Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science, Commerce, Baramati

(Empowered Autonomous)

DEPARTMENT OF CHEMISTRY

(Faculty of Science and Technology)

Two Year M.Sc. Degree Program Chemistry

M.Sc. II Organic Chemistry

Sem (IV)

(NEP Pattern)

Choice Based Credit System Structure and Syllabus

(To be implemented from June 2024)

Title of the Programme: M.Sc. II (Organic Chemistry)

Preamble

AES's Tuljaram Chaturchand College has made the decision to change the syllabus of across various faculties from June, 2023 by incorporating the guidelines and provisions outlined in the National Education Policy (NEP), 2020. The NEP envisions making education more holistic and effective and to lay emphasis on the integration of general (academic) education, vocational education and experiential learning. The NEP introduces holistic and multidisciplinary education that would help to develop intellectual, scientific, social, physical, emotional, ethical and moral capacities of the students. The NEP 2020 envisages flexible curricular structures and learning based outcome approach for the development of the students. By establishing a nationally accepted and internationally comparable credit structure and courses framework, the NEP 2020 aims to promote educational excellence, facilitate seamless academic mobility, and enhance the global competitiveness of Indian students. It fosters a system where educational achievements can be recognized and valued not only within the country but also in the international arena, expanding opportunities and opening doors for students to pursue their aspirations on a global scale.

In response to the rapid advancements in science and technology and the evolving approaches in various domains of Chemistry and related subjects, the Board of Studies in Chemistry at Tuljaram Chaturchand College, Baramati - Pune, has developed the curriculum for the first semester of M.Sc. Part-II Chemistry , which goes beyond traditional academic boundaries. The syllabus is aligned with the NEP 2020 guidelines to ensure that students receive an education that prepares them for the challenges and opportunities of the 21st century. This syllabus has been designed under the framework of the Choice Based Credit System (CBCS), taking into consideration the guidelines set forth by the National Education Policy (NEP) 2020, LOCF (UGC), NCrF, NHEQF, Prof. R.D. Kulkarni's Report, Government of Maharashtra's General Resolution dated 20th April and 16th May 2023, and the Circular issued by SPPU, Pune on 31st May 2023.

A chemistry degree equips students with the knowledge and skills necessary for a diverse range of fulfilling career paths. Graduates in chemistry find opportunities in various fields, including This includes industries like glass, cement, paper, textile, leather, dye, etc. We also see huge chemistry applications in industries like paints, pigments, petroleum, sugar, plastics, and Pharmaceuticals.

Overall, revising the chemistry syllabus in accordance with the NEP 2020 ensures that students receive an education that is relevant, comprehensive, and prepares them to navigate the dynamic and interconnected world of today. It equips them with the knowledge, skills, and competencies needed to contribute meaningfully to society and pursue their academic and professional goals in a rapidly changing healthcare needs.

Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science & Commerce, Baramati.

Tuljaram Chaturchand College of Arts, Science & Commerce, Baramati is an autonomous & dynamic institute and has successfully implemented the National Education Policy-2020 since the academic year 2023-24. We are updating our academic policies as per local needs keeping in view the global perspectives. Accordingly, we have updated our program outcomes as per the graduate attributes defined in New Education Policy.

Program Outcomes for M.Sc.

1. Comprehensive Knowledge and Understanding:

Postgraduates will possess a profound understanding of their field, encompassing foundational theories, methodologies, and key concepts within a multidisciplinary context.

2. Practical, Professional, and Procedural Knowledge:

Postgraduates will acquire practical skills and expertise necessary for professional tasks, including industry standards, regulations, and ethical considerations, with effective application in real-world scenarios.

3. Entrepreneurial Mindset, Innovation, and Business Understanding:

Postgraduates will cultivate an entrepreneurial mindset, identify opportunities, foster innovation, and understand business principles, market dynamics, and risk management strategies.

4. Specialized Skills, Critical Thinking, and Problem-Solving:

Postgraduates will demonstrate proficiency in technical skills, analytical abilities, effective communication, and leadership, adapting and innovating in response to changing circumstances.

5. Research, Analytical Reasoning, and Ethical Conduct:

Postgraduates will exhibit observational and inquiry skills, formulate research questions, utilize appropriate methodologies for data analysis, and adhere to research ethics while effectively reporting findings.

6. Communication, Collaboration, and Leadership:

Postgraduates will effectively communicate complex information, collaborate in diverse teams, demonstrate leadership qualities, and facilitate cooperative efforts toward common goals.

7. Digital Proficiency and Technological Skills:

Postgraduates will demonstrate proficiency in using ICT, accessing information sources, analyzing data using appropriate software, and adapting to technological advancements.

8. Multicultural Competence, Inclusive Spirit, and Empathy:

Postgraduates will engage effectively in multicultural settings, respect diverse perspectives, lead diverse teams, and demonstrate empathy and understanding of others' perspectives and emotions.

9. Value Inculcation, Environmental Awareness, and Ethical Practices:

Postgraduates will embrace ethical and moral values, practice responsible citizenship, recognize and address ethical issues, and promote sustainability and environmental conservation.

10. Autonomy, Responsibility, and Accountability:

Postgraduates will apply knowledge and skills independently, manage projects effectively, and demonstrate responsibility and accountability in work and learning contexts, contributing to societal well-being.

List of Members Present for the BOS Meeting

The following internal and external BOS members were attended the Board of Studies

Sr. No.	Name of Member	Designation
1.	**Dr. Sanjay R. Kale** Head & Professor, Department of Chemistry, T. C. College, Baramati.	Chairman
2.	**Dr. Namdeo N. Bhujbal** Professor, Department of Chemistry Magar College, Hadapsar, Pune	External Member VC Nominee.
3.	**Dr. D. M. Pore** Professor, Department of Chemistry Shivaji University, Kolhapur	External Member from other University
4.	**Dr.Shrikrushna T. Salunke** Associate Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
5.	**Mr. Bhimrao R. Torane** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
6.	**Mr. Maharudra A. Dudhe** Assistant Professor, Department of Chemistry, T. C. College, Baramati	Internal Member
7.	**Mr. Ravikiranamrut R. Gandhi** Assistant Professor, Department of Chemistry T. C. College, Baramati	Internal Member
8.	**Dr. Vaibhav P. Landage** Associate Professor, Department of Chemistry T. C. College, Baramati	Internal Member
9.	**Dr. Yogesh N. Indulkar** Assistant Professor, Department of Chemistry T. C. College, Baramati	Internal Member
10.	**Dr. Rahul S. Bhondwe.** Assistant Professor, Department of Chemistry T. C. College, Baramati	Internal Member
11.	**Dr. Nilam C. Dige** Assistant Professor, Department of Chemistry T. C. College, Baramati.	Internal Member
12.	**Mrs. Supriya S. Deokate** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
13.	**Mrs. Jyoti T. Waghmode** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
14.	**Ms. Geetanjali S. Bhunje** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member

15.	**Mrs. Reshma T. Gadadare** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
16.	**Mrs. Swati A. Deokate** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
17.	**Mrs. Gaytri D. Pirale** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
18.	**Mrs. Sonali P. Nale** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
19.	**Ms. Farhin H. Shaikh** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
20.	**Ms. Anjali N. Bhong** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
21.	**Mr. Harshad J. Salunkhe** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
22.	**Mr. Saurabh Pandhare** T. C. College, Baramati	PG Student
23.	**Mr. Niranjan Ghuge** T. C. College, Baramati	UG Student
24.	**Mr. Vijay Gorave** T. C. College, Baramati	UG Student

Course & Credit Structure for M. Sc. II Organic Chemistry (2023 Pattern)
as per NEP – 2020

Sem	Course Type	Course Code	Course Title	Theory/ Practical	Credits
III	Major Mandatory	CHO-601-MJM	Retrosynthesis and stereochemistry	Theory	**04**
	Major Mandatory	CHO-602-MJM	Spectroscopy in Organic chemistry	Theory	**04**
	Major Mandatory	CHO-603-MJM	Ternary Mixture Analysis	Practical	**02**
	Major Mandatory	CHO-604-MJM	Double stage preparation	Practical	**02**
	Major Elective	CHO-611-MJE(A)	Pericyclic Reactions and Heterocyclic Chemistry	Theory	
		CHO-611-MJE(B)	Photochemistry and Free Radical	Theory	**02**
	Major Elective	CHO-612-MJE(A)	Preparation of Analogs	Practical	
		CHO-612-MJE(B)	Single stage preparation	Practical	**02**
		CHO-621-RP	Research Project	Practical	**04**
			Total Credits Semester-III		**20**
IV	Major Mandatory	CHO-651-MJM	Chemistry of Natural Products	Theory	**04**
	Major Mandatory	CHO-652-MJM	Advanced Synthetic Organic Chemistry	Theory	**04**
	Major Mandatory	CHO-653-MJM	Green Chemistry Practical	Practical	**02**
	Major Elective	CHO-661-MJE(A)	A) Organic Stereochemistry	Theory	
		CHO-661-MJE(B)	B) Asymmetric Synthesis	Theory	**02**
	Major Elective	CHO-662-MJE(A)	A) Innovative experiments in organic chemistry	Practical	
		CHO-662-MJE(B)	B) Multiple stage preparation	Practical	**02**
	Research Project (RP)	CHO-681-RP	Research Project	Practical	**06**
			Total Credits Semester-IV		**20**
			Cumulative Credits Semester III + Semester IV		**40**

CBCS Syllabus as per NEP 2020 for M.Sc. II Organic chemistry (NEP Pattern)

Name of the Programme : M.Sc. Chemistry
Program Code : CHE
Class : M.Sc. II
Semester : IV
Course Type : Mandatory Theory
Course Name : Chemistry of Natural Products
Course Code : CHO-651-MJM
No. of Lectures : 60
No. of Credits : 4 credits

Course Objectives:

Course Objective: On completion of the course, the student will be able to:

1. To understand the isolation extraction and separation of natural product.
2. To identify the structure of natural product by chemical and spectroscopic method
3. To study the biogenesis of variety of natural product.
4. To establish the synthesis of natural product.
5. To study the biogenesis of different natural products
6. To know the mechanism of biological formality.

