M. Sc. - II Organic Chemistry
Semester – IV

PSCHO–241 Chemistry of Natural Products-I
(48 L+ 12 T) (4 Credit)

Course Objectives:

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.
7) To gain knowledge of mechanisms involved in biological chemistry

Course Outcomes:

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.

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

1. Isolation of Natural Products **(5 L)**

General methods of isolation and purification:

i) Extraction and fractionation- Maceration, enfleurage, 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, Size exclusion chromatography, HPLC Ref. 1-8

2.Methods of structure determination of Natural Products **(5 L)**

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

Physical/Spectral methods: UV, IR, NMR spectroscopy, MS spectrometry, optical polarimetry, XRD. Ref. 1-8

3. Synthesis and Structure elucidation involving stereochemistry, spectral and chemical methods **(14 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 **(20 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, emetine, cephaeline,

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

e) Derived from tryptophan- psilocin, Harman, harmine, ajmalicine, yohimbine, cinchonine, quinidine, camptothecin, lysergic acid. Ref. 9, 10,11

5. Mechanisms in biological chemistry **(4 L)**

Mechanisms involving NAD/NADP to NADH/NADPH reductive amination in nature, nature's acyl anion equivalent, shikimic acid pathway, oxidation with FAD. Ref. 1

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 2^{nd} 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
(2022 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. II (SEM IV) **Subject**: Organic Chemistry
Course: Chemistry Natural product **Course Code**: PSCHO-241
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**	**PO6**	**PO7**	**PO8**	**PO9**
CO 1	3	0	0	2	0	0	0	0	0
CO 2	0	3	0	0	0	0	0	0	0
CO 3	0	0	3	0	0	0	0	0	0
CO 4	0	0	0	3	0	2	0	0	0
CO 5	0	0	0	0	3	0	0	0	0
CO 6	0	0	0	3	0	3	0	0	3
CO 7	0	0	0	0	3	3	0	0	3

Justification for the mapping

PO 1 (Disciplinary Knowledge):

CO 1: Students will learn different methods of extraction, separation, and purification of natural products. This knowledge contributes to their disciplinary knowledge in the field of natural product chemistry, covering essential techniques.

PO 2 (Critical Thinking and Problem Solving):

CO 2: Students will be able to illustrate the structure of natural products by spectral techniques. This involves critical thinking and problem-solving skills when interpreting complex spectral data to determine natural product structures.

PO 3 (Social Competence):

CO 3: Students will expertise in the synthesis of different types of natural products, which enhances their social competence by addressing the needs of the pharmaceutical and natural product industries.

PO4 (Research-related Skills and Scientific Temper):

CO 4: Students will gain knowledge of mechanisms involved in biological chemistry, supporting research-related skills in understanding the chemical processes in biology.

PO 5 (Trans-Disciplinary Knowledge):

CO 5: Students can identify the stereochemistry of different natural products, which extends to trans-disciplinary knowledge as stereochemistry is essential in various fields, including chemistry, pharmacology, and biochemistry.

PO6: (Personal and Professional Competence)

CO 4 Student will gain knowledge of mechanisms involved in biological chemistry.

CO 6 Ability to troubleshoot common issues and challenges that may arise during extraction processes.

CO 7 Awareness of current advancements and trends in extraction technologies

PO9: (Self-directed and Life-long Learning)

CO 6 Ability to troubleshoot common issues and challenges that may arise during extraction processes.

CO 7 Awareness of current advancements and trends in extraction technologies

PSCHO-242: Advanced Synthetic Organic Chemistry
(48 L+ 12 T) (4 Credit)

Course Objectives:

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:

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

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.

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 Ref. 1-6 **(12 L)**

2. C=C bond formation reactions: Wittig, Horner-Wordworth- Emmons, McMurry Shapiro, Bamford-Stevens, Julia-Lythgoe and Peterson olefination reactions, Titanium-carbene mediated olefination: Tebbe, Petasis. Ref. 2, **(12 L)**

3. Click chemistry other important reactions: criterion for click reaction, Sharpless azides cycloadditions and other ring formation reactions: Pausan-Khand, Bergman.Corey-Chaykovsky Reaction. (**8 L**)

