chemistry, Vol. I & II (5/e), by S. S. Kadam, K. R. Mahadik, K. G. Bothra (Nirali Prakashan).
3. Principles of Medicinal Chemistry by William O. Foye (ed.), Lea and Febiyer, Philadelphia.
4. Wilson and Gisvold's Text-book of Organic Medicinal and Pharmaceutical Chemistry (5/e, 1982) by Robert F. Doerge (J. B. Lippincott Company, Philadelphia/Toppan Co. Ltd., Tokyo).
5. Essential of Medicinal Chemistry (2/e) by Andrejus Korolkovas (A Wiley Interscience Publication, 1988, John Wiley & Sons, Canada).
6. Medicinal Chemistry by Ashutoshkar (Wiley Eastern Ltd., 1993).
7. The Pharmaceutical Basis of Therapeutics by Goodman and Gilman (The Macmillan Co.).
8. The Organic Chemistry of Drug Synthesis, Vol. I, II & III (1980), Ed. By D. Lednicer and L. A. Mitscher (John Wiley and Sons, New York).Topics in Medicinal Chemistry, Vol. I & II by Rabinowitz and Myerson (Editor) (Interscience, 1968).
9. Adhunik Sanshleshit Aushodhonu Rasayanvighyan, Dr. Anamik Shah, University Granth Nirman Board, Ahmedabad.
10. Medicinal Chemistry, D. Sriram and P. Yogeeswari, 1st edi., Pearson Education, 2007.
11. Handbook of pharmaceutical chemicals by Dr. A. R. Shenoy and Dr. V. R. Shenoy Multitech Publishing Co., 15-Yogesh, Hingwala Lane, Ghatkopar (East) Mumbai.
12. Fundamentals of Medicinal Chemistry by G Thomas.

e-Resources:

1. **https://pmc.ncbi.nlm.nih.gov/articles/PMC6155886/**
2. **https://www.bbau.ac.in/dept/Chemistry/TM/MCH%20402%20Medicinal%20Chemistry%20(Chapter%20III)%20DoC.pdf**
3. **https://clinpharmacol.fmhs.auckland.ac.nz/docs/mechanisms-of-drug-action-and-drug-targets.pdf**
4. **https://www.coursera.org/learn/antimicrobial-resistance**
5. **https://www.coursera.org/learn/antimicrobial-resistance**
6. **https://annamalaiuniversity.ac.in/studport/download/engg/pharm/resources/pharmd_3Y_3.5_medicinal%20Chemistry.pdf**

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
1.	√										
2.	√	√									
3.	√	√									
4.		√	√				√				
5.	√										
6.		√	√				√				
7.		√	√				√				
8.	√										

M. Sc. (CHEMISTRY) SEMESTER III

Skill Enhancement Course 1

COURSE NAME: Industrial Safety & Water Analysis Techniques

COURSE CODE: CHEMSC-S3SEC1-4CR25 [CREDITS - 02]

Course Learning Outcome
After the successful completion of the course, the learner will be able to 1. Identify and classify types of industrial accidents, objectives of safety management, chemical storage types, static electricity hazards, and hazard symbols and communication methods. 2. Explain various risk assessment methods, including process, industrial hygiene, environmental, and fire/explosive risks, and describe safety protocols for chemical storage and hazard control in industrial settings. 3. Define the concepts of TDS, TSS, Fixed & Volatile Solids, MLSS, MLVSS and describe their significance in water analysis. 4. Describe the sources, impact, and basic detection methods for organic and inorganic contaminants such as, oil, grease, and phenols. 5. Explain the detection methods of ammoniacal nitrogen, Kjeldahl nitrogen, nitrite, nitrate, and phosphate in wastewater treatment. 6. Apply standard laboratory methods to measure heavy metals and toxic substances, including sulphide, sulphate, sodium, potassium, and chromium. 7. Demonstrate the practical application of Fenton's process and hydrodynamic cavitation in the treatment of contaminated water samples.

Module 1	INDUSTRIAL SAFETY	[15L]

Learning Objectives:

This module is intended to

- Understand the classification of accidents, principles of safety management, and various risk assessment methods, and explain safe chemical storage practices, hazard identification, static electricity control, and hazard communication techniques used to maintain safety in industrial and laboratory environments.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Identify and classify types of industrial accidents, objectives of safety management, chemical storage types, static electricity hazards, and hazard symbols and communication methods.
2. Explain various risk assessment methods, including process, industrial hygiene, environmental, and fire/explosive risks, and describe safety protocols for chemical storage and hazard control in industrial settings.

