गोंय विद्यापीठ
ताळगांव पठार,
गोंय - ४०३ २०६
फोन : + ९१ - ८६६९६०९०४८

(Accredited by NAAC with Grade A+)

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GU/Acad –PG/BoS -NEP/2025-26/12 Date: 09.04.2026

CIRCULAR

Ref. No.: GU/Acad –PG/BoS -NEP/2025-26/600 dated 01.12.2025

In supersession to the above referred Circular, the syllabus of Semester III & IV of the **Master of Science in Organic Chemistry** Programme approved by the Standing Committee of the Academic Council in its meeting held on 24th & 25th November 2025 is attached.

The syllabus of Semester II approved earlier by the Academic Council on 13th September 2025 and the syllabus of Semester I approved by the Academic Council on 13th & 14th June 2025 is also attached.

The Dean & Vice-Dean (Academic) of the School of Chemical Sciences and the Principals of affiliated Colleges offering the **Master of Science in Organic Chemistry** are requested to take note of the above and bring the contents of the Circular to the notice of all concerned**.**

ASHWIN V LAWANDE
Digitally signed by ASHWIN V LAWANDE
Date: 2026.04.09 16:34:51 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,
1. The Dean, School of Chemical Sciences, Goa University.
2. The Vice-Dean (Academic), School of Chemical Sciences, Goa University.
3. The Principals of affiliated Colleges offering the Master of Science in Organic Chemistry Programme.

Copy to:
1. Chairperson, BoS in Chemistry, Goa University.
2. Programme Director, M.Sc. Organic Chemistry, Goa University.
3. Controller of Examinations, Goa University.
4. Assistant Registrar Examinations (PG), Goa University.
5. Director, Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

GOA UNIVERSITY

MASTER OF SCIENCE IN ORGANIC CHEMISTRY

(Effective from the Academic Year 2025-2026)

ABOUT THE PROGRAMME
This program is designed by integrating academics with research and industrial needs. Students with this degree will be ready for careers in the pharmaceutical, chemical, healthcare, environmental, material science and related industries. Students are equipped with hands-on research experience and skills through projects and dissertations to pursue advanced degrees like Ph.D. programs and contribute to research in the field. Students with this knowledge would excel in competitive exams like NET, GATE, and others.

OBJECTIVES OF THE PROGRAMME
1. To impart fundamental knowledge about key concepts like reaction mechanisms, spectroscopy, and organic synthesis techniques. 2. To provide practical experience with advanced organic chemistry techniques and instruments. 3. To empower students with ability to analyse problems and develop solutions within the context of organic chemistry. 4. To expose students to emerging areas of science and technology such as green chemistry, polymer science, photocatalysis.

ORGANIC CHEMISTRY (CHO) PROGRAMME SPECIFIC OUTCOMES (PSO)	
PSO 1.	Demonstrate understanding of Organic Chemistry principles, apply them to scientific theories, communicate effectively with critical reasoning, and follow safe practices in handling chemical reagents, laboratory equipment, and glassware
PSO 2.	Utilize knowledge of synthetic organic chemistry, stereochemistry, pericyclic reactions, and photochemistry to synthesize organic molecules and elucidate their structures using various spectroscopic techniques
PSO 3.	Undertake synthetic methodologies towards organic compounds of commercial and scientific interest and also apply the concepts in chemistry of pharmaceuticals, natural products, polymers, synthetic intermediates, petroleum products, etc.
PSO 4.	Develop interdisciplinary approach of the subject of organic chemistry and related fields and augment the new progresses in the arena of Bioorganic Chemistry, Green Chemistry, Pharmaceutical Chemistry, Agrochemicals and relevant fields.

ANALYTICAL CHEMISTRY (CHA) PROGRAMME SPECIFIC OUTCOMES (PSO)	
PSO 1.	Understand different chemical and instrumental methods of analysis and apply appropriate methods for qualitative and quantitative analysis.
PSO 2.	Select technique for synthesis, separation, structural characterization and microscopic analysis.
PSO 3.	Interpret data pertaining to optical techniques, diffraction techniques and spectral techniques such as IR, UV, NMR, Mass, X-Ray, and others.
PSO 4.	Develop expertise through hands on training for qualitative and quantitative estimation using chemical and instrumental methods.

INORGANIC CHEMISTRY (CHI) PROGRAMME SPECIFIC OUTCOMES (PSO)	
PSO 1.	Understand the properties of elements and compounds and use concepts like molecular symmetry and tools such as spectroscopy, diffraction, thermal techniques and others, to study chemical structures and solve both theoretical and practical problems in inorganic chemistry.
PSO 2.	Apply inorganic chemistry principles to explain and model biological, environmental, and industrial processes.
PSO 3.	Analyse environmental and industrial samples, including pollutants, ores, and alloys that will prepare students for careers in science and industry.
PSO 4.	Design experiments, interpret results, and propose effective solutions to chemical challenges that will help create and develop materials for use in areas like catalysis, energy, environment, electronics, and healthcare using eco-friendly and sustainable methods.

(PHYSICAL CHEMISTRY) PROGRAMME SPECIFIC OUTCOMES (PSO)	
PSO1	Understand the fundamental principles and core concepts of Quantum chemistry, Electrochemistry, Spectroscopy, Thermodynamics & Reaction Kinetics, and the scientific theories cum models that govern them.
PSO 2	Demonstrate a proficient understanding of the principles of Group Theory and their applications in chemistry, i.e. molecular symmetry, hybridization, and electronic structure, facilitating the interpretation of spectroscopic data and chemical phenomena.
PSO 3	Understand and interpret spectroscopic data of industrially important compounds using microwave, IR, Raman, NMR, and ESR spectroscopy and elucidate their chemical structure and properties.
PSO 4	Demonstrate hands-on expertise in handling instruments like conductometer, potentiometer, pH meter, colorimeter, linear sweep and cyclic voltammeter, and bomb calorimeter, and use them to monitor the kinetic rates and thermodynamic properties of chemical reactions.
PSO 5	Design, synthesize, and characterize nano-catalysts and use them to address societal problems of wastewater pollution, using adsorption and photocatalytic technology.
PSO 6	Acquire the ability to fabricate efficient electrodes and test their efficiency in electrocatalytic and spectro-electrochemical reactions such as HER and CO_2 reduction, electrochemical energy generation and storage systems such as batteries, fuel cells, photovoltaics, and supercapacitors.
PSO 7	Determine the fundamental physical properties such as density, viscosity, specific gravity, etc., and use them to construct phase diagrams.
PSO 8	Acquire the ability to write computer programs. Ab-initio programs like Gaussian are used to calculate the molecular and spectroscopic properties of chemical compounds.

PROGRAMME STRUCTURE
Master of Science in Organic Chemistry
Effective from the Academic Year 2025-2026

Bridge Course			
Sr. No.	**Course Code**	**Title of the Course**	**Credits**
1	CHC-1000	Bridge Course in mathematical concepts for chemistry	1
2	CHC-1001	Bridge Course in organic chemistry	1

SEMESTER I				
Discipline Specific Core (DSC) Courses (16 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	CHO-5000	Fundamental Concepts in Organic Chemistry	4	400
2	CHI-5000	Concise Inorganic Chemistry	4	400
3	CHP-5000	Fundamentals of Physical Chemistry	4	400
4	CHA-5000	Analytical Chemistry Techniques	4	400
Total Credits for DSC Courses in Semester I			**16**	
Discipline Specific Elective (DSE) Course (4 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	CHO-5201	Organic Chemistry Practical - I	2	400
2	CHO-5202	Organic Chemistry Practical - II	2	400
3	CHI-5201	Inorganic Chemistry Practical - I	2	400
4	CHI-5202	Inorganic Chemistry Practical - II	2	400
5	CHP-5201	Physical Chemistry Practical - I	2	400
6	CHP-5202	Physical Chemistry Practical - II	2	400
7	CHA-5201	Analytical Chemistry Practical - I	2	400
8	CHA-5202	Analytical Chemistry Practical - II	2	400
Total Credits for DSE Courses in Semester I			**4**	
Total Credits in Semester I			**20**	

SEMESTER II				
Discipline Specific Core (DSC) Courses				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**CHO-5001**	Organic Spectroscopy	4	500
2	**CHO-5002**	Pericyclic and Organic Photochemical Reactions	4	500
3	**CHO-5003**	Synthetic Methodologies in Organic Chemistry	4	500
4	**CHO-5004**	Stereochemistry and Organic Transformations	4	500
Total Credits for DSC Courses in Semester II			**16**	
Discipline Specific Elective (DSE) Courses (4 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	**CHO-5201**	Organic Chemistry Practical - I	2	400
2	**CHO-5202**	Organic Chemistry Practical - II	2	400
3	**CHI-5201**	Inorganic Chemistry Practical - I	2	400
4	**CHI-5202**	Inorganic Chemistry Practical - II	2	400
5	**CHP-5201**	Physical Chemistry Practical - I	2	400
6	**CHP-5202**	Physical Chemistry Practical - II	2	400
7	**CHA-5201**	Analytical Chemistry Practical - I	2	400
8	**CHA-5202**	Analytical Chemistry Practical - II	2	400
Total Credits for DSE Courses in Semester II			**4**	
Total Credits in Semester II			**20**	

SEMESTER III				
Research Specific Elective (RSE) Courses				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	CHO-6000	Organic Chemistry Practical - III	4	500
2	CHO-6001	Organic Chemistry Practical - IV	4	500
3	CHO-6002	Retrosynthesis and Heterocyclic Chemistry	4	500
4	CHO-6003	Chemistry of Natural Products	4	500
5	CHO-6004	Polymer Chemistry: Concepts, Synthesis and Characterization of Polymers	4	500
6	CHO-6005	Advanced Synthetic Organic Chemistry	4	500
7	CHO-6006	Research Methodology in Organic Chemistry	4	500
Total Credits for RSE Courses in Semester III			**12**	
Discipline Specific Vocational Elective (DSVE) Courses				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	CHO-6401	Medicinal Chemistry	2T+2P	500
2	CHO-6402	Molecular Rearrangements in Organic Chemistry	2T+2P	500
3	CHO-6403	Processing of Polymers and Experiments in Polymer Chemistry	2T+2P	500
Total Credits for DSVE Courses in Semester III			**8**	

Discipline Specific Dissertation (DSD) (40 Credit Dissertation)				
Discipline Specific Dissertation (DSD)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	CHO-6501	Discipline Specific Dissertation (DSD)	40	500