4. Baylis Hilman, Eschenmoser-Tanabe fragmentation Mitsunobu reaction. Ref. 8, 10 **(8 L**)
Metathesis: Grubbs catalyst, Olefin cross coupling (OCM), ring Closing (RCM) and ring

opening (ROM) metathesis, Shrock catalysts, Buchwaldcatalysts, **(4 L)**

5. Use of Boron and Silicon in organic synthesis Ref. 2, 4, 9 **(4 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
(2022Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. II (SEM IV) **Subject**:Organic Chemistry
Course: Advanced Synthetic Organic Chemistry **CourseCode**: PSCHO-242
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	PO6	PO7	PO8	PO9
CO 1	3	0	0	0	2	0	0	0	0
CO 2	0	3	0	0	0	0	0	0	0
CO 3	0	0	3	3	0	0	0	0	0
CO 4	0	0	3	3	0	2	0	0	0
CO 5	0	0	0	0	3	0	0	0	0
CO 6	0	0	0	0	0	3	0	0	0
CO 7	0	0	0	0	0	0	0	0	3

PO 1 (Disciplinary Knowledge):

CO 1: Students will learn click chemistry and related important reactions. This knowledge is essential for their disciplinary knowledge in the field of synthetic organic chemistry, covering modern reactions and methodologies.

PO 2 (Critical Thinking and Problem Solving):

CO 2: Students will get knowledge of organoboranes in detail. This involves critical thinking when understanding the properties and reactivity of organoboranes, which can be used for problem-solving in synthetic chemistry.

PO 3 (Social Competence):

CO 3: Students will be experts in various coupling reactions. This expertise is valuable in the context of social competence, as coupling reactions are widely used in the synthesis of pharmaceuticals and other important compounds.

CO 4: Students will be experts in silicon and boron reagents in organic reactions, contributing to social competence by addressing the needs of the chemical and pharmaceutical industries.

PO 4 (Research-Related Skills and Scientific Temper):

CO 3: Expertise in various coupling reactions supports research-related skills by enabling students to explore and develop novel synthetic methodologies.

CO 4: Knowledge of silicon and boron reagents in organic reactions contributes to research-related skills, as these reagents have significant applications in organic and medicinal chemistry research.

PO 5 (Trans-Disciplinary Knowledge):

CO 5: Students will get knowledge of ring-forming reactions in organic synthesis, extending to trans-disciplinary knowledge as ring-forming reactions are essential in various chemical and biochemical fields.

PO6 (Personal and Professional Competence):

CO 4 Students will be expertise in silicon and boron reagents in organic reactions

CO 6 Understanding the role of catalysts and reaction conditions in promoting C=C bond formation reactions.

PO9 (Self-directed and Life-long Learning):

CO 7 Awareness of current advancements and trends in C=C bond formation reactions, such as the development of new catalysts and greener reaction conditions.

PSCHO-243: Biomolecules, Org chemistry of drug design and chiral drugs (48 L+ 12 T) (4 Credit)

Course Objectives:

1) Student will understand : biomolecules, their properties and reactions.
2) Basic concept of Chiron approach retrosynthetic strategy and synthesis of chiral compounds.
3) Synthesis of pharmacologically active chiral drugs.
4) The biological properties ofdrugs.

Course Outcomes:

CO1. Explain Principle of drug design, Chemistry of diseases and Drug development.
CO2. Explain Peptide sequencing and applications in therapeutics.
CO3. Explain Pharmacokinetics and Pharmacodynamics.
CO4. Explain Structure and activity Relationship: QSAR And application.
CO5. Understanding the biological and industrial significance of sugars and polysaccharides.
CO6. Ability to apply the acquired knowledge in practical applications, such as carbohydrate synthesis or analysis.
CO7. Understanding Familiarity with the Killani-Fischer Synthesis and glucal formation and reactions

1. Advanced carbohydrates (8 L)

1. Monosaccharides: Introduction of sugars, structures of triose, tetrose, pentose, hexose, stereochemistry and reactions of Glucose, conformation and anomeric effects in hexoses, mutarotation, glycoside formation, acetonide formation, reduction, synthesis of D-glyceraldehyde, Killani-Fischer Synthesis, glucal formation and reactions.