1.1	Classification of accident, Objectives of safety Management Risk Assessment: Process Risk Assessment, Industrial Hygiene Risk Assessment, Environmental Risk Assessment, Fire & Explosive Risk Management Chemical Storage Safety: Bulk storage, Solvent storage, Explosive chemical storage, Transportation storage Static electricity, its hazards, and control measures Hazard Identification, Communication and Symbol	
Module 2	**WATER QUALITY ANALYSIS**	**[15L]**

Learning Objectives:

This module is intended

- To gain hands-on experience in measuring and analysing solids, organic and inorganic contaminants, nutrients, and heavy metals in water.
- To enable students to understand the principles, practical approaches, and techniques required to effectively monitor the chemical elements to assess water quality.
- To understand the significance of various contaminants, their sources, and their effects on human health and aquatic ecosystems.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Define the concepts of TDS, TSS, Fixed & Volatile Solids, MLSS, MLVSS and describe their significance in water analysis.
2. Describe the sources, impact, and basic detection methods for organic and inorganic contaminants such as, oil, grease, and phenols.
3. Explain the detection methods of ammoniacal nitrogen, Kjeldahl nitrogen, nitrite, nitrate, and phosphate in wastewater treatment.
4. Apply standard laboratory methods to measure heavy metals and toxic substances, including sulphide, sulphate, sodium, potassium, and chromium.
5. Demonstrate the practical application of Fenton's process and hydrodynamic cavitation in the treatment of contaminated water samples.

2.1	Solids in Water: Total Dissolved Solids (TDS) & Total Suspended Solids (TSS), Fixed and Total Volatile Solids, Fixed Dissolved Solids, The Methods of measurement and significance Organic and Inorganic Contaminants: Mother Liquor Suspended Solids (MLSS) & Mother Liquor Volatile Suspended Solids (MLVSS), Oil, Grease & Phenols - Sources, impact, and detection methods, Chloride & Fluoride - Detection methods, Health and environmental implications Nutrient Analysis: Ammoniacal Nitrogen & Kjeldahl Nitrogen - Detection methods, Significance in wastewater treatment, Nitrite & Nitrate - Detection methods, Impact on human health and aquatic life, Phosphate - Detection methods Heavy Metals and Toxic Substances: Sulphide & Sulphate Detection methods, Sodium and Potassium - Detection methods, Their role in water quality assessment, Chromium Determination- Methods of detection and effects on the environment.	

REFERENCE BOOKS:

1. Fundamentals of Industrial safety and health by Dr. K.U. Mistry, Vol-1&2.
2. Industrial accidental prevention, H. W. Heinrich
3. Encyclopedia of Occupational Health & Safety, ILO, Geneva, Switzerland
4. Accident, Prevention Manual for Industrial Operation, NSC, USA.
5. Analytical methods for drinking water, Advances in sampling and Analysis by Phillippe Quevauviller, K. Clive Thompson.
6. Industrial Water Analysis Handbook by Natrajan Manivasakan.

e-Resources:

1. **https://coursera.org/specializations/chemical-hazards-and-process-safety**
2. **https://coursera.org/learn/chemicals-health**

3. https://www.iitb.ac.in/safety/sites/www.safety.iitb.ac.in/files/Chemical%20Safety_0.pdf
4. http://acl.digimat.in/nptel/courses/video/103107156/L02.html
5. https://archive.nptel.ac.in/courses/103/107/103107156/
6. https://archive.nptel.ac.in/courses/114/106/114106017/
7. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000014ER/P000271/M027320/ET/1518526335paper_16__module_28_etext.pdf
8. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/environmental_chemistry/12.waste_water_purification/et/5507_et_et.pdf
9. https://archive.nptel.ac.in/courses/105/105/105105178/
10. https://archive.nptel.ac.in/courses/103/107/103107212/
11. https://www.intechopen.com/chapters/49024

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
1.	√	√	√								
2.	√	√	√								
3.	√	√	√								
4.	√	√	√								
5.	√	√									
6.	√	√									
7.	√	√									

M. Sc. (CHEMISTRY) SEMESTER III

Practical CC7

COURSE NAME: Organic Preparations

COURSE CODE: CHEMSC-S3PR7-2CR25 [CREDITS – 02]