SEMESTER IV				
Generic Electives (GE) Courses (20 Credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	CHO-6201	Bioorganic Chemistry	4	500
2	CHO-6202	Reagents in Organic Synthesis	4	500
3	CHO-6203	Concepts in Green Chemistry	4	500
4	CHO-6204	Applied Organic Chemistry	4	500
5	CHO-6205	Organic Chemistry Practical - V	4	500
6	CHO-6206	Organic Chemistry Practical - VI	4	500
7	CHO-6207	Organic Chemistry Practical - VII	4	500
Total Credits for GE courses in Semester IV			**20**	

Discipline Specific Dissertation (DSD)/ Internship (20 Credit Dissertation)				
Discipline Specific Dissertation (DSD)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	CHO-6502	Discipline Specific Dissertation (DSD)	20	500

Blooms Taxonomy Cognitive Levels	
Cognitive Level	**Notations**
K1	Remembering
K2	Understanding
K3	Applying
K4	Analyzing
K5	Evaluating
K6	Create

BRIDGE COURSES

Title of the Course	Bridge Course in Mathematical Concepts for Chemistry
Course Code	CHC-1000
Number of Credits	1
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	Yes
Course for advanced learners	No

<table>
<tr><td>Pre-requisites for the Course:</td><td colspan="4">NIL</td></tr>
<tr><td>Course Objectives:</td><td colspan="4">To introduce mathematical concepts to the students of MSc Part-I (Chemistry).</td></tr>
<tr><td rowspan="5">Course Outcomes:</td><td colspan="2">Students will be able to solve problems based on:</td><td colspan="2">Mapped to PSO</td></tr>
<tr><td colspan="2">CO 1. Matrices in M.Sc. Chemistry</td><td colspan="2">PSO1</td></tr>
<tr><td colspan="2">CO 2. Determinants in M.Sc. Chemistry</td><td colspan="2">PSO1</td></tr>
<tr><td colspan="2">CO 3. Differential calculus in M.Sc. Chemistry</td><td colspan="2">PSO1</td></tr>
<tr><td colspan="2">CO 4. Integral calculus in M.Sc. Chemistry</td><td colspan="2">PSO1</td></tr>
<tr><td>Content:</td><td></td><td>No of</td><td>Mapped</td><td>Cognitive</td></tr>
</table>

		hours	to CO	Level
Module 1:	1. Calculus for thermodynamics and kinetics a. Introduction to Differentiation: Notation, Differentiating various f functions, Differentiating a Sum, Product Rule, Quotient Rule, Chain Rule, Partial Differentiation: exact and inexact differentials. b. Introduction to Integration: Notation, Rules for Integrals, Integrating various functions, Definite and indefinite Integrals.	**8**	CO3, CO4	K5
Module 2:	2. Matrices, Determinants and vector algebra: a. Types of Matrices: Identity, reflection, rotation, inversion, distance matrix, Matrix Algebra, Matrix similarity transformation. b. The Determinant, Minors and Cofactors, Inverse of a Matrix, Character of a matrix, Linear algebra. c. Vectors and molecular structure.	**7**	CO1, CO2	K5
Pedagogy:	Mainly lectures and tutorials. Seminars/assignments/presentations/self-study or a combination of some of these can be used. ICT mode should be preferred. Sessions can preferably be interactive to enable peer group learning.			
Texts:	Robert G. Mortimer, Mathematics for Physical Chemistry, Elsevier, New York. 4th ed., 2013			
References/ Readings:	James R. Barrante, Applied Mathematics for Physical Chemistry, 3rd ed., Prentice-Hall, New Jersey, 1998			

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Title of the Course	Bridge Course in Organic Chemistry
Course Code	CHC-1001
Number of Credits	1
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	Yes
Course for advanced learners	No

<table>
<tr><td>Pre-requisites for the Course:</td><td colspan="4">NIL</td></tr>
<tr><td>Course Objectives:</td><td colspan="4">To understand various principles of organic chemistry.
To apply the importance of chirality in organic syntheses.
To analyse stereoselective reactions.
To interpret oxidation and reduction reactions.</td></tr>
<tr><td rowspan="5">Course Outcomes:</td><td colspan="2">Students will be able to:</td><td colspan="2">Mapped to PSO</td></tr>
<tr><td colspan="2">CO 1. understand knowledge of basic reaction mechanisms in organic transformation.</td><td colspan="2">PSO2</td></tr>
<tr><td colspan="2">CO 2. apply chirality in organic synthesis.</td><td colspan="2">PSO2</td></tr>
<tr><td colspan="2">CO 3. compare configurations/ conformations of organic molecules.</td><td colspan="2">PSO2</td></tr>
<tr><td colspan="2">CO 4. assess oxidizing and reducing reagents in organic synthesis.</td><td colspan="2">PSO2</td></tr>
<tr><td>Content:</td><td></td><td>No of</td><td>Mapped</td><td>Cognitive</td></tr>
</table>

		hours	to CO	Level
Module 1:	1. Fundamentals of organic chemistry: Electron movement with arrows, half and double headed arrows (Cleavage of bonds: homolysis and heterolysis) in organic reaction mechanisms; inductive effect, electromeric effect, resonance and hyperconjugation, steric hindrance, hydrogen bonding; reactivity of organic molecules: nucleophiles and electrophiles; reactive intermediates: carbocations, carbanions and free radicals; strength of organic acids and bases, aromaticity, benzenoids and Huckel's rule.	**8**	CO1	K1, K2
Module 2:	2. Stereochemistry: Conformations with respect to butane and cyclohexane; interconversion of wedge formula, Newmann, Sawhorse and Fischer representations; CIP Rules: R/S configurations.	**3**	CO2, CO3	K2, K3, K4
Module 3:	3. Substitution, elimination and addition reactions: Substitution and elimination reactions (SN1, SN2, E1 and E2), addition of different groups on olefins.	**2**	CO1	K2, K3
Module 4:	4. Oxidation and reduction reactions: Basic concepts, oxidizing and reducing reagents and some examples.	**2**	CO4	K3, K4
Pedagogy:	Mainly lectures and tutorials. Seminars/assignments/presentations/self-study or a combination of some of these can be used. ICT mode should be preferred. Sessions can preferably be interactive to enable peer group learning.			
Texts:	1. D. Nassipuri, Stereochemistry of Organic compounds - Principles and Application, 4th ed., Wiley Eastern Limited, New Academic Science Limited, Lucknow, India, 2013 2. E. L. Eliel, Stereochemistry of carbon compounds, Tata MacGraw Hill Publishing Company Ltd., New Delhi, 1990. 3. J. March, Advanced Organic Chemistry: Reaction, Mechanism and Structure, 4th ed., Wiley, USA, 2010. 4. J. Clayden, N. Greeves, S. Warren & Wothers, Organic Chemistry, 2nd ed., Oxford University Press, Oxford, 2012 5. I. L. Finar Stereochemistry and Chemistry of Natural products, Vol. 2, 3rd ed., , Longmans, ELBS London, 1963 6. F. A. Carey and R.J. Sundberg, Advanced Organic Chemistry, Vol. I & II. Plenum Press, New York, 1977 7. E. S. Gould et al., Mechanism and structure in Organic Chemistry, Holt, Rinehart And Winston, New York, 1965 8. F. A. Carey, Organic Chemistry, 4th ed., McGraw-Hill Higher Education, USA, 2000			

	9. S. H. Pine, Organic Chemistry, 5th ed., McGraw-Hill International Education, New York, 2010
References/ Readings:	1. V. M. Potapov, Stereochemistry, MIR Publishers, Moscow, 1979 2. J. M. Harris & C.C. Wamser, Fundamentals of Organic Reaction Mechanisms, John Wiley & Sons. Inc. New Jersey, 1976. 3. F. M. Menger, D.J. Goldsmith & L. Mendell, Organic Chemistry, A concise approach, 2nd ed., Addison Wesley Longman, Boston 1975.

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SEMESTER I

Discipline Specific Core Courses

Title of the Course	Fundamental Concepts in Organic Chemistry
Course Code	CHO-5000
Number of Credits	4
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	NIL	
Course Objectives:	• To study the various concepts based on molecular orbital theory, Aromaticity, Acids and bases. • To understand the concepts of stereochemistry and their significance in determining the structure, reactivity, and properties of organic molecules • To understand the mechanistic aspects of various type of reactions in organic synthesis and the use of selective reagents in organic transformations.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**

	CO 1. Understand the effect of delocalization of electrons & presence or absence of aromaticity in organic compounds.		PSO1, PSO 2	
	CO 2. Apply various concepts in stereochemistry to understand stereochemical outcome in a reaction.		PSO1, PSO 2	
	CO 3. Evaluate plausible mechanisms of organic reactions.		PSO1, PSO2, PSO3	
	CO 4. Apply various reagents for desired organic transformations.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Molecular orbitals and delocalized chemical bonding** a. Qualitative description of molecular orbitals of simple acyclic and monocyclic systems, frontier molecular orbitals. b. Conjugation, cross conjugation, hyperconjugation and tautomerism (types and examples). c. Aromaticity: Origin of Huckel's rule, examples of aromatic, non-aromatic and antiaromatic compounds; concept of Mobius aromaticity. **1.2 Structure & Reactivity** a. Acidity, basicity and pKa of organic compounds; Acid and base strengths; HSAB concept & Factors affecting it, effect of structure & medium on acid and base strength. b. Concept of superacids and superbases. c. Electrophilicity & nucleophilicity, examples of ambident nucleophiles & electrophiles. (Including revision of aromatic electrophilic and nucleophilic substitution)	**15**	CO1	K1, K2, K3, K4,K5
Module 2:	**2. Stereochemistry** a. Brief revision of configurational nomenclature: R & S; D & L; E & Z; cis & trans and *syn* & *anti* nomenclature. Chirality in molecules with two and more chiral centers. b. Conformational analysis of open chain compounds (Butane, 2, 3-butane	**15**	CO2, CO3	K1, K2, K3, K4, K5

	diol, 2,3-dibromobutane etc.). *Erythro* and *threo* nomenclature. c. Topicity and Prostereoisomerism: Topicity of ligands and faces-homotopic, enantiotopic and diastereotopic, ligands and faces. d. Chemoselective, regioselective and stereoselective reactions with examples. e. Conformation and reactivity of cyclohexane and substituted cyclohexanes, cyclohexene / cyclohexanone. Conformational isomerism and analysis in acyclic and simple cyclic systems substituted ethane, cyclopentane, cyclohexane. f. Optical isomerism - optical activity - molecular dissymmetry and chirality - elements of symmetry. optical isomerism in biphenyls, allenes and spirans - optical isomerism of nitrogenous compounds racemisation and resolution.			
Module 3:	**3.1 Reaction Mechanism** a. Structure, stability and reactivity of reactive intermediates (carbocations, carbanions, free radicals, carbenes, arynes and nitrenes) b. Types of mechanisms, types of reactions, thermodynamic and kinetic control. c. Methods of determining reaction mechanisms: i. Identification of products. ii. Determination of the presence of intermediates (isolation, detection, trapping and addition of suspected intermediate. iii. Isotopic labelling. iv. Stereochemical evidence. v. Kinetic evidence and Isotope effect. (at least two examples to be covered for above methods) **3.2 Selective reagents for Organic transformation** a. Oxidation of organic compounds: PCC, PDC and MnO_2, ozonolysis,	**15**	CO2, CO3	K1, K2, K3, K4, K5