2.Disaccharides: Maltose, lactose, sucrose and their hydrolysis

3.Polysaccharides: Starch, amylopectine. Ref. 1, 2, 6

2. Chiron approach (8 L)

Introduction, the concept of chiral templates and chirons wherein the carbon skeleton is the chiralprecursor.Utilisation of the basic concepts for retrosynthetic strategy and synthesis of thefollowing:

1) (S) Propanediol, **2)** (R) and (S)-Epichlorohydrin,
3)L (+)-Alanine, **4)** (-)Multistratin,
5)(-) Pentenomycin, **6)**(-) Shikimic acid Ref. 1,2,3

3. Amino acids, proteins, enzymes **(8 L)**

1 Amino acids: Introduction to α-amino acids: acidic, basic, neutral, Strecker synthesis, modified Gabriel synthesis, Erlenmeyer synthesis, reaction of amino acid with ninhydrin.

2 Proteins: Introduction to proteins, calculation of weight of polypeptide, N-terminal amino acid determination, Carboxy-terminal amino acid determination, Edman degradation of peptides, sequence determination, synthesis of peptide: Merrifield solid-phase synthesis

3 Enzymes : Enzyme classification with their role in organic synthesis, Factors enhancing rate of enzyme catalyzed reactions, working of citrate synthase enzyme. Ref. 4, 5

4. Organic Chemistry of Drug Design **(14L)**

1. Organic chemistry of drug design and drug action-quantitative structure activity relationship Hammet equation, Taft equation Hansch analysis-derivations and application in drug design, illustration with examples.

2. Lypophilicity effect measurement of lipophilicities identification of active part moleculargraphics and lead modifications. SAR.

3. Combinatorial chemistry- general aspects, split synthesis, peptide and non-peptide libraries

4. Drug receptor interactions enzyme inhibitor and drug target. Ref. 7-14

5. Chiral Drugs **(10 L)**

1 Introduction of chiral drugs, Eutomer, Distomer and eudesmic ratio.

2 Distomers -i) with no side effects ii) with undesirable side effects

3 Synthesis of some drugs: Propranolol, Diazepam, Adrenaline, Omeprazole, S-Ibuprofen,S-Metaprolol, Captopril. Ref. 15,16

References:

1. Organic Chemistry – R. P. Morrison and R. N. Boyd
2. Organic Chemistry – I. L. Finar, volume II
3. Chiron Approach in organic synthesis – S. Hanessianh
4. Chemistry of Natural Products: Amino Acids, Peptides, Proteins, and Enzymes- V. K.Ahluwalia, Lalita S. Kumar, Sanjiv Kumar
5. Organic Chemistry- John McMurry
6. Organic Chemistry- Morrison and Boyd
7. Medicinal Chemistry an Introduction-Gareth Thomas 2nd Ed. Wiley

8. An introduction to medicinal chemistry-Graham L. Patrick 5nd Ed. Oxford
9. Introduction to Medicinal Chemistry-Alex Gringauz (Wiley)
10. Foye's Medicinal Chemistry
11. Medicinal Chemistry-A. Burger
12. Medicinal Chemistry-Ashutosh Karr
13. Pharmaceutical, medicinal and natural product Chemistry-P.S. Kalsi and SangeetaJagtap
14. Chemistry of natural products- S. V. Bhat, B. A. Nagasampagi, M. Sivakumar
15. Pharmaceutical Chemistry and drug synthesis –Rot and Kleeman
16. Drug Design –E.J. Arienes

Choice Based Credit System Syllabus

(2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

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

Course: Biomolecules, Org Chemistry of drug design and chiral drugs **Course Code**: PSCHO-243

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**	**PO6**	**PO7**	**PO8**	**PO9**
CO 1	3	0	0	0	0	0	0	0	0
CO 2	3	0	0	0	0	0	0	0	0
CO 3	0	3	0	0	0	1	0	0	0
CO 4	0	0	3	0	0	2	0	0	0
CO 5	0	0	0	3	2	0	0	0	0
CO 6	0	0	0	0	0	3	0	0	3
CO 7	0	0	0	0	0	3	0	0	0

PO 1 (Disciplinary Knowledge):

CO 1: Students will explain the principle of drug design, chemistry of diseases, and drug development, which is crucial for building their disciplinary knowledge in the fields of medicinal chemistry and drug design.

CO 2: Students will explain peptide sequencing and its applications in therapeutics, contributing to their disciplinary knowledge by covering essential concepts in biochemistry and pharmaceuticals.

PO 2 (Critical Thinking and Problem Solving):

CO 1: Understanding the principle of drug design involves critical thinking and problem-solving skills to design and optimize drug molecules effectively.

CO 2: Explaining peptide sequencing and its applications requires critical thinking and problem-solving abilities to understand and apply these techniques in therapeutics.