Course Learning Outcome
After successful completion of the course, students will be able to: 1. Understand and explain the synthetic routes of key industrially significant organic compounds, intermediates, and dyes. 2. Demonstrate practical knowledge of multistep synthesis and interconversion of organic compounds starting from basic raw materials. 3. Analyze reaction mechanisms, intermediates, and selectivity involved in complex organic syntheses. 4. Apply green chemistry principles, wherever feasible, in industrial synthesis routes. 5. Identify and evaluate the industrial relevance, structure–activity relationship, and commercial application of the synthesized compounds. 6. Develop laboratory skills related to synthesis, purification, and characterization techniques (e.g., recrystallization, TLC, melting point, IR/UV/GC where applicable).
Learning Objectives
This module is intended to: 1. Describe the stepwise synthetic routes for compounds like sulfanilamide, acridone, eosin, benzocaine, and others. 2. Explain the transformation of functional groups and rearrangements during synthesis (e.g., nitration, sulfonation, oxidation, esterification, etc.). 3. Illustrate synthetic pathways using retrosynthetic analysis. 4. Correlate structure with function for pharmaceuticals (e.g., benzocaine, sulfanilamide) and dyes (e.g., eosin, Congo red). 5. Justify the choice of starting materials and reagents in terms of efficiency, selectivity, and sustainability. 6. Predict potential by-products and purification methods based on the nature of the reaction. 7. Perform and record organic syntheses in a systematic and safe manner following lab protocols.

Preparation of Industrially Important Compounds (Minimum 8)

1. Sulfanilamide from p-acetamido benzene sulphonyl chloride and p-acetamido benzene-sulfonamide.
2. Acridone from anthranilic acid via o-chloro benzoic acid and N-phenylanthranilic acid.
3. Benzocaine from p-nitro toluene via p-nitro benzoic acid and p-amino benzoic acid.
4. Eosin from phthalic acid via phthalic anhydride and fluorescein.
5. Benzanilide from benzene via Benzophenone and Benzophenonoxime.
6. p-Nitro chloro benzene from acetanilide via p-nitro acetanilide and p-nitroaniline.
7. p-Chloro benzene from acetanilide via p-bromo acetanilide and p-bromoaniline.
8. Anthrone from phthalic anhydride via o-benzoyl benzoic acid and anthraquinone.
9. 4-Methyl-7-hydroxy-8-acetyl coumarin from resorcinol via 4-methyl-7-hydroxycoumarin and 4-methyl-7-acetyl coumarin.
10. Preparation of Congo red dye from naphthionic acid via hydrozobenzene.
11. Preparation of o- & p-hydroxyacetophenone from aniline via phenol and phenylacetate.

References:

1. A text book of practical organic chemistry – A. I. Vogel
2. Practical organic Chemistry – Mann and Saunders
3. A handbook of quantitative and qualitative analysis – H. T. Clarke
4. Comprehensive Practical Organic Chemistry : Qualitative Analysis V K Ahluwalia & S. Dhingra.
5. Comprehensive Practical Organic Chemistry : Preparations and Quantitative Analysis V K Ahluwalia& R. Aggarwal Universities Press.
6. An Advance Course in practical Chemistry, A K. Nad, B. Mahapatra and A. Ghoshal.

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Outcomes										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1.		√		√	√	√					
2.		√		√	√	√					
3.		√		√	√	√					
4.		√		√	√	√					
5.		√		√	√	√					
6.		√		√	√	√					

M. Sc. (CHEMISTRY) SEMESTER III

Practical CC8

COURSE NAME: Green Synthesis

COURSE CODE: CHEMSC-S3PR8-2CR25 [CREDITS – 02]