	peracids. b. Reduction of organic compounds: $NaBH_4$, LAH, DIBAL reduction and reduction with borane and dialkylboranes. Clemmensen reduction, Birch reduction and Wolff-Kishner reduction			
Module 4:	**4.1 Aliphatic Nucleophilic substitution** a. Nucleophilic substitutions with respect to mechanism and various factors affecting such reactions. b. The Neighbouring Group Participation (NGP)/ Anchimeric assistance: General approach to various NGP processes; NGP by unshared/lone pair of electrons; NGP by π-electrons; NGP by aromatic rings (formation of phenonium ion intermediate); NGP by sigma bonds with special reference to bornyl and nor- bornyl system (formation of nonclassical carbocation) **4.2 Elimination reactions** a. The E2, E1 and E1cB mechanisms. Orientation of the double bond, Saytzeff and Hofmann rule. b. Effects of substrate, base, leaving group and medium on: i. Overall reactivity ii. E1 vs. E2 vs. E1cB iii. Elimination vs substitution, mechanism and orientation in pyrolytic *syn* elimination (various examples involving cyclic and acyclic substrates to be studied).	**15**	CO3. CO4	K1, K2, K3, K4, K5
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th ed. Pearson Education, New Delhi, 2010 2. D. Nassipuri, Stereochemistry of Organic Compounds: Principles and Applications, 4th ed. New Age International, New Delhi, 2020 3. J. Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, 2nd ed. Oxford University Press, Oxford, 2012			

	4. J. March, Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 4th ed. Wiley Student Edition, New York, 2003. 5. P. S. Kalsi, Stereochemistry: Conformation and Mechanism, 11th ed. New Age International, New Delhi, 2022 6. E. L. Eliel, S. H. Wilen, Stereochemistry of Organic Compounds, 1st ed. John Wiley and Sons, New York, 1994 7. H. O. House, Modern Synthetic Reactions, 2nd ed. W. A. Benjamin, New York, 1965 8. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, 5th ed. Springer India Private Limited, New Delhi, 2007
References/ Readings:	1. R. Bruckner, Advanced Organic Chemistry: Reaction Mechanisms, 1st ed. Harcourt/Academic Press, San Diego, 2002. 2. P. Y. Bruice, Organic Chemistry, 8th ed, Pearson, New Delhi, 2020

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Title of the Course	Concise Inorganic Chemistry
Course Code	CHI-5000
Number of Credits	4
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	NIL	
Course Objectives:	• To explain fundamentals of solid state, coordination, organometallic, bioinorganic, and environmental chemistry. • To describe atomic structure, molecular structure, bonding, and symmetry in molecules. • To know fundamental aspects of elements & their compounds. • To comprehend the effects of pollution, and its treatments.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. explain basic concepts in solid state, coordination, organometallic, bioinorganic, and environmental chemistry.	PSO1, PSO2
	CO 2. illustrate characteristic of inorganic compounds related to biology and environment.	PSO2, PSO3
	CO 3. analyze molecular structure and their properties.	PSO1, PSO3

	CO 4. design compounds for various applications.		PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Atomic structure, molecular structure and bonding** a. Atomic Structure: Structures of hydrogenic atoms: some principles of quantum mechanics, atomic orbitals. Many electron atoms: penetration & shielding, building up principle, classification of elements. Spectroscopic terms. Atomic properties: atomic radii, ionic radii, ionization energy, electron affinity, electronegativity, polarizability. b. Molecular Structure & bonding: Lewis structures: octet rule, resonance. VSEPR model: basic shapes, modification of the basic shapes. Valence bond theory: hydrogen molecule, homonuclear diatomic molecules, polyatomic molecules, promotion, hypervalence, hybridization. Molecular orbital theory: approximation, boding & antibonding orbitals. Homonuclear diatomic molecules & heteronuclear diatomic molecules.	**10**	CO1, CO2, CO3, CO4	K2, K3, K4, K5
Module 2:	**2. Solid state chemistry** a. Structures of solids: crystal structures, lattices and unit cells, fractional atomic coordinates and projections, close packing of spheres, holes in closed-packed structures. b. Structures of metals & alloys: polytypism, nonclosed-packed structures, polymorphism of metals, atomic radii of metals, alloys, substitutional and interstitial solid solutions, intermetallic compounds. c. Ionic solids: characteristic structures of ionic solids, binary phases, ternary phases, rationalization of structures, ionic radii, radius ratio, structure maps, energetics of ionic bonding, lattice energy and Born Haber cycle, calculation of lattice enthalpies (numerical expected).	**10**	CO1, CO2, CO3, CO4	K2, K3, K4, K5
Module 3:	**3. Molecular Symmetry and chemistry of *d*- and *f*- block elements** a. Symmetry elements and symmetry operations, equivalent symmetry elements and equivalent atoms, symmetry point groups and molecular symmetry. Systematic	**15**	CO1, CO2, CO3,	K2, K3, K4, K5

	procedure for symmetry classification of molecules. Dipole moment, optical activity and point groups. b. *d*-block elements**:** Zinc, cadmium and mercury: occurrence and properties. Transition element: IUPAC definition, occurrence and physical properties, chemical properties, metal halides, metal oxides & oxido compounds, metal sulfides and sulfide compounds, metal-metal bonded compound and clusters, magnetic properties. c. *f*-block elements: Lanthanides; occurrence and physical properties, lanthanide contraction, oxidation states, compounds of lanthanides, electronic, optical and magnetic properties. Actinoid; occurrence and properties, oxidation states, general trends, electronic spectra, thorium and uranium.		CO4	
Module 4:	**4. Coordination, Organometallic and Bioinorganic Chemistry** a. Coordination chemistry: Introduction, representative ligands, nomenclature. Constitution and geometry, isomerism & chirality in square planar and octahedral complexes, ligand chirality. Electronic properties of metal complexes: CFT applied to octahedral and tetrahedral complexes, magnetic moments, CFSE. Electronic spectroscopy: basic concepts, Orgel diagram for octahedral and tetrahedral complexes of d^1 & d^9 ions. b. Organometallic Chemistry: Introduction to organometallic chemistry, nomenclature, stability and inert gas rules (neutral atom, and donor pair electron count methods). Homoleptic metal carbonyls - synthesis, properties, and spectroscopic studies. c. Bioinorganic Chemistry: Macronutrients/micronutrients. Role of elements in biology. Metallobiomolecules, metalloporphyrins, structure of porphin and heme group, iron porphyrins (Haemoglobin and myoglobin), examples of metalloenzymes of Cu and Zn.	**15**	CO1, CO2, CO3, CO4	K2, K3, K4, K5
Module 5:	**5. Environmental Chemistry** Directive of the Supreme Court in 1993 to introduce environmental education at all levels.	**10**	CO1, CO2, CO3,	K2, K3, K4, K5

	a. Air Pollution: Classification of air pollutants and photochemical reactions in the atmosphere. Common air pollutants (e.g. CO, NOx, SO_2, hydrocarbons and particulates) i. sources ii. physiological and environmental effect iii. monitoring, iv. various remedial & technological measures to curb pollution. Air quality standards. b. Water pollution: Importance of buffer & buffer index in waste water treatments. Chemical, physical & biological characteristics of water pollution, specific & non-specific characterization of water. DO, BOD, COD, and chlorine demand, typical water treatment & waste water treatment (Municipal). Impact of plastic pollution and its effect.		CO4	

Pedagogy:

Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature toenable peer group learning.

Texts:

1. P. W. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Shriver & Atkins Inorganic Chemistry, 5th Ed., Oxford University Press, Oxford, 2009.
2. F. A. Cotton, G. Wilkinson, P. L. Gauss, Basic Inorganic Chemistry, 3rd Ed., Wiley India, New delhi, 2008 (reprint).
3. F. A. Cotton, Chemical applications of group theory, 3rd Ed., Wiley India, New Delhi, 2012 (reprint).
4. A. K. De, Environmental Chemistry, 3rd Ed., New Age Intl. Publishers, New Delhi, 2005.
5. J. E. Huheey, E. A. Kieter, R. L. Kieter, O. K. Medhi, Inorganic Chemistry: Principles of Structure & Reactivity, 4th Ed., Pearson, New Delhi, 2011.
6. J. D. Lee, Concise Inorganic Chemistry, 5th Ed., Wiley India, New Delhi, 2008.
7. H. V. Keer, Principles of Solid State Chemistry, 1st Ed., New Age Intl. Ltd, New Delhi, 1993, (reprint 2008).
8. A. R. West, Solid State Chemistry and Its Applications, 1st Ed., Wiley India, New Delhi, 1984 (reprint 2007).
9. D. K. Chakrabarty, Solid State Chemistry, 2ed Ed., New Age Intl. Publishers, New Delhi, 2010.
10. R. S. Drago, Physical Methods in Inorganic Chemistry, Affiliated East West Press Pvt. Ltd., New Delhi, 2017.
11. A. V. Salker, Environmental Chemistry: Pollution and Remedial Perspective, 1st Ed., Narosa Publication, New

	Delhi, 2017.
References/ Readings:	1. F. A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 6rd Ed., Wiley India, New Delhi, 2003 (reprint 2012). 2. G. C. Miessler, D. A. Tarr, Inorganic Chemistry, 3rd Ed., Pearson, New Delhi, 2004.