PO 3 (Social Competence):

CO 3: Students will explain pharmacokinetics and pharmacodynamics, enhancing their social competence by addressing the needs of the pharmaceutical and healthcare industries.

PO 4 (Research-Related Skills and Scientific Temper):

CO 4: Students will explain structure-activity relationships, quantitative structure-activity relationships (QSAR), and their applications. This supports research-related skills as these concepts are fundamental for designing effective drug molecules.

PO 5 (Trans-Disciplinary Knowledge):

CO 5: Explaining structure-activity relationships and their application extends to trans-disciplinary knowledge, as these concepts are relevant not only in medicinal chemistry but also in various scientific and pharmaceutical fields.

PO6 (Personal and Professional Competence)

CO 3 Explain Pharmacokinetics and Pharmacodynamics.
CO 4 Explain Structure and activity Relationship: QSAR and application.
CO 6 Ability to apply the acquired knowledge in practical applications, such as carbohydrate synthesis or analysis.
CO7 Understanding Familiarity with the Killani-Fischer Synthesis and glucal formation and reactions

PO9 (Self-directed and Life-long Learning)

CO 6 Ability to apply the acquired knowledge in practical applications, such as carbohydrate synthesis or analysis

PSCHO 244-: Organic Stereochemistry II and Asymmetric Synthesis
(48 L+ 12 T) (4 Credit)

Course Objectives:

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

Course Outcomes:

CO1. Resolution and analysis of stereoisomer - formation of racemization and methods of resolution.

CO2. Asymmetric Synthesis, Chirol pool and Chiral auxillaries.

CO3. Transition Metal-Catalyzed Homogeneous Asymmetric Hydrogenation, Hydroxylation and Epoxidation

CO4. It involves principle and applications of asymmetric synthesis which helps to predict the chiral products in organic synthesis.

CO5. Students also came to know the use of cram rule, felkinanh rule, cram chelate model, use of chiral auxillary and chiral reagents in organic synthesis.

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

CO7. Awareness of current advancements and research in the field of geometrical isomerism and stereochemistry of olefins.

1. Organic Stereochemistry-II **(24L)**

1 Resolution of racemic modification: Resolution By mechanical separation of crystals, Resolution by formation of diastereomers, Resolving agents conditions for good resolving agents, Criteria for optical purity, Enantiomeric excess, Resolution of specific type of organic compounds, Resolution by molecular complex (Clathrate inclusion complex), Second order asymmetric transformation, Resolution by Kinetic Asymmetric Transformation

2 Geometrical Isomerism and Stereochemistry of olefins. Methods for determination of configuration (By formation of cyclic derivatives and by chemical correlation,) interconversion of geometrical isomers, Steriochemistry of hydrogenation of olefins, Steriochemistry of electrophilic addition, Steriochemistry of hydroboration. Ref 1-4

2. Principles and applications of asymmetric synthesis: (24 L)

1. Asymmetric Synthesis: Brief introduction, the chiral pool-nature's readymade chiral center, stereoselective aldol reactions, Zimmerman-Traxler T.S. model, Synthesis of propranolol and chloroamphenicol

2. Specific reactions: Evan's aldol, Mukaiyama, Masamune, Conforth model, Cieplak model Cram's rule, Felkin Anh rule, Cram's chelate model, use of chiral auxiliaries: oxazolidinone and norephedrine-derived,

3. chiral reagents and catalysts: Palladium-catalyzed asymmetric hydrosilylation of styrene, preparation and use of CBS asymmetric reducing agent, ,Sharpless asymmetric epoxidation, dihydroxylation.,

4. Enantioselective carbonyl reductions: BINAP based Noyori type. Ref. 3

References:

1. Stereochemistry of carbon compounds - E. L. Eliel

2. Stereochemistry of carbon compounds - E. L. Eliel and S. H. Wilen

3. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers 1st. Ed.

4. Stereochemistry of organic compounds –Nasipuri

Choice Based Credit System Syllabus
(2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. II (SEM IV) **Subject**:Organic Chemistry
Course:Organic Stereochemistry II and Asymmetric Synthesis**CourseCode**: PSCHO-244
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	PO6	PO7	PO8	PO9
CO 1	3	0	0	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	0	0	0
CO 3	0	3	3	3	0	1	0	0	0
CO 4	2	0	0	3	0	2	0	0	0
CO 5	3	0	0	0	3	0	0	0	0
CO 6	0	0	0	0	0	3	0	0	0
CO 7	0	0	0	0	0	3	0	0	3

Justification for the mapping

PO 1 (Disciplinary Knowledge):

CO 1: Students will learn about the resolution and analysis of stereoisomers, formation of racemization, and methods of resolution. This knowledge contributes to their disciplinary knowledge in the field of organic chemistry and stereochemistry.