Course Outcomes:

Course Outcomes: On completion of the course, the student should be able to:

CO**1.** Student can learn different methods of extraction , separation and purification of Natural products.

CO2. Students can able to illustrate the structure of natural product by spectral techniques. CO3. Students will expertise in the synthesis of different types of natural product.

CO4. Student will gain knowledge of mechanisms involved in biological chemistry.

CO5. Students can identify the stereochemistry of different natural products.

CO6. Ability to troubleshoot common issues and challenges that may arise during extraction processes.

CO7. Awareness of current advancements and trends in extraction technologies.

Topics and Learning Points

1. Isolation of Natural Products **(6L)**

General methods of isolation and purification:

i) Extraction and fractionation- Maceration, Soxhlet extraction, supercritical fluid extraction, extraction with solvents, steam distillation

ii) General methods of separation/purification:

Separation by chromatographic techniques: column chromatography, ion exchange and charcoal chromatography, HPLC

Ref. 1-8

2. Methods of structure determination of Natural Products **(8L)**

Chemical methods: Based on functional group- Bicarbonate extraction, sodium bisulphate adduct formation, derivatization of functional group; degradation of alkaloids- Emde's degradation, etc.

Physical/Spectral methods: UV, IR, NMR spectroscopy, MS spectrometry, optical, XRD.

Ref. 1-8

3. Synthesis and Structure elucidation involving stereochemistry, spectral and chemical methods **(16 L)**

- **(i)** Terpenoids: Menthol (Takasago) and Caryophyllene (E J Corey)
- **(ii)** Alkaloids: Reserpine (R B Woodward) and morphine (Marshall Gates)
- **(iii)** Prostaglandins: Synthesis of PGE2 and PGF2 (E. J. Corey)
- **(iv)** Antibiotics: Cephalosporin (R B Woodward)

Ref. 1-8

4. Biogenesis of natural products **(24 L)**

i). Terpenoids - Mono, Sesqui, Di, Triterpenoids

ii) Alkaloids

a) Derived from ornithine- hygrine, cocaine, tropine, cuscohygrine, hyoscymine, retronecine,

b) Derived from Lysine-anaferin, lobeline, piperine, pelletierine, lupinine,

c) Derived from Tyrosine- mescaline, anhalonine, reticuline, thebaine, codeine, morphine.

d) Derived from nicotinic acid- biosynthesis of nicotinic acid, biogenesis of nicotine, nornicotine

e) Derived from tryptophan- psilocin, Harman, harmine, ajmalicine, yohimbine, cinchonine, quinidine.

Ref. 9, 10,11

5. Mechanisms in biological chemistry **(6L)**

Mechanisms involving NAD/NADP to NADH/NADPHreductive amination in nature, nature's acyl anion equivalent, shikimic acid pathway, oxidation with FAD.

Ref. 1,9

References:

1. Pharmaceutical, medicinal and natural product Chemistry-P.S. Kalsi and Sangeeta Jagtap
2. Chemistry of natural products, a laboratory handbook- N. R. Krishnaswamy
3. Chemistry of natural products- S. V. Bhat, B. A. Nagasampagi, M. Sivakumar
4. Principles of organic synthesis by R. O. C. Norman and J.M.Coxon; Chapman and Hall

5. Classics in organic synthesis – K. C. Nicolaou & E. J. Sorensen
6. Natural products chemistry, sources, separations and structures- Raymond Cooper, George Nicola
7. Chemistry of plant natural products, stereochemistry, conformation, synthesis, biology and medicine- Sunil Kumar Talapatra and Bani Talapatra
8. Organic chemistry vol 2- Stereochemistry and chemistry of natural products- I. L. Finar
9. Medicinal Natural Products - A Biosynthetic approach by Paul M. Dewick 2nd Ed.(Wiley)
10. Secondary metabolism - J. Mann, 2nd edition.
11. Chemical aspects of Biosynthesis – J. Mann (1994).
12. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press)

Choice Based Credit System Syllabus
(NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. II (SEM IV) **Subject**:Organic Chemistry
Course: Chemistry of Natural Products **Course Code**: CHO-651-MJM
Weightage: 1=weak or low relation, 2= moderate or partial relation, 3=strong or direct relation

Program Outcomes (POs) and Course Outcomes (COs) Matrix with Weightage:

	Programme Outcomes(POs)									
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	0	0	0	0	3	0	0	2	1
CO2	2	2	0	3	0	0	0	0	0	0
CO3	1	3	2	0	0	0	0	0	0	0
CO4	2	0	0	2	3	0	0	0	0	0
CO5	1	3	0	2	2	0	0	0	0	0
CO6	3	3	0	0	0	3	0	0	2	0
CO7	0	0	2	2	2	0	3	2	3	0

Justification for the mapping

PO1 Comprehensive Knowledge and Understanding:
CO1. Student can learn different methods of extraction , separation and purification of Natural products.
CO2. Students can able to illustrate the structure of natural product by spectral techniques. CO3.Students will expertise in the synthesis of different types of natural product.
CO4. Student will gain knowledge of mechanisms involved in biological chemistry.
CO5. Students can identify the stereochemistry of different natural products.
CO6. Ability to troubleshoot common issues and challenges that may arise during extraction processes.

PO2 Practical, Professional, and Procedural Knowledge:
CO2. Students can able to illustrate the structure of natural product by spectral techniques. CO3. Students will expertise in the synthesis of different types of natural product.
CO5. Students can identify the stereochemistry of different natural products.
CO6. Ability to troubleshoot common issues and challenges that may arise during extraction processes.

PO3 Entrepreneurial Mindset, Innovation, and Business Understanding:
CO3. Students will expertise in the synthesis of different types of natural product.
CO7. Awareness of current advancements and trends in extraction technologies.

PO4 Specialized Skills, Critical Thinking, and Problem-Solving:
CO2. Students can able to illustrate the structure of natural product by spectral techniques. CO3.Students will expertise in the synthesis of different types of natural product.
CO4. Student will gain knowledge of mechanisms involved in biological chemistry.
CO5. Students can identify the stereochemistry of different natural products.
CO7. Awareness of current advancements and trends in extraction technologies.

PO5 Research, Analytical Reasoning, and Ethical Conduct:
CO4. Student will gain knowledge of mechanisms involved in biological chemistry.
CO5. Students can identify the stereochemistry of different natural products.
CO7. Awareness of current advancements and trends in extraction technologies.

PO6 Communication, Collaboration, and Leadership:
CO1. Student can learn different methods of extraction , separation and purification of Natural products.
CO6. Ability to troubleshoot common issues and challenges that may arise during extraction processes.

PO7 Digital Proficiency and Technological Skills:
CO7. Awareness of current advancements and trends in extraction technologies.

PO8 Multicultural Competence, Inclusive Spirit, and Empathy:
CO7. Awareness of current advancements and trends in extraction technologies.

PO9 Value Inculcation, Environmental Awareness, and Ethical Practices:
CO1. Student can learn different methods of extraction , separation and purification of Natural products.
CO6. Ability to troubleshoot common issues and challenges that may arise during extraction processes.
CO7. Awareness of current advancements and trends in extraction technologies.

PO10 Autonomy, Responsibility, and Accountability:
CO1. Understand the principles of stereochemistry and apply them to analyze the stereochemistry of six-membered rings, rings other than six-membered, fused bridged, and caged rings.

CBCS Syllabus as per NEP 2020 for M.Sc. II Organic chemistry (NEP Pattern)

Name of the Programme : M.Sc. Chemistry
Program Code : CHE
Class : M.Sc. II
Semester : IV
Course Type : Mandatory Theory
Course Name : Advanced Synthetic Organic chemistry
Course Code : CHO-652-MJM
No. of Lectures : 60
No. of Credits : 4 credits

Course Objectives:

Course Objective: On completion of the course, the student will be able to:

1) To study different cross coupling reactions for C-C bond formation
2) To study different cross coupling reactions for C=C bond formation
3) To study the use of transition metals in organic synthesis.
4) To study the importance of click chemistry
5) To study different ring forming reactions in organic synthesis.
6) To study the use of boron and silicon chemistry

Course Outcomes:

COl. Student will learn click chemistry and related important reactions.

CO2. Students will get knowledge of organoboranes in details

CO3. Students will be expertise in various coupling reactions

CO4. Students will be expertise in silicon and boron reagents in organic reactions

CO5. Students will get knowledge of ring forming reactions in organic synthesis

CO6. Understanding the role of catalysts and reaction conditions in promoting C=C bond formation reactions.