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Title of the Course	Fundamentals of Physical Chemistry
Course Code	CHP-5000
Number of Credits	04
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	NIL	
Course Objectives:	• To introduce various mathematical and computational concepts of chemistry • To gain knowledge of core concepts of physical chemistry i.e. thermodynamics, kinetics, quantum chemistry and electrochemistry • To inculcate critical thinking and apply the knowledge of physical chemistry concepts in problem solving • To understand and apply physical chemistry principles to other areas of chemistry	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. Explain various concepts in physical chemistry.	PSO1, PSO2
	CO 2. Utilise concepts of electrochemistry and their applications in renewable energy generation and storage.	PSO1, PSO6
	CO 3. Demonstrate the concepts during the lab course in physical chemistry.	PSO3, PSO4, PSO5

	CO 4. Apply fundamentals of chemical kinetics and thermodynamics for understanding reaction processes and mechanisms		PSO3, PSO7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Mathematical Preparations** a. Introduction to various functions and function plotting (exponential, logarithmic, trigonometric etc.), functions of many variables. complex numbers and complex functions. b. Linear equations, vectors, matrices and determinants. c. Basic rules of differentiation and integration, Partial differentiation, location and characterization of critical points of a function, Regression methods, curve fitting. d. Introduction to series, convergence and divergence, power series, Fourier series e. Probability (permutations and combinations).	**10**	CO1, CO3	K1, K2, K3
Module 2:	**2. Quantum Chemistry** a. Operators, Functions, Eigen value equations, Postulates. b. Schrödinger equation, application to simple system viz. free particle, particle in one dimensional, two dimensional and three-dimensional box (quantization, separation of variables, degenerate wave functions). c. Hydrogen like atoms, Schrödinger equation and its solutions, atomic orbital wave functions and interpretation. d. Hückel MO theory, Secular equations, Secular determinant, delocalization energy, charge density, π-bond order, free valence, applications to C_2H_4, C_3H_5 (radical), C_4H_6, C_4H_4, C_6H_6, C_6H_8.	**20**	CO1, CO3	K1, K2, K5
Module 3:	**3. Thermodynamics** a. Thermodynamic properties: Gas laws, real gases, Boyle temperature, critical temperature, state and path properties. Intensive and extensive properties. Exact and inexact differentials. Internal energy, enthalpy, entropy, free energy and	**12**	CO1, CO3, CO4	K1, K2, K3, K5

	their relations and significances. Maxwell relations. Thermodynamic equations of state. b. Joule-Thomson effect. Joule-Thomson coefficient for van der Waals' gas. Joule-Thomson effect and production of low temperature, adiabatic demagnetization, Joule-Thomson coefficient, inversion temperature. c. The third law of thermodynamics. Need for the third law. Apparent exceptions to third law. Application of third law. Use of thermodynamic functions in predicting direction of chemical change. Entropy and third law of thermodynamics. d. Phase equilibria: Phase rule, Discussion of two component systems forming solid solutions with and without maximum or minimum in freezing point curve. Systems with partially miscible solid phases. e. Three component systems: Graphical representation. Three component liquid systems with one pair of partially miscible liquids. Influence of temperature. Systems with two pairs and three pairs of partially miscible liquids. The role of added salts.			
Module 4:	**4. Electrochemistry** a. EMF series, cell potential: Nernst equation, Cells at equilibrium. Determination of thermodynamic functions. b. Decomposition potential and overvoltage, electronegativity, basic principles, completeness of deposition, separation with controlled potentials, constant current electrolysis, composition of electrolyte, potential buffers, physical characteristics of metal deposits. c. Electroplating and electroless plating, electrosynthesis. d. Concepts of acid-base aqueous and non-aqueous solvents, hard and soft acid-base concept and applications.	**9**	CO1, CO2, CO3	K1, K2, K3, K5, K6
Module 5:	**5. Chemical Kinetics** a. General introduction to various types of order of reaction including fractional order, molecularity of the reaction.	**9**	CO1, CO3, CO4	K1, K2, K3, K4, K5

	b. Introduction to reversible and irreversible reactions and reactions leading to equilibrium. van't Hoffs equation and analysis of Gibbs free energy of equilibrium reactions. c. Collision theory and Maxwell Boltzmann distribution of energies of colliding molecules. The concept of collisional cross section and reactive cross section and its significance. d. Comparative study of transition state and collision state theory. e. Reaction Mechanisms: elementary reactions, consecutive elementary reactions, steady state approximation, the rate determining step and pre-equilibria. f. Free radical reactions, complex reactions such as acetaldehyde decomposition and reaction between H_2 and Br_2. Homogeneous reactions and acid-base catalysis. g. Elementary enzyme reactions. Lineweaver-Burk plot and its analysis.			
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. P. W. Atkins and J. D. Paula, Physical Chemistry, 8th ed., Oxford University Press, New Delhi. 2007 2. G. M. Barrow, Physical Chemistry, 5th ed., Tata McGraw Hill, New Delhi. 2016 3. J. E. House, Principles of Chemical Kinetics, 2nd ed., Academic Press, Elsevier Burlington, USA, 2007 4. I. N. Levine, Quantum Chemistry, 7th ed., Prentice-Hall, New Delhi. 1999. 5. S. Glasstone, Text Book of Physical Chemistry, D. Van Nostrand Company, New York, Reprint 1942.			
References/ Readings:	1. B. R. Puri, L. R. Sharma and M. S. Pathania, Principles of Physical Chemistry, 49th ed., Vishal Publishing Co., New Delhi, 2020 2. A. Saggion, R. Faraldo, M. Pierno, Thermodynamics - Fundamental Principles and Applications, Springer, Switzerland, 2019 3. J. Bockris, A. K.N. Reddy, M. E. Gamboa-Aldeco, Modern Electrochemistry: Fundamentals of Electrodics, Vol. 2A, 2nd ed., Kluwer Academic Publishers, New York, 2002 4. J. Bockris, A. Reddy, Modern Electrochemistry: Ionics, Vol. 1, 2nd ed., , 2nd Ed., Kluwer Academic Publishers, New York, 2002			

	5. J. E. House, Principles of Chemical Kinetics, 2nd ed., Academic Press, Burlington MA, 2007 6. J. P. Lowe, K. Peterson, Quantum Chemistry, 3rd ed., Elsevier, Burlington MA, 2006 7. R. G. Mortimer, Physical Chemistry, 3rd ed., Elsevier, Burlington MA, 2008

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Title of the Course	Analytical Chemistry Techniques
Course Code	CHA-5000
Number of Credits	4
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	NIL	
Course Objectives:	• To learn various methods of data handling in analysis. • To explain the significance of sampling and calibration techniques. • To understand principles and applications of various types of techniques • To train the students to deduce structures based on IR, NMR, MS combined data.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO 1. explain the role of statistical tools for determination of error and organize data management for systematic interpretation.	PSO1
	CO 2. analyse the appropriate technique for thermoanalytical studies.	PSO1
	CO 3. explain basic principles and scope of different methods of separation and techniques of analysis	PSO1. PSO2

	CO 4. solve problems based on IR, NMR, MS combined spectral data.		PSO1, PSO2, PSO3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1. Analytical Objectives and Data Handling:** Importance of analytical chemistry in research and industry; statistics and data handling in analytical chemistry, standard operating procedures, good laboratory practices: quality assurance, method validation and quality control.	**5**	CO1	K1, K2, K3, K4
	1.2. Sampling and Calibration Techniques: Sampling and sample preparation, general steps in chemical analysis, calibration of glassware. Finding the best straight line - least square regression, correlation coefficient; Calibration curves, standard addition, external standards and internal standards. Chemical concentrations. Classical methods of Analysis: Gravimetry and Titrimetric methods: Principle, methodology, advantages & disadvantages over instrumental methods.	**5**	CO1	K1, K2, K3, K4
	1.3. Thermoanalytical techniques: Principle, instrumentation and applications of Thermogravimetric Analysis (TGA), Differential Thermal Analysis (DTA), and Differential Scanning Calorimetry (DSC). Numericals based on TGA.	**5**	CO1, CO2	K1, K2, K3, K4, K5
Module 2:	**2.1. Concepts in Chromatography** Principles of chromatography, classification of chromatographic techniques based on mechanism of retention, configuration, mobile and stationary phase. Efficiency of separation- plate theory (theoretical plate concept) and rate theory (van Deemter equation).	**4**	CO3	K1, K2, K3, K4, K5
	2.2. Chromatographic techniques Principles and applications of Paper chromatography, thin layer chromatography, HPTLC, Size exclusion and Ion exchange chromatography. Counter-current chromatography for isolation of natural products.	**4**	CO3	K1, K2, K3, K4, K5

	2.3. Gas and Liquid Chromatography Introduction; Instrumental Modules; Separation System; Choice of Conditions of Analysis; Sample Inlet Systems; Detectors; Practical Considerations in Qualitative and Quantitative Analysis; Coupled Systems-introduction to GCMS, GCIR, LCMS: Applicability, interpretation and numericals.	**7**	CO3	K1, K2, K3, K4, K5
Module 3:	**3.1. Spectroscopic Techniques** Interaction of Electromagnetic Radiation with Matter, Electromagnetic spectra, regions of spectrum, numericals. Ultraviolet and visible Spectroscopy: Electronic spectra and Molecular structure: types of electronic transition, Chromophore and auxochrome, absorption by isolated chromophore, conjugated chromophores, aromatic compounds, inorganic chelates. Choices and effect of solvents on UV-Vis. Quantitative Calculations: Beer-Lambert Law; Mixtures of absorbing species-laws of additivity of absorbance; calibration curve for calculation of unknown; Spectrometric errors in measurement; Deviation from Beer-Lambert Law - chemical deviation, instrumental deviation; Numericals for quantitative analysis using UV-Vis spectroscopy. Infrared Spectroscopy: Infrared absorption and molecular structures, molecular vibrations, types of vibrations, IR spectra, overtones and bands-basis of NIR absorption. Spectrometric instrumentation of UV-Vis and IR: Sources, monochromators, sample cells, detectors, instrumental wavelength and absorption calibration.	**10**	CO4	K1, K2, K3, K4, K5, K6
	3.2. Applications of UV-Vis spectroscopy for qualitative analysis Calculating λmax for Conjugated Dienes, Trienes, polyenes, α,β-unsaturated carbonyl compounds, Numericals. Applications of IR spectroscopy for qualitative analysis: Spectra interpretation, Frequencies of functional group, Spectral Databases, Identification of unknown compounds.	**5**	CO4	K3, K4, K5