CO 4 It involves principle and applications of asymmetric synthesis which helps to predict the chiral products in organic synthesis.

CO 5 Students also came to know the use of cram rule, felkinanh rule, cram chelate model, use of chiral auxillary and chiral reagents in organic synthesis.

PO 2 (Critical Thinking and Problem Solving):

CO 2: 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.

PO 3 (Social Competence):

CO 3: Students will learn about the principle and applications of asymmetric synthesis, which enhances their social competence by addressing the needs of the pharmaceutical and chemical industries, which rely on the production of chiral compounds.

PO 4 (Research-Related Skills and Scientific Temper):

CO 4: 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.

PO 5 (Trans-Disciplinary Knowledge):

CO 5: Learning the use of various principles and rules in asymmetric synthesis extends to trans-disciplinary knowledge, as these concepts are applicable not only in organic chemistry but also in various scientific and industrial fields.

PO6 (Personal and Professional Competence):

CO4 It involves principle and applications of asymmetric synthesis which helps to predict the chiral products in organic synthesis.

CO 6 Ability to identify and differentiate between different geometrical isomers of olefins.

CO 7 Awareness of current advancements and research in the field of geometrical isomerism and stereochemistry of olefins.

PO9 (Self-directed and Life-long Learning):

CO 7 Awareness of current advancements and research in the field of geometrical isomerism and stereochemistry of olefins.

PSCHO-245: Innovative experiments in organic chemistry [4 credits]

Course Objectives:

1) The students are expected to learn,
2) Handling of single step reactions.
3) Isolation of product and purification.
4) Perform physical constant of product.
5) Isolation of natural products.

Course Outcomes:

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

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

At least **twelve** experiments should be carried out on micro scale.

1)Phase transfer catalyst

a) Oxidation of benzyl alcohol with hypochlorite solution

b) Flavone from o-hydroxyacetophenone and benzoylchloride.

2) **Microwave assisted reactions**

a) o-Phenylene diamine to Benzimidazole

b) KMnO4 oxidation of toluene

3) Photochemical

a) Benzophenone to benzopinacol

b) Dimerization of cinnamic acid to truxillic acid.

4) Enzyme catalysed reactions

a) Sucrose to ethyl alcohol (Baker's yeast)

b) Asymmetric reduction of EAA by using Baker's yeast

c) Hydrolysis of cane sugar using invertase enzyme

5) Solid state reactions

a) Preparation of 1, 1-bis-2-naphthol under grinding at room temperature.

b) Solvent free aldol condensation between aldehyde and active methylene compound

c) Solvent free quantitative solid phase synthesis of azomethines from substitutedanilines and substituted benzaldehydes

d) BenzilBenzilic acid rearrangement under solvent free condition

6) Water mediated reaction

a) [4+2] cycloaddition reaction in aqueous medium at room temperature

b) Glucose to glucosazone

7) Ionic liquid Preparation and IL mediated reaction

a) Preparation of ionic liquid

b) Preparation of5-arylidene barbiturate using [Bmim]OH(Knovengel condensation)

8) Reactions using nanoparticles

a) Preparation of ZnOnanoparticle

b) Claisen Schmidt condensation using ZnOnanoparticle

9) To understand the atom economy

a) Preparation of chalcone using conventional method

b) Preparation of chalcone using green method

c) Calculation of atom economy

10) Use of green catalysts

a) Benzoin condensation using thiamine hydrochloride

b) Clay catalyzed solid state synthesis of 7-hydroxy-4-methylcoumarin

c) Bromination of trans-stilbene using sodium bromide and sodium bromated.

d) Ecofriendly nitration of phenols and its derivatives using Calcium nitrate .

11) Report on industrial visit or study tour.