CO7. Awareness of current advancements and trends in C=C bond formation reactions, such as the development of new catalysts and greener reaction conditions.

Topics and Learning Points

1. Transition metal complexes in organic synthesis: only Pd, Ni, Co, Fe (Metal mediated C-Cand C-X bond formation reactions): Suzuki, Heck, Sonogashira, Stille, Fukuyama, Kumada, Hiyama, Negishi, Buchwald-Hartwig, Reppe **(14 L)**

2. C=C bond formation reactions: (Reaction, Mechanism and Application) Wittig, Horner-Wordworth-Emmons, McMurry, Shapiro, Bamford-Stevens, Julia-Lythgoe, Brood, Corey Winter and Peterson olefination reactions, Titanium-carbene mediated olefination: Tebbe, Petasis Reagent **(14 L)**

3. Click chemistry: Criterion for click reaction, Reaction and Mechanism of Sharpless azides cycloadditions, Ring formation reactions: Pausan-Khand, Bergman. Corey-Chaykovsky Reaction. Grubbs catalyst, Olefin cross coupling (OCM), ring Closing (RCM) and ring opening (ROM) metathesis, **(12L)**

4. Baylis Hilman, Eschenmoser-Tanabe fragmentation Mitsunobu reaction, Boekelheide reaction, Chugaev reaction, Ugi Reaction, Passerini and Mannich Reaction. **(10 L**)

5. Use of Organo Boron in organic synthesis : Dialkyl borane, Diisoamyl Borane, Disamyl Borane, Thexil Borane, Diisopinacamphyl Borane, 9 borabicyclo –[3.3.1.] -nonane (9-BBN) Preparation reactivity and applications in synthesis of Alcohol etc. **(10 L)**

References:

1. Organic synthesis using transition metals-Roderick Bates (Wiley)
2. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press)
3. Designing of organic synthesis – S. Warren (Wiley)
4. Some modern methods of organic synthesis – W. Carruthers (Cambridge)
5. Organic synthesis – Michael B. Smith
6. Organometallics in organic synthesis – J. M. Swan and D. C. Black (Chapman and Hall)
7. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition (2007)
8. Guidebook to organic synthesis-R. K.Meckie, D. M. Smith and R. A. Atken
9. Organic synthesis- Robert E Ireland
10. Strategic Applications of named reactions in organic synthesis-Laszlo Kurti and Barbara Czako
11. New Trends in Green Chemistry- V.K. Ahluwalia, M. Kidwai

Choice Based Credit System Syllabus
(NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. II (SEM IV) **Subject**:Organic Chemistry
Course: Advanced Synthetic Organic chemistry **Course Code**: CHO-652-MJM
Weightage: 1=weak or low relation, 2= moderate or partial relation, 3=strong or direct relation

Program Outcomes (POs) and Course Outcomes (COs) Matrix with Weightage:

	Programme Outcomes(POs)									
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	0	0	0	0	2	0	0	3	1
CO2	1	0	1	3	0	0	0	0	0	0
CO3	2	0	2	1	0	0	0	0	0	0
CO4	2	0	3	3	3	0	0	0	0	0
CO5	0	1	0	3	2	0	0	0	0	0
CO6	0	3	0	1	0	1	0	0	2	0
CO7	0	2	0	0	3	0	0	2	3	0

Justification for the mapping

PO1 Comprehensive Knowledge and Understanding:
CO1. Student will learn click chemistry and related important reactions.
CO2. Students will get knowledge of organoboranes in details
CO3. Students will be expertise in various coupling reactions
CO4. Students will be expertise in silicon and boron reagents in organic reactions

PO2 Practical, Professional, and Procedural Knowledge:
CO5. Students will get knowledge of ring forming reactions in organic synthesis
CO6. Understanding the role of catalysts and reaction conditions in promoting C=C bond formation reactions.
CO7. Awareness of current advancements and trends in C=C bond formation reactions, such as the development of new catalysts and greener reaction conditions

PO3 Entrepreneurial Mindset, Innovation, and Business Understanding:
CO2. Students will get knowledge of organoboranes in details
CO3. Students will be expertise in various coupling reactions
CO4. Students will be expertise in silicon and boron reagents in organic reactions

PO4 Specialized Skills, Critical Thinking, and Problem-Solving:
CO2. Students will get knowledge of organoboranes in details
CO3. Students will be expertise in various coupling reactions
CO4. Students will be expertise in silicon and boron reagents in organic reactions
CO5. Students will get knowledge of ring forming reactions in organic synthesis
CO6. Understanding the role of catalysts and reaction conditions in promoting C=C bond formation reactions.

PO5 Research, Analytical Reasoning, and Ethical Conduct:
CO4. Students will be expertise in silicon and boron reagents in organic reactions
CO5. Students will get knowledge of ring forming reactions in organic synthesis
CO7. Awareness of current advancements and trends in C=C bond formation reactions, such as the development of new catalysts and greener reaction conditions

PO6 Communication, Collaboration, and Leadership:
CO1. Student will learn click chemistry and related important reactions.
CO6. Understanding the role of catalysts and reaction conditions in promoting C=C bond formation reactions.

PO8 Multicultural Competence, Inclusive Spirit, and Empathy:
CO7. Awareness of current advancements and trends in C=C bond formation reactions, such as the development of new catalysts and greener reaction conditions

PO9 Value Inculcation, Environmental Awareness, and Ethical Practices:
CO1. Student will learn click chemistry and related important reactions.
CO6. Understanding the role of catalysts and reaction conditions in promoting C=C bond formation reactions.
CO7. Awareness of current advancements and trends in C=C bond formation reactions, such as the development of new catalysts and greener reaction conditions.

PO10 Autonomy, Responsibility, and Accountability:
COl. Student will learn click chemistry and related important reactions.

CBCS Syllabus as per NEP 2020 for M.Sc. II Organic chemistry (NEP Pattern)

Name of the Program : M.Sc. Chemistry
Program Code : CHO
Class : M.Sc. II
Semester : IV
Course Type : Mandatory Practical
Course Name : Green Chemistry Practical
Course Code : CHO-653-MJM
No. of Lectures : 30
No. of Credits : 02 credits

Course Objectives:

Course Objective: On completion of the course, the student will be able to:

1) To know the principles of green chemistry
2) Handling of single step reactions.
3) To know the solvent free reactions, green catalyst and green solvents.
4) To understand the advantage of green reaction over conventional organic reaction
5) To Know how to minimize hazardous waste.
6) To get acquainted with teaching material on sustainable development goal

Course Outcomes:

Course Outcomes: On completion of the course, the student will be able to:

CO l. Student will learn use of phase transfer catalyst in different synthesis.

CO2. Students will expertise in microwave, photochemical and enzyme catalyzed reactions.

CO3. Student will get the knowledge in the synthesis using green catalyst (ionic liquid, nanoparticles)

CO4. Due to industrial visit during study tour students will get industrial knowledge which will be helpful for their future opportunities.

CO5. Ability to analyze and interpret the results obtained from water-mediated reactions and ionic liquid reactions.

CO6. Ability to apply principles of green chemistry and sustainability in the context of water-mediated reactions and ionic liquid reactions

CO7. Awareness of current advancements and trends in the field of water-mediated reactions and ionic liquid reactions.

Topics and Learning Points

Green Chemistry Practicals

1. Benzophenone to benzopinacol
2. Preparation of 1, 1-bis-2-naphthol under grinding at room temperature.
3. Preparation of chalcone using green method
4. Solvent free quantitative solid phase synthesis of azomethines from substituted anilines and substituted benzaldehydes
5. Benzil Benzilic acid rearrangement under solvent free condition
6. Benzoin condensation using thiamine hydrochloride
7. Bromination of trans-stilbene using sodium bromide and sodium bromated.
8. Ecofriendly nitration of phenols and its derivatives using Calcium nitrate .
9. Flavone from o-hydroxyacetophenone and benzoylchloride.
10. Preparation of ZnO nanoparticle
11. Claisen Schmidt condensation using ZnO nanoparticle
12. Bromination of acetanilide using CAN
13. [4+2] cycloaddition reaction in aqueous medium at room temperature
14. Transesterification reaction /synthesis of biodiesel.
15. Microwave assisted oxidation of toluene by KMnO4.