Module 4:	**4.1. Raman Spectroscopy** Theory, Basic instrumentation and Structural analysis using Raman Spectra. Mass Spectrometry: Principle, Instrumentation and various fragmentation patterns.	**5**	CO4	K2, K3, K4
	4.2. Proton and Carbon NMR Spectroscopy Theory of NMR, Instrumentation, Chemical shift, factors influencing chemical shift, solvents used in NMR, spin-spin splitting, coupling constant calculation, factors influencing coupling constant.	**5**	CO4	K1, K2, K3, K4, K5, K6
	4.3. Conjoint spectrometry problems Structural elucidation of organic molecules using IR, UV, NMR and MS.	**5**	CO4	K3, K4, K5, K6
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. G. D. Christian, Analytical Chemistry, 6th Ed., Wiley, Singapore, 2004. 2. G. W. Ewing, Instrumental Methods of Chemical Analysis, 5th Ed., McGraw- Hill Int., New York, 1985. 3. W. Kemp, Organic Spectroscopy, 3rd Ed., Palgrave, New York, 1991. 4. D. A. Skoog, D. M. West, F. J. Hollar, S. R. Crouch, Fundamentals of Analytical Chemistry, 9th Ed., Cengage learning, USA, 2014. 5. R. M. Silverstein, F. X. Webster, Spectrometric identification of Organic Compounds, 6th Ed., Wiley, USA, 1998. 6. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, B. Sivasankar, Vogel's Text Book of Quantitative Chemical Analysis, 6th Ed., Pearson, New Delhi, 2009 7. F. J. Holler, D. A. Skoog, S. R. Crouch, Principles of Instrumental Analysis, 6th Ed., Thomson Books, London, 2007. 8. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Instrumental methods of Analysis, 7th Ed., HCBS Publishing, India, 2004. 9. C. N. Banwell, E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw- Hill, India, 2006. 10. P. S. Kalsi, Spectroscopy of Organic Compounds, 2nd Ed., New Age International, New Delhi, 2000.			
References/ Readings:	1. J. H. Kennedy, Analytical Chemistry: Principles, 2nd Ed., Saunders College Publishing, Philadelphia, 1990. 2. H. Gunzler, A. Williams, Handbook of Analytical Techniques, 1st Ed., Wiley, Germany, 2001. 3. E. Pretsch, P. Buhlmann, C. Affolter, Structural Determination of Organic Compounds, 2nd Ed., Springer,			

	Germany, 2005. 4. L. D. Field, S. Sternhell, J. R. Kalman; Organic Structures from Spectra, 4th Ed., Wiley, Singapore, 2007. 5. R. A. Day, A. L. Underwood, Quantitative Analysis, 6th Ed., Prentice Hall, USA, 2001. 6. B. K Sharma, Instrumental methods of chemical analysis, Goel Publishing House, Meerut, 2004. 7. K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, 6th Ed., Wiley, USA, 2009. 8. P. J. Larkin, Infrared and Raman Spectroscopy: principles and spectral interpretation, 2^{nd} Ed., Elsevier, Netherland, 2018.

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SEMESTER II

Discipline Specific Core (DSC) Courses

Title of the Course	Organic Spectroscopy
Course Code	CHO-5001
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil
Course Objectives:	• To study the various principles based on spectroscopic identification of organic compounds. • To learn the significance of spectroscopy in determining the structure and properties of molecules. • To learn interpretational aspects of spectral data pertaining to UV, IR, PMR, CMR, 2D NMR and MS. • To train students for use of combined spectroscopic techniques in structure elucidation.

Course Outcomes:	Students will be able to:		**Mapped to PSO**	
	CO 1. explain how IR spectroscopy and Mass spectrometry can be used in structure elucidation.		PSO1, PSO2, PSO3, PSO4	
	CO 2. apply various concepts in organic spectroscopy (PMR, CMR, MS and 2D NMR) and analyse/ predict PMR, CMR, MS and 2D NMR spectral data based on given structures of simple molecules.		PSO1, PSO2, PSO3, PSO4	
	CO 3. analyse certain structural features of simple organic molecules by UV-Visible spectroscopy.		PSO1, PSO2, PSO3, PSO4	
	CO 4. elucidate structures of moderately complex organic molecules based on IR, UV, NMR, MS and 2D NMR data.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Infrared Spectroscopy** IR spectroscopy in structural elucidation of organic compounds (various functional classes to be considered). Methods in IR-Spectroscopy, effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination and Fermi resonance bands. Factors influencing vibrational frequencies. Characteristic frequencies of organic molecules. Interpretation of spectra.	**6**	CO1, CO4	K1, K2, K3, K4, K5, K6
	1.2 Mass spectrometry Ionization Methods, Mass Analysis, Even and odd electron ions and fragmentation modes.	**9**	CO1, CO4	K1, K2, K3, K4, K5, K6

	Molecular Formulae Index, Molecular ion peak, base peak, metastable ions, Nitrogen rule, effect of isotopes. Prediction of molecular formulae based on relative abundance. Rules for fragmentation, McLafferty rearrangement, retro-Diels Alder fragmentation, fragmentation associated with functional groups; rearrangement and mass spectra of some chemical classes.			
Module 2:	**NMR Spectroscopy** Principles of NMR. Instrumentation. Chemical shift- (revision of the basic concepts) Coupling constants and AB, A_2B_2/A_2X_2, AMX and ABX spin systems. Interpretation of PMR spectra. Simplification of complex spectra i. Double resonance and decoupling ii. Nuclear Overhauser Effect and its applications. iii. NMR Shift reagents	**15**	CO2, CO4	K1, K2, K3, K4, K5, K6
Module 3:	**3.1 ^{13}C NMR spectroscopy** Introduction to ^{13}C NMR spectroscopy. Electronic effects, *α*-, *β*- and *γ*-substituent effects, heavy atom effect and ring size effects on the ^{13}C chemical shifts Proton coupled and proton decoupled ^{13}C spectra. Off- resonance decoupling, APT & DEPT techniques. Interpretation of ^{13}C NMR spectra.	**10**	CO2, CO4	K1, K2, K3, K4, K5, K6

	3.2 ^{19}F- NMR and ^{31}P- NMR spectroscopy Principles and applications; heteronuclear coupling of carbon to ^{19}F and ^{31}P.	**05**	CO2, CO4	K1, K2, K3, K4, K5, K6
Module 4:	**4.1 Two-dimensional NMR spectroscopy** Introduction to 2D NMR techniques such as COSY, NOESY, TOCSY, HSQC, HMQC, HMBC, and INADEQUATE and interpretation of spectra of simple organic compounds using these techniques Note: Problems involving combined use of different types of spectra, in line with course objective/ Course outcomes are to be emphasized.	**10**	CO2, CO3, CO4,	K1, K2, K3, K4, K5, K6
	4.2 UV-Visible Spectroscopy Introduction, electronic transition and energy levels, the absorption laws. Measurement of the spectrum, chromophores, effect of solvent, conjugation on UV-spectra. Study of tautomerism, steric effect and geometrical isomerism in UV spectra. Woodward-Fieser rules for conjugated dienes and carbonyl compounds. Note: Problems involving combined use of different type of spectra, in line with the course objective/ Course outcomes, are to be emphasized.	**5**	CO2, CO3, CO4,	K1, K2, K3, K4, K5, K6
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. D. L. Pavia, G. M. Lampman, G. S. Kriz, J. R. Vyvyan, Introduction to Spectroscopy, 5th Ed., Brooks Cole, Boston, Massachusetts, USA, 2015. 2. P.S. Kalsi, Spectroscopy of Organic compounds, 7th Ed., New Age International Pub. Ltd. & Wiley Eastern Ltd., New Delhi, India, 2016.			

	3. R.M. Silverstein, F. X. Webster, D. Kiemle, D. Bryce, S. Samant, V. S. Nadkarni, Spectrometric Identification of Organic compounds, An Indian Adaptation 8th Ed., John Wiley & Sons Inc., Hoboken, New Jersey, USA, 2022. 4. W. Kemp, Organic Spectroscopy, 3rd Ed., Palgrave Macmillan, London, UK, 1991.
References/ Readings:	1. D.H. Williams, I. Fleming, Spectroscopic Methods in Organic Chemistry, 6th Ed., Tata McGraw Hill Education, New Delhi, India, 2011. 2. J.R. Dyer, Applications of Absorption Spectroscopy of Organic Compounds, 1st Ed., Prentice Hall of India, New Delhi, India, 1987. 3. L.D. Field, H.L. Li, A.M. Magill, Organic Structures from 2D NMR Spectra, 1st Ed., Wiley, Chichester, UK, 2015. 4. U.N. Dash, Analytical Chemistry: Theory and Practice, 3rd Ed., Sultan Chand and Sons, New Delhi, India, 2013. 5. V.M. Parikh, Absorption Spectroscopy of Organic Molecules, Addison Wesley Longman Publishing Co., Reading, Massachusetts, USA, 1974. 6. W. Kemp, NMR in Chemistry: A Multinuclear Introduction, 1st Ed., Macmillan, London, UK, 1986.

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Title of the Course	Pericyclic and Organic Photochemical Reactions
Course Code	CHO-5002
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To introduce various concepts in pericyclic chemistry based on Hückel molecular orbital theory • To analyse pericyclic reactions using theoretical concepts. • To learn mechanistic aspects of pericyclic & photochemical reactions in organic synthesis. • To apply concepts of pericyclic & photochemical reactions in organic synthetic transformations.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. predict the pathway of a given pericyclic reaction using theoretical concepts.	PSO1, PSO2
	CO 2. apply knowledge of pericyclic and organic photochemistry to predict stereochemical outcome in reactions.	PSO1, PSO2

	CO 3. propose plausible mechanisms of pericyclic/photochemical reactions.		PSO1, PSO2, PSO3	
	CO 4. synthesise important organic compounds by using concepts of pericyclic and organic photochemistry.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Pericyclic Reactions: Theoretical Concepts** Introduction to pericyclic reactions, classification and theory of pericyclic reactions i. Frontier Molecular Orbital (FMO) theory ii. Transition state aromaticity (Mobius-Huckel theory) concept iii. Orbital correlation diagram method. Analysis of pericyclic reactions (including stereochemistry) using the above concepts with reference to i. Cycloaddition reactions ii. Electrocyclic reactions iii. Sigmatropic rearrangements under thermal and photochemical conditions (Note: Various important features to be discussed taking examples important reactions and synthetically useful reactions of each type.)	**15**	CO1, CO2, CO3	K1, K2, K3, K4, K5
Module 2:	**Pericyclic Reactions: Synthetic applications** Diels-Alder and retro Diels-Alder reaction: Regioselectivity, stereochemistry and intramolecular reactions. 1,3-dipolar additions, examples of various 1,3-dipoles and dipolarophiles. Intramolecular 1,3-dipolar additions.	**15**	CO2, CO3, CO4	K1, K2, K3, K4, K5, K6