Reference:

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
4. Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task Force Committee, DST
5. Practical organic chemistry by Mann and Saunders, ELBS and Longman group

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 **CourseCode**: PSCHO-245
Weightage: 1=weakorlowrelation,2=moderateorpartialrelation,3=strongordirectrelation

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

CO \ PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO6**	**PO7**	**PO8**	**PO9**
CO 1	3	0	0	0	0	0	0	0	0
CO 2	3	3	0	0	0	0	0	0	0
CO 3	3	3	3	3	0	1	0	0	0
CO 4	0	0	0	0	3	2	0	0	0
CO 5	0	0	0	0	0	0	0	0	0
CO 6	0	0	0	0	0	3	0	0	3
CO 7	0	0	0	0	0	3	0	0	3

Justification for the mapping

Program Outcome 1 (PO 1: Disciplinary Knowledge):

CO 1: Students will learn the use of phase transfer catalyst in different synthesis, which contributes to their disciplinary knowledge in the field of organic chemistry, specifically in reaction mechanisms and synthetic methodologies.

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

CO 3 Student will get the knowledge in the synthesis using green catalyst (ionic liquid, nanoparticles)

PO 2: Critical Thinking and Problem Solving):

CO 2: Students will gain expertise in microwave, photochemical, and enzyme-catalyzed reactions, requiring critical thinking and problem-solving skills when designing and optimizing innovative reaction conditions.

CO 3: Learning about the synthesis using green catalysts such as ionic liquids and nanoparticles involves critical thinking and problem-solving in the context of sustainable and environmentally friendly chemistry.

PO 3: (Social Competence):

CO 3: Students will get knowledge in the synthesis using green catalysts, which enhances their social competence by addressing the growing need for sustainable and eco-friendly practices in the chemical industry.

PO 4: Research-Related Skills and Scientific Temper):

CO 4: Due to the industrial visit during a study tour, students will gain industrial knowledge. This supports research-related skills by exposing students to real-world industrial practices and fostering a scientific temper.

PO 5: Trans-disciplinary Knowledge

CO 4. Due to the industrial visit during a study tour, students will gain industrial knowledge. This supports research-related skills by exposing students to real-world industrial practices and fostering a scientific temper.

PO6: Personal and Professional Competence

CO 3: Student will get the knowledge in the synthesis using green catalyst (ionic liquid, nanoparticles)

CO 4 : Due to industrial visit during study tour students will get industrial knowledge which will be helpful for their future opportunities.

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.

PO9: Self-directed and Life-long Learning

CO 6 Ability to apply principles of green chemistry and sustainability in the context of water-mediated reactions and ionic liquid reactions

CO 7 Awareness of current advancements and trends in the field of water-mediated reactions and ionic liquid reactions.

PSCHO-246: Project
[4 credits]

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 : 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

❖ Students must perform project work and submit the thesis in prescribed format

Choice Based Credit System Syllabus
(2022 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. II (SEM IV) **Subject**: Organic Chemistry
Course: Project **Code**: PSCHO-246
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
CO 1	3	0	2	0	1	0	0	0	0
CO 2	2	3	2	0	0	0	0	0	0
CO 3	2	0	3	0	0	0	0	0	0
CO 4	2	0	2	3	2	0	0	0	0
CO 5	2	0	2	0	3	0	0	0	0
CO6	0	0	0	0	0	0	0	0	3
CO7	0	0	0	0	0	0	0	0	3

Justification for the mapping

PO 1 (Apply Academic Knowledge):

CO1. Students will apply the theoretical and practical knowledge acquired during their academic coursework to real-world research, demonstrating the practical application of academic knowledge.

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 (Demonstrate Research Skills):

CO 2: Students will demonstrate their research skills by planning, conducting, and managing independent research, including experimental work, data collection, and analysis.

PO 3 (Critical Thinking):

CO1. Students will apply the theoretical and practical knowledge acquired during their academic coursework to real-world research, demonstrating the practical application of academic knowledge.

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 4: Contribute to Knowledge:

CO 4: Students will contribute to the existing body of knowledge in their chosen area of study by conducting original research and making meaningful findings, thereby advancing knowledge.

PO 5: Trans-disciplinary Knowledge

CO1. Students will apply the theoretical and practical knowledge acquired during their academic coursework to real-world research, demonstrating the practical application of academic knowledge

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.

PO6: Personal and Professional Competence

CO 4 Student will gain knowledge of mechanisms involved in biological chemistry.

CO 6 Ability to troubleshoot common issues and challenges that may arise during extraction processes.

CO 7 Awareness of current advancements and trends in extraction technologies

PO9: Self-directed and Life-long Learning

CO 6 Knowledge of purification techniques for organic compounds, such as column chromatography or recrystallization.

CO 7 Proficiency in performing organic reactions and handling reagents safely