References:

1. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Renu Aggarwal
2. A text book of practical organic chemistry by A. I. Vogel, ELBS and Longman group.
3. Laboratory manual of organic chemistry by R. K. Bansal

Choice Based Credit System Syllabus
(NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. II (SEM IV) **Subject**:Organic Chemistry
Course: Greeen Chemistry Practical **Course Code**: CHO-653-MJM

Weightage: 1=weak or low relation, 2= moderate or partial relation, 3=strong or direct relation

Program Outcomes (POs) and Course Outcomes (COs) Matrix with Weightage:

	Programme Outcomes(POs)									
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	0		0	0	0	0	0	0
CO2	1	3	0	2	0	0	0	0	0	0
CO3	3	2	2	3	0	0	0	0	2	0
CO4	2	0	3	3	0	3	0	0	0	0
CO5	3	0	3	2	3	0	0	0	0	1
CO6	0	0	2	1	2	0	0	0	0	0
CO7	0	0	0	0	0	0	1	1	0	2

Justification for the mapping

PO1 Comprehensive Knowledge and Understanding:
CO1. Student will learn use of phase transfer catalyst in different synthesis.
CO2. Students will expertise in microwave, photochemical and enzyme catalyzed reactions.
CO3. Student will get the knowledge in the synthesis using green catalyst (ionic liquid, nanoparticles)
CO4. Due to industrial visit during study tour students will get industrial knowledge which will be helpful for their future opportunities.
CO5. Ability to analyze and interpret the results obtained from water-mediated reactions and ionic liquid reactions.
CO6. Ability to apply principles of green chemistry and sustainability in the context of water-mediated reactions and ionic liquid reactions

PO2 Practical, Professional, and Procedural Knowledge:
CO1. Student will learn use of phase transfer catalyst in different synthesis.
CO2. Students will expertise in microwave, photochemical and enzyme catalyzed reactions.
CO3. Student will get the knowledge in the synthesis using green catalyst (ionic liquid, nanoparticles)

PO3 Entrepreneurial Mindset, Innovation, and Business Understanding:
Student will learn use of phase transfer catalyst in different synthesis.
CO3. Student will get the knowledge in the synthesis using green catalyst (ionic liquid, nanoparticles)
CO4. Due to industrial visit during study tour students will get industrial knowledge which will be helpful for their future opportunities.
CO5. Ability to analyze and interpret the results obtained from water-mediated reactions and ionic liquid reactions.
CO6. Ability to apply principles of green chemistry and sustainability in the context of water-mediated reactions and ionic liquid reactions

PO4 Specialized Skills, Critical Thinking, and Problem-Solving:
CO2. Students will expertise in microwave, photochemical and enzyme catalyzed reactions.
CO3. Student will get the knowledge in the synthesis using green catalyst (ionic liquid, nanoparticles)
CO4. Due to industrial visit during study tour students will get industrial knowledge which will be helpful for their future opportunities.
CO5. Ability to analyze and interpret the results obtained from water-mediated reactions and ionic liquid reactions.
CO6. Ability to apply principles of green chemistry and sustainability in the context of water-mediated reactions and ionic liquid reactions

PO5 Research, Analytical Reasoning, and Ethical Conduct:
CO5. Ability to analyze and interpret the results obtained from water-mediated reactions and ionic liquid reactions.
CO6. Ability to apply principles of green chemistry and sustainability in the context of water-mediated reactions and ionic liquid reactions

PO6 Communication, Collaboration, and Leadership:
CO4. Due to industrial visit during study tour students will get industrial knowledge which will be helpful for their future opportunities.

PO7 Digital Proficiency and Technological Skills:
CO7. Awareness of current advancements and trends in the field of water-mediated reactions and ionic liquid reactions.

PO8 Multicultural Competence, Inclusive Spirit, and Empathy:
CO7. Awareness of current advancements and trends in the field of water-mediated reactions and ionic liquid reactions

PO9 Value Inculcation, Environmental Awareness, and Ethical Practices:
CO3. Student will get the knowledge in the synthesis using green catalyst (ionic liquid, nanoparticles)

PO10 Autonomy, Responsibility, and Accountability:
CO5. Ability to analyze and interpret the results obtained from water-mediated reactions and ionic liquid reactions.
CO6. Ability to apply principles of green chemistry and sustainability in the context of water-mediated reactions and ionic liquid reactions

CBCS Syllabus as per NEP 2020 for M.Sc. II Organic chemistry (NEP Pattern)

Name of the Programme	**:** M.Sc. Chemistry
Program Code	**:** CHE
Class	**:** M.Sc. II
Semester	**:** IV
Course Type	**:** Major Elective Theory
Course Name	**:** Organic Stereochemistry
Course Code	**:** CHO-661-MJE (A)
No. of Lectures	**:** 30
No. of Credits	**:** 02 credits

Course Objective

Course Objective:

1) Develop a foundational understanding of stereochemistry concepts and terminology
2) Students will be able to explain the concept of racemic modifications and their significance in stereochemistry.
3) Examine the stereochemical outcomes of important organic reactions such as oxidation, reduction, epoxidation, and bromination,
4) Investigate the stereochemistry of rearrangement reactions and specific compounds like Hardwickiic acid and Endiandric acid A, correlating structure with reactivity.
5) Students will be able to identify and explain the stereochemical relationships among D-aldoses with three to six carbon atoms, including their structural formulas and configurations.
6) Students will classify linear carbohydrates into enantiomers, diastereomers, and epimers, providing examples and discussing their properties and implications..

Course Outcome

Course Outcomes : On completion of the course, the student should be able to;

CO1. Understand different methods used for resolution of racemic mixtures.

CO2. Understand the configuration of Geometrical isomers and their physical properties and stability.

CO3. Predict the stereochemical outcome from addition and displacement reactions

CO4. Predict the selectivity in organic reactions involved in synthesis of large molecules

CO5. Determine the correct stereochemistry and Selectivity in organic reactions viz. oxidation,reduction, epoxidation, Grignard reaction, bromination, epoxide opening,

rearrangement reaction etc.

CO6. Predict the stereochemistry and stereoisomers in enantiomers, diastereomers epimers and anomers in carbohydrates.

CO7. Solve Complex Organic Chemistry Problems based on Stereochemistry of cyclic rings, acyclic organic compounds

Topics and Learning Points

1. Resolution of racemic modification (8L)

Formation of Racemic Modifications, Resolution by mechanical separation of crystals, resolution by formation of diastereomers, second order asymmetric transformation, resolution by equilibrium asymmetric transformation, biochemical asymmetric transformation, criteria of optical purity.

Ref. 1, 2

2. Geometrical Isomerism and Stereochemistry of olefins (8L)

Determination of Configuration of Geometrical Isomers, Physical Properties of Geometrical Isomers, Relative Stability and Interconversion of Geometrical Isomers, Stereochemistry of Addition Reactions of Acetylenes, Stereochemistry of Addition Reactions of olefins, Stereochemistry of Nucleophilic Displacement in Olefinic Halides. Ref. 1, 2, 3

3. Stereochemistry of carbohydrates (6L)

Stereochemical Relationships Among D-aldoses with Three To Six Carbon Atoms, Stereochemical Relationships Among D-ketoses with Three To Six Carbon Atoms, D and L configurations, R and S system for naming chiral molecules, Stereoisomers for linear carbohydrates- enantiomers, diastereomers and epimers. stereoisomers for cyclic carbohydrates and anomers. Ref. 5, 6

4. Determination of stereochemistry of organic compounds using NMR (8L)

Determination of stereochemistry of organic compounds including cyclohexane ring, cyclohexanone ring, fused ring using NMR, determination of confirmations, Spreading out effect in different ring sizes, Significance of coupling constant in stereochemistry. Determination of stereochemistry in some reactions eg oxidation, reduction, epoxidation, Grignard reaction, bromination, epoxide opening, rearrangement reaction, stereochemistry of Hardwickiic acid, Endiandric acid A

Ref. 4, 7, 8

References:

1. Stereochemistry of carbon compounds - E.L. Eliel
2. Stereochemistry of organic compounds - Nasipuri
3. Stereochemistry of organic compounds - Kalsi
4. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers 1st. Ed. Chapters 32
5. Organic Chemistry – R. P. Morrison and R. N. Boyd
6. Organic Chemistry – I. L. Finar, volume II
7. Tetrahedron Letters, 3751 (1964).
8. J. Am. Chem. Soc. 1982, 104, 20, 5555–5557

Choice Based Credit System Syllabus
(NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. II (SEM IV) **Subject**:Organic Chemistry
Course: Organic Stereochemistry **Course Code**: CHO-661-MJE(A)
Weightage: 1=weak or low relation, 2= moderate or partial relation, 3=strong or direct relation

Program Outcomes (POs) and Course Outcomes (COs) Matrix with Weightage:

	Programme Outcomes(POs)									
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	0	1	0	0	0	0	1	0
CO2	3	2	0	0	0	0	0	0	0	0
CO3	3	3	2	3	2	0	0	0	0	1
CO4	3	3	2	3	2	0	0	0	0	1
CO5	3	3	2	3	2	2	0	0	0	1
CO6	3	3	2	3	2	0	0	0	0	1
CO7	3	3	2	3	2	2	2	2	0	2

Justification for the mapping

PO1 Comprehensive Knowledge and Understanding:
CO1 Understand different methods used for resolution of racemic mixtures.
CO2 Understand the configuration of Geometrical isomers and their physical properties and stability.
CO3 Predict the stereochemical outcome from addition and displacement reactions
CO4 Predict the selectivity in organic reactions involved in synthesis of large molecules
CO5 Determine the correct stereochemistry and Selectivity in organic reactions viz. oxidation, reduction, epoxidation, Grignard reaction, bromination, epoxide opening, rearrangement reaction etc.
CO6 Predict the stereochemistry and stereoisomers in enantiomers, diastereomers epimers and anomers in carbohydrates.
CO7 Solve Complex Organic Chemistry Problems based on Stereochemistry of cyclic rings, acyclic organic compounds

PO2 Practical, Professional, and Procedural Knowledge:
CO1 Understand different methods used for resolution of racemic mixtures.
CO2 Understand the configuration of Geometrical isomers and their physical properties and stability.
CO3 Predict the stereochemical outcome from addition and displacement reactions
CO4 Predict the selectivity in organic reactions involved in synthesis of large molecules
CO5 Determine the correct stereochemistry and Selectivity in organic reactions viz. oxidation, reduction, epoxidation, Grignard reaction, bromination, epoxide opening, rearrangement reaction etc.
CO6 Predict the stereochemistry and stereoisomers in enantiomers, diastereomers epimers

and anomers in carbohydrates.
CO7 Solve Complex Organic Chemistry Problems based on Stereochemistry of cyclic rings, acyclic organic compounds

PO3 Entrepreneurial Mindset, Innovation, and Business Understanding
CO3 Predict the stereochemical outcome from addition and displacement reactions
CO4 Predict the selectivity in organic reactions involved in synthesis of large molecules
CO5 Determine the correct stereochemistry and Selectivity in organic reactions viz. oxidation, reduction, epoxidation, Grignard reaction, bromination, epoxide opening, rearrangement reaction etc.
CO6 Predict the stereochemistry and stereoisomers in enantiomers, diastereomers epimers and anomers in carbohydrates.
CO7 Solve Complex Organic Chemistry Problems based on Stereochemistry of cyclic rings, acyclic organic compounds.