Course Learning Outcome
After the successful completion of the course, students will be able to: 1. Explain the principles and importance of green chemistry in organic synthesis. 2. Perform green synthetic methods such as solid-state grinding, aqueous reactions, and solvent-free conditions. 3. Demonstrate proficiency in eco-friendly procedures for reactions like aldol condensation, nitration, bromination, and cycloaddition. 4. Prepare various organic compounds such as benzopinacolone, biodiesel, acetanilide, and dihydropyrimidinones using green methods. 5. Evaluate the environmental impact and advantages of green protocols over conventional methods. 6. Apply the knowledge of green synthesis in real-world and industrial contexts for sustainable chemical production.
Learning Objectives
This module is intended 1. To introduce students to eco-friendly and sustainable synthetic methodologies in organic chemistry. 2. To develop understanding of green chemistry principles through practical experiments. 3. To familiarize students with modern synthetic techniques that minimize the use of hazardous reagents and solvents. 4. To encourage students to adopt green approaches for commonly practiced organic reactions. 5. To enhance skills in performing chemical reactions using alternative energy sources (e.g., grinding, aqueous medium). 6. To promote critical thinking about environmental and safety aspects of chemical synthesis.
Green Synthesis (Any 7) 1. Green approach for the preparation of benzopinacolone from benzopinacol using iodine catalyst.Preparation of 1,1-bis-2-naphthol under grinding at room temperature. 2. Three-component coupling reaction using a green approach (Synthesis of dihydropyrimidinone).

	3. Green approach to transesterification reaction (Synthesis of biodiesel). 4. Eco-friendly nitration of phenols and their derivatives using calcium nitrate. 5. Preparation of acetanilide from aniline and acetic acid using Zn dust. 6. Base-catalyzed aldol condensation using $LiOH.H_2O$ as a catalyst. 7. Bromination of trans-stilbene using sodium bromide and sodium bromate. 8. [4+2] Cycloaddition reaction in aqueous medium at room temperature. 9. Benzil-Benzilic acid rearrangement under solvent-free conditions.	

References:

1. Monograph on Green Chemistry Laboratory Experiments – Green Chemistry Task Force Committee, DST.
2. "Green Chemistry: Theory and Practice" Authors: Paul T. Anastas and John C. Warner Publisher: Oxford University Press
3. A foundational book explaining the 12 principles of green chemistry and their practical applications.
4. "Green Chemistry: An Introductory Text"Author: Mike Lancaster Publisher: Royal Society of Chemistry Offers examples of green synthetic strategies and laboratory-scale green experiments.
5. "Organic Syntheses Based on Name Reactions and Unnamed Reactions" Author: Alfred Hassner Publisher: Pergamon Useful for understanding mechanisms in green organic synthesis.
6. "Laboratory Manual of Green Chemistry" Author: Mukesh Doble and Anil Kumar Publisher: I.K. International Publishing

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Outcomes										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1.		√		√	√	√					
2.		√		√	√	√					
3.		√		√	√	√					
4.		√		√	√	√					
5.		√		√	√	√					
6.		√		√	√	√					

M. Sc. (CHEMISTRY) SEMESTER III

Practical CC9

COURSE NAME: Spectral Exercise

COURSE CODE: CHEMSC-S3PR9-2CR25 [CREDITS – 02]

Course Learning Outcome
After the successful completion of the course, students will be able to: 1. By the end of this course, students will be able to analyze and interpret spectroscopic data (UV, IR, NMR, and Mass spectra). 2. To determine the molecular structure of organic compounds. They will develop problem-solving skills in structure elucidation, applying theoretical and practical knowledge of modern spectroscopic techniques.

Learning Objectives
This module is intended to: 1. Understand the fundamental principles behind UV, IR, NMR, and Mass spectroscopy. 2. Identify functional groups and structural features using IR spectroscopy. 3. Analyze electronic transitions and conjugated systems using UV-Visible spectroscopy. 4. Interpret NMR spectra (1H and 13C) including chemical shifts, coupling constants, and splitting patterns.

Spectral Exercise (Minimum 10) Structure interpretation of organic compounds using spectra (UV, IR, NMR, and Mass).

References:

1. A text book of practical organic chemistry – A. I. Vogel
2. Practical organic Chemistry – Mann and Saunders
3. A handbook of quantitative and qualitative analysis – H. T. Clarke
4. Comprehensive Practical Organic Chemistry : Qualitative Analysis V K Ahluwalia & S. Dhingra.
5. Comprehensive Practical Organic Chemistry : Preparations and Quantitative Analysis V K Ahluwalia& R. Aggarwal Universities Press.
6. An Advance Course in practical Chemistry, A K. Nad, B. Mahapatra and A. Ghoshal.
7. Monograph on Green Chemistry Laboratory Experiments – Green Chemistry Task Force Committee, DST.
8. https://www.lehigh.edu/~kjs0/carey-13.PDF

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Outcomes										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1.		√		√	√	√					
2.		√		√	√	√					