	[3, 3]-Shifts; Claisen, Cope, aza-Cope-, oxy-Cope rearrangements and fluxional molecules, variants of Claisen Rearrangement such as Johnson-Claisen, Eschenmoser-Claisen, Carroll- Claisen and Ireland-Claisen. [2,3]-Sigmatropic rearrangements such as Sommelet-Hauser rearrangement, Sulfonium ylide rearrangement, Meisenheimer rearrangement, Wittig rearrangement, Mislow-Evans rearrangement Ene reaction: Introduction, regioselectivity, intramolecular Ene reaction, hetero-ene, retro-ene reactions.			
Module 3:	**Organic Photochemistry: introduction, alkenes, dienes and carbonyl compounds** Interaction of electromagnetic radiation with matter, laws of photochemistry; fate of excited molecule; principles of energy transfer, types of photochemical reactions. Theoretical concepts in organic photochemistry w. r. t. cycloadditions, electrocyclic reactions and sigmatropic reactions Photochemical reactions of alkenes, dienes and arenes including the following- geometrical isomerisation: *Cis-trans* isomerization; photostationary equilibrium; photochemical cycloaddition and dimerization reactions, [1,3], [1,5] and [1,7] - sigmatropic hydrogen shifts; Di-π-methane rearrangement; bicycle rearrangement Photochemical reactions of carbonyl compounds: Norrish type cleavages; photoreduction and photopinacolization; Paterno-Buchi reaction.	**15**	CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
Module 4:	**Organic Photochemistry: aromatic compounds and photooxygenation reaction and functionalization at unactivated carbon** Photochemistry of aromatic compounds: Valence isomerization; photostationary state of benzene and azabenzenes. [4+4] photodimerization of derivatives of naphthalenes. Cycloaddition reaction of benzene, naphthalene, pyrrole and indoles with alkenes and alkynes	**15**	CO2, CO3, CO4	K1, K2, K3, K4, K5, K6

	Reactions involving singlet and triplet oxygen: Photooxygenation reactions, examples of [2+2] and [4+2] cycloaddition reaction with isocyclic, heterocyclic, dienes and polynuclear aromatic compounds Applications of Organic Photochemistry: Photochemical Reactions as Key Steps in Natural Product Synthesis (any four examples such as a. synthesis of vitamin D_3, b. Luminosantonin c. Granulatimide from Didemnimide A, d. synthesis of (+)-preussin using Paternò–Büchi reaction, e. Synthesis of (+)-epiraikovenal starting from preraikovenal); example of photopolymerization. Photochemical functionalization at unactivated carbon: Barton reaction, the hypohalite reaction and the Hofmann-Loffler-Freytag reaction			
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. B. Dinda, Essentials of Pericyclic and Photochemical Reactions, 1st Ed. Springer, Switzerland, 2017. 2. J. Kopecky, Organic Photochemistry- A Visual Approach, VCH Pub., New York, 1992. 3. N. Turro, V. Ramamurthy, J.C. Scaiano, Modern Molecular Photochemistry of Organic molecules, University Science Books, USA, 2010. 4. T. L. Gilchrist, R. C. Storr, Pericyclic Reactions, Cambridge Univ. Press, Cambridge, 1972.			
References/ Readings:	1. F. A. Carrey, R. J. Sundberg, Advanced Organic Chemistry Part A and B, 3rd Ed., Pelnum Pub., New York, 1990. 2. I. Fleming, Frontier Orbitals and Organic Chemical Reactions, 1st Ed., John Wiley & Sons, England, 1991. 3. R. B. Woodward, R. Hoffmann, Conservation of Orbital Symmetry, Verlag chemie, Academic Press, New York, 1972. 4. R. E. Lehr., A. P. Marchand, Orbital Symmetry: A Problem Solving Approach, Academic Press, New York, 1972. 5. S. Kumar, V. Kumar, S.P. Singh, Pericyclic Reactions: A Mechanistic and Problem-Solving Approach, Elsevier, London, 2016.			

	6. T. Lowery, K. Richardson, Mechanisms and Theory in Organic Chemistry, 3rd Ed., Harper and Row Pub., New York, 1987.

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Title of the Course	Synthetic Methodologies in Organic Chemistry
Course Code	CHO-5003
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To study various concepts and name reactions related to carbon-carbon bond formation and selectivity. • To understand designing of organic synthesis to make molecules of interest • To plan synthesis of organic compounds based on protection-deprotection strategy • To apply concepts in asymmetric synthesis for stereoselective transformations.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO 1. explain how a carbon-carbon bond can be constructed along with the selectivity in bond formations	PSO1, PSO2, PSO3
	CO 2. apply knowledge of various name reactions in construction of simple to complex organic	PSO1, PSO2,

	molecules		PSO3, PSO4	
	CO 3. design protecting group strategies for synthesis of organic molecules		PSO1, PSO2, PSO3, PSO4	
	CO 4. analyze and evaluate various concepts in asymmetric synthesis for stereoselective transformations		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Enolate chemistry and name reactions** Keto-enol tautomerism; Introduction, acidity, basicity concepts & pKa scale, neutral nitrogen and oxygen bases. Formation of enols by proton transfer, mechanism of enolization by acids & bases, types of enols & enolates, kinetically & thermodynamically stable enols, consequences of enolization, stable enolate equivalents, preparation and reactions of enol ethers. Formation of Enolates; Introduction, preparation & properties, non-nucleophilic bases, E / Z geometry in enolate formation, kinetic vs. thermodynamic control, other methods for the generation of enolates, issue of enolate ambidoselectivity. Alkylation of enolates; diverse reactivity of carbonyl groups, alkylation involving nitriles and nitroalkanes, choice of electrophile for alkylation, lithium enolates of carbonyl compounds and alkylation, specific enol equivalents to alkylate aldehydes and ketones, alkylation of β-dicarbonyl compounds, problem of regioselectivity during ketone alkylation and the remedy provided by enones. Reaction of enolates with aldehydes and ketones; Introduction, aldol reaction including cross & intramolecular version, enolisable substrates which are not electrophilic in nature, controlling aldol reactions with specific enol equivalents, specific enol equivalents for carboxylic acids, aldehydes and ketones.	**30**	CO1, CO2	K1, K2, K3, K4, K5, K6

	Acylation at carbon; Introduction, the Claisen ester condensation (intramolecular and inter / crossed), acylation of enolates by esters, preparation of keto-esters by the Claisen reaction, directed C-acylation of enols and enolates & acylation of enamines. Conjugate addition of enolates; Introduction, thermodynamic control vs. conjugate addition, utility of various electrophilic alkenes in conjugate addition, formation of six-membered rings via conjugate addition and nitroalkanes as versatile synthons. Condensation reactions in organic synthesis: Examples pertaining to the application of following reactions in organic synthesis - Mukaiyama reaction, Perkin reaction, Dieckmann condensation, Michael addition, Robinson annulation, Sakurai reaction, Knoevenagel Reaction, Darzen, Stobbe, Benzoin, Pechmann condensation. Synthetic utility of important name reactions / methodology Mannich Reaction, Nef Reaction, Mitsunobu and Appel Reaction, Baylis Hillman reaction, Mc. Murry coupling, vicarious nucleophilic substitution, Steglich and Yamaguchi esterification. Ring closing and cross metathesis; Grubb's various generation, Grubbs-Hoveyda, Schrock catalysts.			
Module 2:	**Ylides and Protecting Groups in Organic Synthesis** Phosphorus Ylides; Nomenclature and Preparation. Wittig olefination: mechanism, stereoselectivity, cis- and trans selective reactions, Wittig reagents derived from α-halo carbonyl compounds. Modified Wittig, Horner – Wadsworth – Emmons, Stille-Gennari modification with achiral and chiral substrates, Peterson reaction, Julia Olefination. Sulfur Ylides; Sulfonium & sulfoxonium ylides in synthesis, diphenylcyclopropyl sulfonium ylides & their reactions with carbonyl compounds / Michael acceptors. Introduction and effective use of protecting groups, umpolung of reactivity. Common protective groups namely acetals & ketals, dithio acetal/ketals, trialkylsilyl, TBDMS, THP, MOM, MEM, SEM & benzyl ether, methyl ether, benzyl amine, Cbz, t-Boc, Fmoc,	**15**	CO1, CO2, CO3	K1, K2, K3, K4, K5, K6

	t-butyl ester and methods for deprotection. Some examples of multistep synthesis using protection-deprotection procedures.			
Module 3:	**Asymmetric synthesis, halogenation and esterification reactions** Chiral pool (chiron approach). Chiral auxiliary approach; Oxazolidinone & norephedrine-derived chiral auxiliary controlled Diels-Alder reaction and alkylation of chiral enolates and aldol reaction, Alkylation using SAMP and RAMP Chiral Reagents - Use of (-)-sparteine. Asymmetric catalysis; CBS catalyst, Ruthenium catalyzed chiral reductions of ketones, Catalytic asymmetric hydrogenation of alkenes, Asymmetric epoxidation (Sharpless and Jacobson), Sharpless asymmetric dihydroxylation reaction, Organocatalyzed aldol reaction (Use of proline) Formation of Carbon Halogen bonds; Substitution in saturated compounds, alcohols, carbonyl compounds, substitution at allylic and benzylic compounds, bromodecarboxylation (Hunsdiecker reaction), Finkelstein reaction, iodolactonisation. Acid and base catalyzed esterification and hydrolysis.	**15**	CO1, CO2, CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. D. Nassipuri, Stereochemistry of Organic Compounds: Principles and Applications, 4th ed., New Age International, New Delhi, India, 2020. 2. E. L. Eliel, S. H. Wilen, Stereochemistry of Organic Compounds, John Wiley and Sons, New York, USA, 1994. 3. J. Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, 2nd ed., Oxford University Press, Oxford, UK, 2012			

	4. J. March, Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 4th ed., Wiley Student Edition, New York, USA, 2003. 5. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th ed., Pearson, Noida, India, 2010. 6. W. Caruthers, I. Coldham, Modern Methods of Organic Synthesis, 4th ed., Cambridge University Press, Cambridge, UK, 2016.
References/ Readings:	1. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, 5th Ed., Springer India Private Limited, New Delhi, India, 2007. 2. H. O. House, Modern Synthetic Reactions, 2nd Ed., W. A. Benjamin, New York, USA, 1965. 3. P. S. Kalsi, Stereochemistry: Conformation and Mechanism, 11th Ed., New Age International, New Delhi, India, 2022. 4. P. Y. Bruice, Organic Chemistry, 8th ed., Pearson, Noida, India, 2020. 5. R. Bruckner, Advanced Organic Chemistry: Reaction Mechanisms, Harcourt/Academic Press, San Diego, USA, 2002.

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Title of the Course	Stereochemistry and Organic Transformations
Course Code	CHO-5004
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil
Course Objectives:	• To introduce students to the fundamental concepts of stereochemistry in complex ring systems and their conformational behaviour. • To provide a strong foundation in stereoselective strategies used in organic synthesis. • To develop critical thinking skills for understanding and applying principles of asymmetric synthesis in stereoselective reactions. • To familiarise students with the role of redox reactions in the stereoselective modification of functional groups in organic molecules.