PO4 Specialized Skills, Critical Thinking, and Problem-Solving:
CO1 Understand different methods used for resolution of racemic mixtures.
CO3 Predict the stereochemical outcome from addition and displacement reactions.
CO4 Predict the selectivity in organic reactions involved in synthesis of large molecules.
CO5 Determine the correct stereochemistry and Selectivity in organic reactions viz. oxidation,
reduction, epoxidation, Grignard reaction, bromination, epoxide opening, rearrangement reaction etc.
CO6 Predict the stereochemistry and stereoisomers in enantiomers, diastereomers epimers and anomers in carbohydrates.
CO7 Solve Complex Organic Chemistry Problems based on Stereochemistry of cyclic rings, acyclic organic compounds

PO5 Research, Analytical Reasoning, and Ethical Conduct
CO3 Predict the stereochemical outcome from addition and displacement reactions.

CO4 Predict the selectivity in organic reactions involved in synthesis of large molecules.

CO5 Determine the correct stereochemistry and Selectivity in organic reactions viz.

oxidation,reduction, epoxidation, Grignard reaction, bromination, epoxide opening,

rearrangement reaction etc.

CO6 Predict the stereochemistry and stereoisomers in enantiomers, diastereomers epimers

and anomers in carbohydrates.

CO7 Solve Complex Organic Chemistry Problems based on Stereochemistry of cyclic rings,

acyclic organic compounds.

PO6 Communication, Collaboration, and Leadership
CO5 Determine the correct stereochemistry and Selectivity in organic reactions viz. oxidation,reduction, epoxidation, Grignard reaction, bromination, epoxide opening, rearrangement reaction etc.
CO7 Solve Complex Organic Chemistry Problems based on Stereochemistry of cyclic rings,

acyclic organic compounds

PO7 Digital Proficiency and Technological Skills
CO7 Solve Complex Organic Chemistry Problems based on Stereochemistry of cyclic rings, acyclic organic compounds

PO8 Multicultural Competence, Inclusive Spirit, and Empathy:
CO7 Solve Complex Organic Chemistry Problems based on Stereochemistry of cyclic rings, acyclic organic compounds

PO9 Value Inculcation, Environmental Awareness, and Ethical Practices:
CO1 Understand different methods used for resolution of racemic mixtures.

PO10 Autonomy, Responsibility, and Accountability
CO3 Predict the stereochemical outcome from addition and displacement reactions
CO4 Predict the selectivity in organic reactions involved in synthesis of large molecules
CO5 Determine the correct stereochemistry and Selectivity in organic reactions viz. oxidation,
reduction, epoxidation, Grignard reaction, bromination, epoxide opening, rearrangement reaction etc.
CO6 Predict the stereochemistry and stereoisomers in enantiomers, diastereomers epimers and anomers in carbohydrates.
CO7 Solve Complex Organic Chemistry Problems based on Stereochemistry of cyclic rings, acyclic organic compounds

CBCS Syllabus as per NEP 2020 for M.Sc. II Organic chemistry (NEP Pattern)

Name of the Programme : M.Sc. Chemistry
Program Code : CHE
Class : M.Sc. II
Semester : IV
Course Type : Major Elective Theory
Course Name : Asymmetric Synthesis
Course Code : CHO-661-MJE (B)
No. of Lectures : 30
No. of Credits : 02 credits

Course Objectives:

Course Objective: On completion of the course, the student will be able to:

1) Student should understand and learn the concept of Asymmetric synthesis.
2) To understand the importance of stereochemistry of the product.
3) Discover reactions that will reliably provide optically pure compounds.
4) Develop effective strategies for using chiral auxiliaries, catalysts, and the substrate to control stereochemical relationships.
5) Students will be able to give a detailed account of the course and mechanism of illustrative examples of the asymmetric reactions that utilize chiral auxiliaries
6) Students will be able to suggest the correct type of catalyst used for asymmetric reactions, the mechanism and applications of these reactions

Course Outcomes:

Course Outcomes: On completion of the course, the student should be able to:

CO**1.** Students will learn about the importance and need of asymmetric reagents and catalyst This knowledge contributes to their disciplinary knowledge in the field of organic chemistry and stereochemistry.

CO2. : Students will study asymmetric synthesis, Chirol pool, and chiral auxiliaries, which require critical thinking and problem-solving skills when designing chiral molecules and strategies for asymmetric synthesis.

CO3: Understanding transition metal-catalyzed homogeneous asymmetric hydrogenation, hydroxylation, and epoxidation involves critical thinking and problem-solving in the context of designing chiral catalysts and reactions.

CO4. : Students will gain knowledge of the use of cram rule, Felkin-Anh rule, cram chelate

model, and the use of chiral auxiliaries and chiral reagents in organic synthesis. This supports research-related skills by enabling students to explore and develop novel methods for asymmetric synthesis.

CO5: Learning the use of various principles and rules in asymmetric synthesis extends to transdisciplinary knowledge, as these concepts are applicable not only in organic chemistry but also in various scientific and industrial fields.

CO6. Ability to identify and differentiate between different geometrical isomers of olefins.

CO7. Awareness of current advancements and research in the field of organometallic chemistry .

Topics and Learning Points

1. Asymmetric Synthesis : Brief introduction, Need for Asymmetric Synthesis, Chiral pool-nature's readymade chiral center, Synthesis of propranolol and chloramphenicol, chiral auxiliaries: oxazolidinone (Evans Chiral auxiliary) and norephedrine-derived. **(10L)**

2. Specific reactions : Enantiomeric excess, Evans aldol, Zimmer-Traxler T.S. model, Mukaiyama, Masamune, Cornforth model , Cram's rule, Felkin Anh rule, Cram's chelate model, and their applications in advanced organic synthesis. **(10L)**

3. Chiral reagents and catalysts : Palladium-catalyzed asymmetric hydrosilylation of styrene preparation and use of CBS asymmetric reducing agent, ,Sharpless asymmetric epoxidation, Sharpless Asymmetric Dihydroxylation and it's application in industrially relevant molecule.like L-DOPA and Menthol, Enantioselective carbonyl reductions : BINAP based Noyori type. Alpineborane (Midland reagent) preparation and application, Novel Macmillan imidazolidinone asymmetric organocatalysis and it's application in Diels-Alder reaction. **(10L)**

References

1. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers 1st. Ed.
2. Asymmetric Synthesis principal and methodology- Y Vatsala
3. Journal of the American Chemical Society Cite this: J. Am. Chem. Soc. 2000, 122, 17, 4243–4244 https://doi.org/10.1021/ja000092s Published April 15, 2000
4. Stereoselectivity in organic synthesis, G. Procter, Oxford Chemistry Primers, 2007.
5. Fundamentals of asymmetric catalysis, P.J.Walsh and M.C. Kozlowski, University

science books, USA, 2009.

6. Catalytic Asymmetric Synthesis, 3rd ed,Ed: I. Ojima, John Wiley & Sons, New Jersey,2010.

7. Comprehensive Asymmetric Catalysis I-III; Editors: Eric N. Jacobsen, Andreas Pfaltz, Hisashi Yamamoto; Springer-Verlag Berlin Heidelberg, Germany, 1999.

8. Asymmetric Synthesis – The Essentials, Eds.: M. Christmann and S. Brase, Wiley-VCH Verlag GmbH,

Choice Based Credit System Syllabus
(NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. II (SEM IV) **Subject**:Organic Chemistry
Course: Asymmetric Synthesis **Course Code**: CHO-661-MJE (B)
Weightage: 1=weak or low relation, 2= moderate or partial relation, 3=strong or direct relation

Program Outcomes (POs) and Course Outcomes (COs) Matrix with Weightage:

	Programme Outcomes(POs)									
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	1	2	2	1	0	0	0	0	3
CO2	2	3	0	2	3	0	0	0	0	0
CO3	1	0	0	0	2	0	3	0	0	0
CO4	1	0	2	3	0	3	0	0	0	0
CO5	1	2	3	1	0	1	0	0	0	0
CO6	2	0	0	0	0	0	0	0	0	2
CO7	1	2	2	0	2	1	2	2	2	1

Justification for the mapping

PO1 Comprehensive Knowledge and Understanding:
CO1: Students will learn about the importance and need of asymmetric reagents and catalyst This knowledge contributes to their disciplinary knowledge in the field of organic chemistry and stereochemistry.
CO2: Students will study asymmetric synthesis, Chirol pool, and chiral auxiliaries, which require critical thinking and problem-solving skills when designing chiral molecules and strategies for asymmetric synthesis.
CO3: Understanding transition metal-catalyzed homogeneous asymmetric hydrogenation, hydroxylation, and epoxidation involves critical thinking and problem-solving in the context of designing chiral catalysts and reactions.
CO4: Students will gain knowledge of the use of cram rule, Felkin-Anh rule, cram chelate model, and the use of chiral auxiliaries and chiral reagents in organic synthesis. This supports research-related skills by enabling students to explore and develop novel methods for asymmetric synthesis.
CO5: Learning the use of various principles and rules in asymmetric synthesis extends to transdisciplinary knowledge, as these concepts are applicable not only in organic chemistry but also in various scientific and industrial fields.
CO6. Ability to identify and differentiate between different geometrical isomers of olefins.
CO7. Awareness of current advancements and research in the field of organometallic chemistry .

PO2 Practical, Professional, and Procedural Knowledge:
CO1. Students will learn about the importance and need of asymmetric reagents and catalyst This knowledge contributes to their disciplinary knowledge in the field of organic chemistry and stereochemistry.
CO2. : Students will study asymmetric synthesis, Chirol pool, and chiral auxiliaries, which require critical thinking and problem-solving skills when designing chiral molecules and strategies for asymmetric synthesis.

CO5: Learning the use of various principles and rules in asymmetric synthesis extends to transdisciplinary knowledge, as these concepts are applicable not only in organic chemistry but also in various scientific and industrial fields.
CO7. Awareness of current advancements and research in the field of organometallic chemistry .

PO3 Entrepreneurial Mindset, Innovation, and Business Understanding:
CO1. Students will learn about the importance and need of asymmetric reagents and catalyst This knowledge contributes to their disciplinary knowledge in the field of organic chemistry and stereochemistry.
CO4.: Students will gain knowledge of the use of cram rule, Felkin-Anh rule, cram chelate model, and the use of chiral auxiliaries and chiral reagents in organic synthesis. This supports research-related skills by enabling students to explore and develop novel methods for asymmetric synthesis.
CO5: Learning the use of various principles and rules in asymmetric synthesis extends to transdisciplinary knowledge, as these concepts are applicable not only in organic chemistry but also in various scientific and industrial fields.
CO7. Awareness of current advancements and research in the field of organometallic chemistry .

PO4 Specialized Skills, Critical Thinking, and Problem-Solving:
CO1. Students will learn about the importance and need of asymmetric reagents and catalyst This knowledge contributes to their disciplinary knowledge in the field of organic chemistry and stereochemistry.
CO2. : Students will study asymmetric synthesis, Chirol pool, and chiral auxiliaries, which require critical thinking and problem-solving skills when designing chiral molecules and strategies for asymmetric synthesis.
CO4.: Students will gain knowledge of the use of cram rule, Felkin-Anh rule, cram chelate model, and the use of chiral auxiliaries and chiral reagents in organic synthesis. This supports research-related skills by enabling students to explore and develop novel methods for asymmetric synthesis.
CO5: Learning the use of various principles and rules in asymmetric synthesis extends to transdisciplinary knowledge, as these concepts are applicable not only in organic chemistry but also in various scientific and industrial fields.

PO5 Research, Analytical Reasoning, and Ethical Conduct:
CO1. Students will learn about the importance and need of asymmetric reagents and catalyst This knowledge contributes to their disciplinary knowledge in the field of organic chemistry and stereochemistry.
CO2. : Students will study asymmetric synthesis, Chirol pool, and chiral auxiliaries, which require critical thinking and problem-solving skills when designing chiral molecules and strategies for asymmetric synthesis.
CO3: Understanding transition metal-catalyzed homogeneous asymmetric hydrogenation, hydroxylation, and epoxidation involves critical thinking and problem-solving in the context of designing chiral catalysts and reactions.
CO7. Awareness of current advancements and research in the field of organometallic chemistry .

PO6 Communication, Collaboration, and Leadership:
CO4.: Students will gain knowledge of the use of cram rule, Felkin-Anh rule, cram chelate model, and the use of chiral auxiliaries and chiral reagents in organic synthesis. This supports research-related skills by enabling students to explore and develop novel methods for asymmetric synthesis.
CO5: Learning the use of various principles and rules in asymmetric synthesis extends to transdisciplinary knowledge, as these concepts are applicable not only in organic chemistry but also in various scientific and industrial fields.
CO7. Awareness of current advancements and research in the field of organometallic chemistry .

PO7 Digital Proficiency and Technological Skills:
CO4.: Students will gain knowledge of the use of cram rule, Felkin-Anh rule, cram chelate model, and the use of chiral auxiliaries and chiral reagents in organic synthesis. This supports research-related skills by enabling students to explore and develop novel methods for asymmetric synthesis.
CO5: Learning the use of various principles and rules in asymmetric synthesis extends to transdisciplinary knowledge, as these concepts are applicable not only in organic chemistry but also in various scientific and industrial fields.
CO6. Ability to identify and differentiate between different geometrical isomers of olefins.
CO7. Awareness of current advancements and research in the field of organometallic chemistry .

PO8 Multicultural Competence, Inclusive Spirit, and Empathy:
CO7. Awareness of current advancements and research in the field of organometallic chemistry .

PO9 Value Inculcation, Environmental Awareness, and Ethical Practices:
CO7. Awareness of current advancements and research in the field of organometallic chemistry .

PO10 Autonomy, Responsibility, and Accountability:
CO1: Students will gain knowledge of the use of cram rule, Felkin-Anh rule, cram chelate model, and the use of chiral auxiliaries and chiral reagents in organic synthesis. This supports research-related skills by enabling students to explore and develop novel methods for asymmetric synthesis.
CO5: Learning the use of various principles and rules in asymmetric synthesis extends to transdisciplinary knowledge, as these concepts are applicable not only in organic chemistry but also in various scientific and industrial fields.
CO6: Ability to identify and differentiate between different geometrical isomers of olefins.
CO7: Awareness of current advancements and research in the field of organometallic chemistry .

CBCS Syllabus as per NEP 2020 for M.Sc. II organic chemistry (NEP Pattern)

Name of the Programme	**:** M.Sc. Chemistry
Program Code	**:** CHE
Class	**:** M.Sc. II
Semester	**:** IV
Course Type	**:** Major Elective Practical
Course Name	**:** Innovative Experiments in Organic chemistry
Course Code	**:** CHO-662-MJE (A)
No. of Lectures	**:** 30
No. of Credits	**:** 02 credits

Course Objectives:

Course Objective: On completion of the course, the student will be able to:

1) Develop proficiency in performing organic synthesis including the use of appropriate laboratory equipment and methods for the synthesis and purification
2) Acquire hands-on experience in performing various synthetic methods and techniques specific to the synthesis of heterocyclic compounds, such as cyclization reactions, functional group transformations.
3) Gain knowledge about the principles and mechanisms of multiple component reactions
4) Develop an understanding of the mechanism of different organic reactions, laboratory procedures, purification methods etc
5) Develop practical skills in handling and manipulating organic compounds, including proper techniques for weighing, measuring, and transferring reagents, as well as safe handling and disposal of hazardous materials
6) Develop practical skills in handling and synthesizing organic compounds and characterization of compound using different spectroscopic techniques.

Course Outcomes:

Course Outcomes: On completion of the course, the student should be able to:

CO1. Students will gain proficiency in performing organic synthesis and purification techniques.

CO2. Students will acquire hands-on experience in performing various synthetic methods and techniques specific to the synthesis of heterocyclic compounds.

CO3. Students will gain knowledge about the principles and mechanisms of multicomponent reactions and performing reactions using various catalyst.

CO4. Enhancing communication skills by effectively documenting experimental procedures and results.

CO5. Develop an understanding of the mechanism of different organic reactions, laboratory procedures, purification techniques.

CO6. Developing practical skills in handling and manipulating organic compounds.

CO7. Develop practical skills in handling and synthesizing organic compounds and characterization of compound using different spectroscopic techniques.

Topics and Learning Points

Organic Preparations:

1. Benzaldehyde + ethyl acetoacetate +thiourea to give tetrahydro pyrimidine-2-thione (antiproliferative activity)
2. Benzaldehyde + acetophenone + gaunidine to give 4,6- diphenyl pyrimidin-2-amine
3. Benzaldehyde + ethyl acetoacetate +urea to give dihydropyrimidone
4. 2-Amino-6-hydroxy-4-(phenyl)-pyrimidine-5-carbonitrile from Benzaldehyde
5. 5-(4-chlorophenyl)-1,5-dihydro-2H-dipyrimido[1,2-a:4',5' -d] pyrimidine-2, 4(3H)-dione from p-Cl Benzaldehyde
6. Synthesis of substituted coumarin by ultrasonic irradiation
7. Synthesis of substituted coumarin by thermal method and comparison of both methods
8. PEG mediated Synthesis of 4,7-Dihydro-2H-pyrazolo[3,4-b]pyridine
9. Synthesis of Azo dyes (Organol Brown, Para red and Indigo)
10. Synthesis of pharmaceutical scaffolds (Benzimidazole, Benzoxazole, Carbazoles, etc)
11. Synthesis of Agrochemicals
12. Preparation of 5-arylidene barbiturate using [Bmim]OH (Knovengel condensation)
13) Interpretation of given FTIR spectral data.
14) Interpretation of given 1HNMR spectral data
15) Interpretation of given 13C NMR spectral data
16) Interpretation of given Mass spectral data

References:

1. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS
2. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M.