Course Outcomes:	Students will be able to		**Mapped to PSO**	
	CO 1. explain stereochemistry in cyclic, polycyclic, fused and bridged compounds.		PSO1, PSO2	
	CO 2. apply methodologies for stereochemical transformations of cyclic and acyclic compounds.		PSO1, PSO2	
	CO 3. evaluate various concepts in asymmetric synthesis for stereoselective transformations.		PSO1, PSO2, PSO3	
	CO 4. create new synthetic plans by applying knowledge of oxidation and reduction reactions in functional group manipulations.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Stereochemistry** Stereoselectivity in cyclic compounds: Introduction, stereochemical control in six-membered rings, reactions on small rings, regiochemical control in cyclohexene epoxides, stereoselectivity in bicyclic compounds Conformations, stability and reactivity of fused ring compounds: Fused bicyclic systems with small and medium rings: *cis*- and *trans*- decalones and decalols, Octahydronaphthalins (octalins), Bicyclo [4.3.0] nonane (*cis* and *trans*-hydrindanes). Fused polycyclic systems: Perhydrophenanthrenes, Perhydroanthracenes, Perhydrocyclopentenophenanthrene system (steroids, triterpenoids and hormones). Conformations and reactivity towards esterification, hydrolysis, chromium trioxide oxidation, ionic additions of halogen (X_2) to double bonds, formation and opening of epoxide ring, epoxidation by peroxy acids. Spirocyclic compounds. Reactions with cyclic intermediates or cyclic transition states.	**15**	CO1, CO2, CO3	K1, K2, K3, K4

	Stereoisomerism due to axial chirality, planar chirality and helicity. Stereochemistry and configurational (*R/S*) nomenclature in appropriately substituted allenes, alkylidenecycloalkenes, spiranes, adamantoids, biaryls, *trans*-cycloalkenes, cyclophanes and ansa compounds. Atropisomerism in biphenyls and bridged biphenyls.			
Module 2:	**Conformation of bridged ring compounds** Bicyclo[2.2.1]heptane (norbornane): Geometry and topic relationship of hydrogens, solvolysis of bicyclo[2.2.1]heptyl systems, formation, stability and reactivity of norbornylcation, relative stability and the rate of formation of endo and exo isomers in both bornane and norbornane systems. Bicyclo[2.2.2]octane system: Geometry and topic relationship of hydrogens, solvolysis of bicyclo[2.2.2]octyl system. Other bridged ring systems: starting from bicyclo[1.1.1]pentane to bicyclo[3.3.3]undecane Bicyclo system with heteroatom: the relative stabilities of tropine, pseudotropine and benzoyl derivatives of norpseudotropine.	**15**	CO1, CO2	K1, K2, K3, K4, K5, K6
Module 3:	**Dynamic Stereochemistry** Stereoselective Reactions: Stereoselectivity- classification, terminology and principle. Selectivity in chemistry substrate and product selectivity. Stereoselective reaction of cyclic compounds: Introduction, reactions of four, five and six-membered rings. Conformational control in the formation of a six-membered rings. Diastereoselective Reactions: Diastereoselectivity- Introduction, making single diastereoisomers using stereospecific reactions of alkenes.	**15**	CO1, CO2, CO3	K1, K2, K3, K4, K5, K6

	1,2-Addition to carbonyl compounds: Predicting various addition outcomes using different predictive models such as Cram Chelate, Cornforth, Felkin-Anh. Specific reactions: allylation/crotylation by Brown, Roush, BINOL catalysed. Stereoselective reaction of acyclic alkenes: The Houk model.			
Module 4:	**Oxidation and reduction reactions** Oxidation reactions: Oxidation of organic compounds using Oppenauer oxidation, Swern oxidation, Pinnick oxidation. Other methods of oxidation such as selenium dioxide, $Pb(OAc)_4$, HIO_4, OsO_4, RuO_4, DMSO (Swern), sodium bromate/CAN & NaOCl, DDQ, hypervalent iodine reagents (IBX, Dess-Martin periodinane etc). Prevost's reagent and Woodward's Conditions; Catalytic oxidation over Pt, Photosensitised oxidation of alkenes, oxidation with molecular oxygen, aromatisation, silver-based reagents. Reduction reactions: Reduction of organic compounds using hydride-transfer reagents and related reactions: MPV reduction, Trialkylborohydrides, LAH, mixed LAH-$AlCl_3$ reagents, enzymatic reduction involving liver alcohol dehydrogenase/NADH & Bakers' yeast, catalytic hydrogenation, dissolving metal reductions including acyloin condensation, other methods of reduction: Raney Ni desulphurisation, diimide.	**15**	CO2, CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. D. Nasipuri, Stereochemistry of Organic Compounds: Principles and Applications, 2nd Ed., New Age International Pvt. Ltd., New Delhi, India, 1994. 2. E. L. Eliel, Stereochemistry of Carbon Compounds, Tata McGraw Hill, New Delhi, India, 1975. 3. I. L. Finar, Organic Chemistry, Volume 2: Stereochemistry and the Chemistry of Natural Products, 5th Ed., Longman ELBS, London, UK, 1975.			

	4. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, Oxford University Press, Oxford, UK, 2016. 5. M. B. Smith, J. March, Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 6th Ed., Wiley, New York, 2006. 6. W. Carruthers, I. Coldham, Modern Methods of Organic Synthesis, 4th Ed., Cambridge University Press, Cambridge, UK, 2016.
References/ Readings:	1. D. G. Morris, Stereochemistry, 1st Ed., Wiley-RSC, Chichester, UK, 2002. 2. E. S. Gould, Mechanism and Structure in Organic Chemistry, Holt, Rinehart and Winston, New York, USA, 1965. 3. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry: Part A and Part B, 5th Ed., Springer India Pvt. Ltd., New Delhi, India, 2007. 4. M. Nógrádi, Stereoselective Synthesis, Revised and Enlarged Ed., VCH Publishers Inc., New York, USA, 1994. 5. N. Greeves, P. Wothers, Organic Chemistry, 2nd Ed., Oxford University Press, Oxford, UK, 2002. 6. R. O. C. Norman, J. M. Coxon, Principles of Organic Synthesis, 3rd Ed., CRC Press Inc., Boca Raton, USA, 1993. 7. V. M. Potapov, A. S. Beknazarov, Stereochemistry, Central Books Ltd., Moscow, Russia, 1980.

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SEMESTER I & II

Discipline Specific Elective Courses

Title of the Course	Organic Chemistry Practical - I
Course Code	CHO-5201
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	NIL	
Course Objectives:	• To understand essential laboratory equipment, safety protocols, and fundamental experimental purification techniques • To create practical skills in basic organic synthesis through key reactions, including electrophilic substitution and other important transformations. • To understand the methods of isolation and purification of naturally occurring organic compounds.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. Understand stoichiometric requirements during organic syntheses.	PSO1, PSO3, PSO4

	CO 2. Apply safe and good laboratory practices and develop skills in handling laboratory glassware, equipment and chemical reagents.		PSO1, PSO3, PSO4	
	CO 3. Create the practical knowledge to perform experiments involving common laboratory techniques like reflux, distillation, steam distillation, vacuum distillation, aqueous extraction, thin layer chromatography (TLC).		PSO1, PSO3, PSO4	
	CO 4. Assess their expertise in isolation of some important natural products.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Introduction to laboratory equipment, apparatus and safety** a. Use of common laboratory equipment like fume hood, vacuum pump, weighing balance. b. Introduction to various types of quick fit joints and apparatus. c. Safety Techniques: i. Disposal of chemicals ii. Personal Protective Equipment (PPE) iii. First aid iv. Fire extinguishers, types of fire v. Chemical hazards and risk assessment **1.2 Laboratory Techniques-I** a. Simple distillation (any one): i. Toluene-dichloromethane mixture using water condenser. ii. Nitrobenzene and aniline using air condenser. b. Steam distillation (any one): i. Separation of o- and p- nitrophenols. ii. Naphthalene from its suspension in water. iii. Clove oil from cloves. c. Crystallisation: Concept of induction of crystallization (any one) i. Crystallisation of phthalic acid from hot water using fluted filter paper and stemless funnel.	**16**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5

	ii. Acetanilide from boiling water iii. Naphthalene from ethanol. iv. Decolorisation and crystallization of brown sugar (sucrose) with animal charcoal using gravity filtration.			
Module 2:	**2 Laboratory Techniques-II** a. Sublimation: Simple or vacuum sublimation of camphor, naphthalene, anthracene or succinic acid (any one).Vacuum distillation (any one): o-dichlorobenzene, diphenyl ether. Explanation of use of nomograph. b. Thin layer Chromatography (any one): i. Separation of o and p-nitroanilines. ii. Separation of analgesic drugs (ibuprofen/paracetamol) iii. Separation of o and p-nitrophenols	**12**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
Module 3:	**3. Organic synthesis (Any Four experiments)** a. Aliphatic electrophilic substitution: Preparation of iodoform from ethanol & acetone. b. Aromatic electrophilic substitution (any one): i. Preparation of p-bromoacetanilide. ii. Bromination of acetophenone to phenacyl bromide iii. Nitration of napththalene to 1-nitronaphthalene iv. Nitration of benzaldehyde to 3-nitrobenzaldehdye. c. Oxidation (any one) i. Benzoic acid from toluene. ii. Cyclohexanone from cyclohexanol. iii. Isoborneol to camphor using Jones reagent. d. Reduction (any one) i. Reduction of o-nitroaniline to o-phenylenediamine using Sn/HCl ii. Reduction of p-nitro benzaldehyde to p-nitrobenzyl alcohol using $NaBH_4$. e. Bromination of an alcohol using CBr_4/ triphenylphosphine. f. Grignard reaction: Triphenylmethanol from benzoic acid ester or benzophenone.	**16**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5

	g. Aldol condensation: Dibenzalacetone from benzaldehyde h. Acetoacetic ester condensation: Preparation of ethyl n-butylacetoacetate or ethyl acetoacetate.			
Module 4:	**Organic synthesis and synthetic reagents (Any two)** a. Cannizzaro reaction using 4-chlorobenzaldehyde as substrate. b. Friedel Craft's reaction i. using toluene and succinic anhydride ii. Resorcinol to resacetophenone, benzene and maleic anhydride to benzoylacrylic acid. c. Solvent free preparation of coumarin by the Knoevenagel condensation under MW irradiation. d. Preparation of oxidizing agent (any one): Pyridinium chlorochromate-silica, pyridinium chlorochromate-alumina, MnO_2. e. Preparation of cuprous chloride. **Isolation from natural sources (Any two)** i. Caffeine from tea powder. ii. Piperine from pepper. iii. Cinnamaldehyde from cinnamon iv. Lemongrass oil from lemongrass	**16**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanation revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.			
Texts:	1. A. I. Vogel, A. R. Tatchell, B. S. Furniss, A. J. Hannaford, Vogel's Textbook of Practical Organic Chemistry, 5th ed. Prentice Hall, New Delhi, 2011 2. K. Tanaka, Solvent-Free Organic Synthesis, 2nd ed, Wiley-VCH, Weinheim, 2009. 3. L. F. Fieser, K. L. Williamson, Organic Experiments, 7th ed. D. C. Heath, Lexington, 1992. 4. K. L. Williamson, K. M. Masters, Macroscale and Microscale Organic Experiments, 6th ed. Cengage Learning, Boston, 2010 5. R. K. Bansal, Laboratory Manual in Organic Chemistry, 5th ed. New Age International, New Delhi, 2016 6. O. R. Rodig, C. E. Bell Jr., A. K. Clark, Organic Chemistry Laboratory: Standard and Microscale Experiments, 3rd			

	ed. Saunders College Publishing, Philadelphia, 2009
References/ Readings:	1. S. Delvin, Green Chemistry, 1st ed. Sarup & Sons, New Delhi, 2005 2. J. Mohan, Organic Analytical Chemistry, 1st ed. Narosa Publishing House, New Delhi, 2014 3. T. Laue, A. Plagens, Named Organic Reactions, 1st ed. John Wiley and Sons, Inc., Hoboken, 2005