Miller, Prentice Hall
3. Macro-scale and Micro-scale Organic Experiments, K. L. Williamson, D. C. Heath.
4. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
5. Handbook of Organic Analysis- Qualitative and Quantitative, H. Clark, Adward Arnold.
6. 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.
7. Laboratory Manual of Organic Chemistry, Fifth edition, R K Bansal, New Age Publishers.

Choice Based Credit System Syllabus
(2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. II (SEM IV) **Subject**:Organic Chemistry
Course: Innovative Experiments in Organic chemistry **Course Code**: CHO-662-MJE (A)
Weightage: 1=weak or low relation, 2= moderate or partial relation, 3=strong or direct relation

Program Outcomes (POs) and Course Outcomes (COs) Matrix with Weightage:

	Programme Outcomes(POs)									
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	0	0	0	0	0	0	0	2	3
CO2	3	2	0	3	1	0	0	0	2	2
CO3	2	0	0	0	0	0	0	0	3	2
CO4	0	3	3	3	0	0	0	0	0	0
CO5	3	3	0	2	3	0	0	0	0	0
CO6	0	2	2	2	2	2	0	0	0	0
CO7	0	2	2	2	1	1	0	2	1	7

Justification for the mapping

PO1 Comprehensive Knowledge and Understanding:
CO1. Students will gain proficiency in performing organic synthesis and purification techniques.
CO2. Students will acquire hands-on experience in performing various synthetic methods and techniques specific to the synthesis of heterocyclic compounds.
CO3. Students will gain knowledge about the principles and mechanisms of multicomponent reactions and performing reactions using various catalyst.
CO4. Enhancing communication skills by effectively documenting experimental procedures and results.
CO5. Develop an understanding of the mechanism of different organic reactions, laboratory procedures, purification techniques.

PO2 Practical, Professional, and Procedural Knowledge:
CO2. Students will acquire hands-on experience in performing various synthetic methods and techniques specific to the synthesis of heterocyclic compounds.
CO4. Enhancing communication skills by effectively documenting experimental procedures and results.
CO5. Develop an understanding of the mechanism of different organic reactions, laboratory procedures, purification techniques.
CO6. Developing practical skills in handling and manipulating organic compounds.
CO7. Develop practical skills in handling and synthesizing organic compounds and characterization of compound using different spectroscopic techniques.

PO3 Entrepreneurial Mindset, Innovation, and Business Understanding:
CO4. Understand the principles and mechanisms of Nitration, esterification reactions and gain practical experience through experiments.
CO5. Develop an understanding of the fundamental principles and concepts of the purification

methods for organic synthesis of analogue.
CO6. Develop practical skills in handling and manipulating organic compounds, including proper techniques for weighing, measuring, and transferring reagents, as well as safe handling and disposal of hazardous materials
CO7. Develop practical skills in handling and synthetic analogue.

PO4 Specialized Skills, Critical Thinking, and Problem-Solving:
CO2. Students will acquire hands-on experience in performing various synthetic methods and techniques specific to the synthesis of heterocyclic compounds.
CO5. Develop an understanding of the mechanism of different organic reactions, laboratory procedures, purification techniques.
CO6. Developing practical skills in handling and manipulating organic compounds.
CO7. Develop practical skills in handling and synthesizing organic compounds and characterization of compound using different spectroscopic techniques.

PO5 Research, Analytical Reasoning, and Ethical Conduct:
CO2. Students will acquire hands-on experience in performing various synthetic methods and techniques specific to the synthesis of heterocyclic compounds.
CO5. Develop an understanding of the mechanism of different organic reactions, laboratory procedures, purification techniques.
CO6. Developing practical skills in handling and manipulating organic compounds.
CO7. Develop practical skills in handling and synthesizing organic compounds and characterization of compound using different spectroscopic techniques

PO6 Communication, Collaboration, and Leadership:
CO6. Develop practical skills in handling and manipulating organic compounds
CO7. Develop practical skills in handling and synthetic analogue and synthesizing organic compounds and characterization of compound using different spectroscopic techniques
PO8 Multicultural Competence, Inclusive Spirit, and Empathy:
CO7. Develop practical skills in handling and synthetic analogue and synthesizing organic compounds and characterization of compound using different spectroscopic techniques

PO9 Value Inculcation, Environmental Awareness, and Ethical Practices:
CO7. Develop practical skills in handling and synthetic analogue and synthesizing organic compounds and characterization of compound using different spectroscopic techniques

PO10 Autonomy, Responsibility, and Accountability:
CO1. Students will gain proficiency in performing organic synthesis and purification techniques.
CO2. Students will acquire hands-on experience in performing various synthetic methods and techniques specific to the synthesis of heterocyclic compounds.
CO3. Students will gain knowledge about the principles and mechanisms of multicomponent reactions and performing reactions using various catalyst.
CO7. Develop practical skills in handling and synthetic analogue and synthesizing organic compounds and characterization of compound using different spectroscopic techniques

CBCS Syllabus as per NEP 2020 for M.Sc. II Organic chemistry (NEP Pattern)

Name of the Programme	**:** M.Sc. Chemistry
Program Code	**:** CHE
Class	**:** M.Sc. II
Semester	**:** IV
Course Type	**:** Major Elective Practical
Course Name	**:** Multiple Stage Preparations
Course Code	**:** CHO-662-MJE (B)
No. of Lectures	**:** 30
No. of Credits	**:** 02 credits

Course Objectives:

Course Objective: On completion of the course, the student will be able to:

1) Develop proficiency in performing organic synthesis and purification techniques, including the use of appropriate laboratory equipment and methods for the synthesis and purification
2) Acquire hands-on experience in performing various synthetic methods and techniques specific to the synthesis of heterocyclic compounds, such as cyclization reactions, functional group transformations.
3) Gain knowledge about the principles and mechanisms of reduction reactions
4) Understand the principles and mechanisms of formylation reactions and gain practical experience through formylation experiments,
5) Develop an understanding of the fundamental principles and concepts of the isolation of natural products, including extraction techniques, purification methods,
6) Develop practical skills in handling and manipulating organic compounds, including proper techniques for weighing, measuring, and transferring reagents, as well as safe handling and disposal of hazardous materials
7) Develop practical skills in handling and synthesizing organic compound

Course Outcomes:

Course Outcomes: On completion of the course, the student should be able to:

CO1. Students will gain proficiency in performing organic synthesis and purification techniques.

CO2. Students will acquire hands-on experience in performing various synthetic methods and techniques specific to the synthesis of heterocyclic compounds.

CO3. Students will gain knowledge about the principles and mechanisms of organic reactions and performing reactions using various reducing agents, or catalysts.

CO4. Through multiple stage synthesis, students will understand principles and mechanism of multiple stage reactions.

CO5. Enhancing communication skills by effectively documenting experimental procedures and results.

CO6. Understanding the fundamental principles and concepts of isolation of natural products.

CO7. Developing practical skills in handling and manipulating organic compounds.

Topics and Learning Points

A) Multiple stage synthesis

1. Glycine to Hippuric acid to Azalactone to 4-Benzylidene 2-phenyl oxazol-5-one.
2. Benzyl cyanide to p-nitro benzyl cyanide to p-Nitro Phenyl acetic acid
3. Aldehyde to benzoin to benzil to 5,5-dimethylhydantoin.
4. Acetanilide to p-Nitro acetanilide to p-Nitro aniline
5. D-glucose to 1,2,5,6-Di-O-isopropylidene-α-D-glucofuranose to S-methyl dithiocarbonate derivative to 3-deoxy-1,2,5,6-Di-O-isopropylidene-α-D-glucofuranose.
6. Benzyl cyanide to p-nitro benzyl cyanide to substituted benzimidazole

B) Isolation of Natural products

1) Caffeine from tea leaves (Soxhlet extraction)
2) Piperine from pepper (Soxhlet extraction)
3) Lycopene from tomatoes
4) Trimyristin from nutmeg
5) Eugenol from clove
6) Curcumin from turmeric powder
7) Casein and lactose from milk
8) β-Carotene from carrots

References:

1. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS
2. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller,
   Prentice Hall
3. Macro-scale and Micro-scale Organic Experiments, K. L. Williamson, D. C. Heath.
4. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.

5. Handbook of Organic Analysis- Qualitative and Quantitative, H. Clark, Adward Arnold.
6. 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.
7. Laboratory Manual of Organic Chemistry, Fifth edition, R K Bansal, New Age Publishers.

Choice Based Credit System Syllabus
(2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. II (SEM IV) **Subject**:Organic Chemistry

Course: Multiple stage preparations **Course Code**: CHO-662-MJE (B)

Weightage: 1=weak or low relation, 2= moderate or partial relation, 3=strong or direct relation

Program Outcomes (POs) and Course Outcomes (COs) Matrix with Weightage:

	Programme Outcomes(POs)									
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	0	1	0	0	0	0	2	3
CO2	3	2	0	3	0	0	0	0	2	2
CO3	2	2	0	2	2	0	0	0	3	2
CO4	2	3	3	3	0	0	0	0	0	0
CO5	0	0	0	0	3	3	0	0	0	0
CO6	0	0	2	0	2	0	0	0	0	0
CO7	0	3	2	2	1	0	0	2	1	7

Justification for the mapping

PO1 Comprehensive Knowledge and Understanding:

CO1. Students will gain proficiency in performing organic synthesis and purification techniques.
CO2. Students will acquire hands-on experience in performing various synthetic methods and techniques specific to the synthesis of heterocyclic compounds.
CO3. Students will gain knowledge about the principles and mechanisms of organic reactions and performing reactions using various reducing agents, or catalysts.
CO4. Through multiple stage synthesis, students will understand principles and mechanism of multiple stage reactions.

PO2 Practical, Professional, and Procedural Knowledge:

CO1. Students will gain proficiency in performing organic synthesis and purification techniques.
CO2. Students will acquire hands-on experience in performing various synthetic methods and techniques specific to the synthesis of heterocyclic compounds.
CO3. Students will gain knowledge about the principles and mechanisms of organic reactions and performing reactions using various reducing agents, or catalysts.
CO4. Through multiple stage synthesis, students will understand principles and mechanism of multiple stage reactions.
CO7. Developing practical skills in handling and manipulating organic compounds.

PO3 Entrepreneurial Mindset, Innovation, and Business Understanding:

CO4. Through multiple stage synthesis, students will understand principles and mechanism of multiple stage reactions.
CO5. Enhancing communication skills by effectively documenting experimental procedures and results.
CO6. Understanding the fundamental principles and concepts of isolation of natural products.
CO7. Developing practical skills in handling and manipulating organic compounds.

PO4 Specialized Skills, Critical Thinking, and Problem-Solving:
CO1. Students will gain proficiency in performing organic synthesis and purification techniques.
CO2. Students will acquire hands-on experience in performing various synthetic methods and techniques specific to the synthesis of heterocyclic compounds.
CO3. Students will gain knowledge about the principles and mechanisms of organic reactions and performing reactions using various reducing agents, or catalysts.
CO4. Through multiple stage synthesis, students will understand principles and mechanism of multiple stage reactions.
CO7. Developing practical skills in handling and manipulating organic compounds.

PO5 Research, Analytical Reasoning, and Ethical Conduct:
CO3. Students will gain knowledge about the principles and mechanisms of organic reactions and performing reactions using various reducing agents, or catalysts.
CO5. Enhancing communication skills by effectively documenting experimental procedures and results.
CO6. Understanding the fundamental principles and concepts of isolation of natural products.
CO7. Developing practical skills in handling and manipulating organic compounds.

PO6 Communication, Collaboration, and Leadership:
CO5. Enhancing communication skills by effectively documenting experimental procedures and results.

PO8 Multicultural Competence, Inclusive Spirit, and Empathy:
CO7. Developing practical skills in handling and manipulating organic compounds.

PO9 Value Inculcation, Environmental Awareness, and Ethical Practices:
CO7. Developing practical skills in handling and manipulating organic compounds.

PO10 Autonomy, Responsibility, and Accountability:
CO1. Students will gain proficiency in performing organic synthesis and purification techniques.
CO2. Students will acquire hands-on experience in performing various synthetic methods and techniques specific to the synthesis of heterocyclic compounds.
CO3. Students will gain knowledge about the principles and mechanisms of organic reactions and performing reactions using various reducing agents, or catalysts.
CO7. Developing practical skills in handling and manipulating organic compounds.

CBCS Syllabus as per NEP 2020 for M.Sc. II Organic chemistry (NEP Pattern)

Name of the Programme	**:** M.Sc. Chemistry
Program Code	**:** CHE
Class	**:** M.Sc. II
Semester	**:** IV
Course Type	**: Research project**
Course Name	**:** Research project
Course Code	**:** CHO-681-RP
No. of Lectures	**:** 90
No. of Credits	**:** 06 credits

Course Objectives:

Course Objective: On completion of the course, the student will be able to:

1. Learn various synthesis techniques, including reaction mechanisms, retrosynthesis, and functional group interconversions.
2. Practice designing and planning synthetic routes for the targeted molecules.
3. Develop skills in laboratory techniques and procedures for organic synthesis.
4. Gain hands-on experience in performing multi-step syntheses of complex organic molecules.
5. Learn about the different types of reagents, catalysts, and reaction conditions used in organic synthesis.

Course Outcomes:

Course Outcomes: On completion of the course, the student should be able to:

CO1. Develop skills in equipment operation and handling, including the use of laboratory techniques and procedures specific to organic synthesis.

CO2. Apply principles of organic chemistry to identify suitable reaction pathways and strategies for the synthesis of complex molecules.

CO3. Demonstrate an understanding of the properties and behavior of different organic functional groups and their impact on reaction selectivity and efficiency.

CO4. Develop proficiency in the characterization of synthesized compounds using various spectroscopic and analytical techniques.

CO5. Learn how to interpret and analyze experimental data to evaluate reaction yields, purity, and efficiency of synthesis.

CO6. Knowledge of purification techniques for organic compounds, such as column chromatography or recrystallization.

CO7. Proficiency in performing organic reactions and handling reagents safely

Topics and Learning Points

- Project shall be started at the beginning of Sem – III and will be accessed bimonthly for its progress and continuous evaluation will be made. High standard research work is expected from the project and students are encouraged to publish it in national or international journals of high repute. External and internal examiners will examine the project jointly at the time of practical examination.

Choice Based Credit System Syllabus
(NEP Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. II (SEM IV) **Subject**: Organic Chemistry
Course: Rearch Project **Code**: CHO-681-RP
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Course Outcomes (COs) and Program Outcomes (POs) Matrix with Weightage:

CO \ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	0	2	0	1	0	0	0	0	0
CO 2	2	3	2	0	0	0	0	0	0	1
CO 3	2	0	3	0	0	0	0	0	0	2
CO 4	2	0	2	0	2	0	0	3	0	0
CO 5	2	0	2	3	3	0	0	2	0	0
CO6	0	0	0	0	0	0	3	0	3	0
CO7	0	0	0	0	0	0	3	0	3	3

Justification for the mapping

PO 1 Comprehensive Knowledge and Understanding::
Outcomes: On completion of the course, the student should be able to:

CO1. Develop skills in equipment operation and handling, including the use of laboratory techniques and procedures specific to organic synthesis.
CO2. Apply principles of organic chemistry to identify suitable reaction pathways and strategies for the synthesis of complex molecules.
CO3. Demonstrate an understanding of the properties and behavior of different organic functional groups and their impact on reaction selectivity and efficiency.
CO4. Develop proficiency in the characterization of synthesized compounds using various spectroscopic and analytical techniques.
CO5. Learn how to interpret and analyze experimental data to evaluate reaction yields, purity, and efficiency of synthesis.

PO 2 Practical, Professional, and Procedural Knowledge:
CO 2: Apply principles of organic chemistry to identify suitable reaction pathways and strategies for the synthesis of complex molecules.

PO 3 Entrepreneurial Mindset, Innovation, and Business Understanding:
CO1. Develop skills in equipment operation and handling, including the use of laboratory techniques and procedures specific to organic synthesis.
CO2. Apply principles of organic chemistry to identify suitable reaction pathways and strategies for the synthesis of complex molecules.
CO3. Demonstrate an understanding of the properties and behavior of different organic functional groups and their impact on reaction selectivity and efficiency.
CO4. Develop proficiency in the characterization of synthesized compounds using various spectroscopic and analytical techniques

PO 4: Specialized Skills, Critical Thinking, and Problem-Solving:
CO5. Learn how to interpret and analyze experimental data to evaluate reaction yields, purity, and efficiency of synthesis.

PO 5: Research, Analytical Reasoning, and Ethical Conduct:
CO1. Develop skills in equipment operation and handling, including the use of laboratory techniques and procedures specific to organic synthesis.
CO4. Develop proficiency in the characterization of synthesized compounds using various spectroscopic and analytical techniques**.**

PO7 Digital Proficiency and Technological Skills:
CO6. Develop proficiency in the characterization of synthesized compounds using various spectroscopic and analytical techniques.
CO7. Learn how to interpret and analyze experimental data to evaluate reaction yields, purity, and efficiency of synthesis.

PO8 Multicultural Competence, Inclusive Spirit, and Empathy:
CO4. Develop proficiency in the characterization of synthesized compounds using various spectroscopic and analytical techniques.
CO5. Learn how to interpret and analyze experimental data to evaluate reaction yields, purity, and efficiency of synthesis.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices:
CO6. Develop proficiency in the characterization of synthesized compounds using various spectroscopic and analytical techniques.
CO7. Learn how to interpret and analyze experimental data to evaluate reaction yields, purity, and efficiency of synthesis.

PO10 Autonomy, Responsibility, and Accountability:
CO2. Apply principles of organic chemistry to identify suitable reaction pathways and strategies for the synthesis of complex molecules.
CO3. Demonstrate an understanding of the properties and behavior of different organic functional groups and their impact on reaction selectivity and efficiency.
CO7. Learn how to interpret and analyze experimental data to evaluate reaction yields, purity, and efficiency of synthesis.