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Title of the Course	Organic Chemistry Practical - II
Course Code	CHO-5202
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	NIL	
Course Objectives:	• To familiarize students with essential laboratory equipment, safety protocols, and fundamental experimental purification techniques • To develop practical skills in basic organic synthesis through key reactions, including electrophilic substitution and other important transformations. • To introduce the methods of isolation and purification of naturally occurring organic compounds.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. Understand stoichiometric requirements during organic syntheses.	PSO1, PSO3, PSO4
	CO 2. Apply safe and good laboratory practices and develop skills in handling laboratory glassware, equipment and chemical reagents.	PSO1, PSO3, PSO4
	CO 3. Create the practical knowledge to perform experiments involving common	PSO1, PSO3, PSO4

	laboratory techniques like reflux, distillation, steam distillation, vacuum distillation, aqueous extraction, thin layer chromatography (TLC).			
	CO 4. Assess their expertise in isolation of some important natural products.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Introduction to laboratory equipment, apparatus and safety** a. Common Hazards in Chemical Laboratory, Risk assessment b. Accidents and Emergency procedures **1.2 Laboratory Techniques (Any Three)** a. Simple distillation: i. Simple distillation of thionyl chloride under anhydrous condition ii. Simple distillation under Nitrogen atmosphere of THF b. Fractional distillation: i. Chloroform-dichloromethane mixture using water condenser. ii. Toluene and cyclohexane using fractionating column. c. Vacuum distillation under inert atmosphere: Distillation of DMF, o-dichlorobenzene, $POCl_3$ d. Thin layer Chromatography: i. Purification and isolation of mixture of acids (o-nitrobenzoic acid and p-nitrobenzoic acid) by using Preparative TLC. ii. Purification and isolation of mixture of phenols (o and p-nitrophenols) by using Preparative TLC. iii. Purification and isolation of pharmaceutical drugs (ibuprofen tablet) using Preparative TLC.	**16**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
Module 2:	**Organic Synthesis (Any Four)** a. p-Iodonitrobenzene by Sandmeyer reaction b. Pinacol- Pinacolone rearrangement	**16**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5

	c. Hydrogenation of Maleic acid (Hydrogen balloon) d. Preparation of nitrostyrene from aldehyde e. Preparation of dibromocinnamic acid f. Reduction of nitro compounds g. Synthesis of Urea from ammonium cyanate			
Module 3:	**3. Two-step Organic Synthesis (Any Two)** a. Benzamide-Benzoic acid-Ethyl Benzoate b. Phthalic anhydride-Phthalimide-Anthranilic acid. c. Methyl benzoate- m-nitrobenzoate- m-nitrobenzoic acid d. Chlorobenzene-2, 4 -dinitrochlorobenzene-2,4 dinitrophenol e. Acetanilide-p-Bromoacetanilide-p-Bromoaniline f. Acetophenone-Oxime-Acetanilide	**16**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
Module 4:	**4.1 Solvent Free Organic synthesis (Any One)** a. Reduction using ball milling technique b. Oxidation of 2° alcohol using $KMnO_4$/Alumina by grinding technique. c. Synthesis of 1,1'-Bi-2-naphthol (BINOL) d. Hunsdiecker reaction of cinnamic acid derivatives e. Beckmann rearrangement of oxime derivatives **4.2 Separation, Isolation and Identification of Organic compounds (Any One)** Separation, purification and identification of compounds of binary mixture (Solid-Solid, Solid-liquid and Liquid-liquid) using the TLC and column chromatography, chemical tests. IR spectra to be used for functional group identification.	**12**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanation revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.			
Texts:	1. A. I. Vogel, A. R. Tatchell, B. S. Furniss, A. J. Hannaford, Vogel's Textbook of Practical Organic Chemistry, 5th ed. Prentice Hall, New Delhi, 2011 2. K. Tanaka, Solvent-Free Organic Synthesis, 2nd ed, Wiley-VCH, Weinheim, 2009			

	3. L. F. Fieser, K. L. Williamson, Organic Experiments, 7th ed. D. C. Heath, Lexington, 1992 4. K. L. Williamson, K. M. Masters, Macroscale and Microscale Organic Experiments, 6th ed. Cengage Learning, Boston, 2010 5. R. K. Bansal, Laboratory Manual in Organic Chemistry, 5th ed. New Age International, New Delhi 2016 6. O. R. Rodig, C. E. Bell Jr., A. K. Clark, Organic Chemistry Laboratory: Standard and Microscale Experiments, 3rd ed. Saunders College Publishing, Philadelphia, 2009
References/ Readings:	1. S. Delvin, Green Chemistry, 1st ed. Sarup & Sons, New Delhi, 2005. 2. J. Mohan, Organic Analytical Chemistry, 1st ed. Narosa Publishing House, New Delhi, 2014. 3. T. Laue, A. Plagens, Named Organic Reactions, 1st ed. John Wiley and Sons, Inc., Hoboken, 2005

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Title of the Course	Inorganic Chemistry Practical-I
Course Code	CHI-5201
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

<table>
<tr><td>Pre-requisites for the Course:</td><td colspan="2">NIL</td></tr>
<tr><td>Course Objectives:</td><td colspan="2">To acquire skills in synthetic inorganic chemistry.
To gain knowledge about various laboratory chemicals.
To determine metal and ligand content in a material.
To evaluate compounds molecular formula to find lattice water molecules.</td></tr>
<tr><td rowspan="4">Course Outcomes:</td><td>Students will be able</td><td>Mapped to PSO</td></tr>
<tr><td>CO 1. explain the synthesis of coordination compounds.</td><td>PSO1, PSO4</td></tr>
<tr><td>CO 2. estimate metals in the coordination compounds by classical methods of analysis.</td><td>PSO1, PSO3</td></tr>
<tr><td>CO 3. characterise commercially available ores and alloys.</td><td>PSO2, PSO3</td></tr>
</table>

	CO 4. choose the appropriate instrumental methods of analysis for characterization ofcompounds		PSO1, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Preparations of Inorganic Compounds (ANY 07)** a. Preparation of hexaamminenickel(II) chloride or hexaamminenickel(II) sulfate. b. Preparation of tris(ethylenediamine)cobalt(III) chloride. c. Preparation of potash alum from scrap aluminum. d. Preparation of potassium trioxalatoaluminate(III) trihydrate. e. Preparation of potassium hexathiocyanato-κ*N*-chromate(III) tetrahydrate. f. Preparation of potassium trioxalatochromate(III) trihydrate. g. Preparation of α- and γ-Fe_2O_3. h. Preparation of Zinc acetate or $[Zn_4O(CH_3CO_2)_6]$. (Powder X-Ray Diffraction (PXRD), Infrared (IR), UV-vis spectroscopy and magnetic studies is expected)	**28**	CO1, CO2	K2, K3, K4, K5
Module 2:	**2. Estimations / Determinations (ANY 08)** a. Estimation of nickel by complexometry or Gravimetry. b. Estimation of cobalt in $[Co(en)_3]Cl_3$ by complexometry. c. Estimation of oxalate in $K_3[Al(C_2O_4)_3]\cdot xH_2O$ or $K_3[Cr(C_2O_4)_3]\cdot xH_2O$ d. Estimation of nitrite by redox titration. e. Estimation of calcium from calcite ore. f. Iodometric determination of copper in commercial copper compounds / alloys. g. Estimation of sulfate by gravimetry. h. Estimation of zinc by complexometric titration. i. Determination of chromium in chrome alum and $K_3[Cr(C_2O_4)_3]\cdot xH_2O$ and to determine degree of hydration.	**32**	CO3, CO4	K2, K3, K4, K5

	j. Estimation of potassium from synthesized compounds. k. Colorimetric/Spectrophotometric determination of nickel or chromium or manganese.			
Pedagogy:	Students will be given pre-lab and post-lab assignments on theoretical aspects of laboratory experiments prior to the conduct of each experiment. Exams will be in the form of ISA, SEA which will involve performing given experiments and conduct of viva, systematic reporting of experiments, results and observations in laboratory report. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. J. Mendham, R.C. Denney, J.D. Barnes, M.J. K. Thomas, Vogel's Text Book of Quantitative Chemical Analysis,6th Ed., Pearson, New Delhi, 2002. 2. G. Svehla, Vogel's Text Book of Qualitative Inorganic Analysis, 7th Ed., Pearson, New Delhi, 2011. 3. G. Brauer, Handbook of Preparative Inorganic Chemistry, Vol. 1 & 2, Academic Press, New York, 1963. 4. G. Pass & H. Sutcliffe, Practical Inorganic Chemistry, Preparations, Reactions and Instrumental Methods, 2nd Ed., Chapman & Hall, New York, 1974. 5. W. L. Jolly, The Synthesis & Characterization of Inorganic Compounds, Prentice-Hall, INC, New Jersey, 1970. 6. G. Marr, B. W. Rockett, Practical Inorganic Chemistry, Van Nostrand Reinhold, London, 1972.			
References/ Readings:	1. S. De Meo, J. Chem. Ed., 80 (2003) 796-798. 2. A. J. Elias, General Chemistry Experiments, Revised Ed., University Press, Hyderabad, 2008.			

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Title of the Course	Inorganic Chemistry Practical-II
Course Code	CHI-5202
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To acquire skills in synthetic inorganic chemistry. • To gain knowledge about various laboratory chemicals. • To determine metal and ligand content in a material. • To evaluate compounds molecular formula to find lattice water molecules.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO 1. understand methodologies related to compound synthesis.	PSO1, PSO4
	CO 2. experiment with various reagents and metal salts to synthesize useful compounds.	PSO1, PSO4

	CO 3. analyse synthesized and commercially available compounds.		PSO1, PSO3	
	CO 4. interpret the chemical composition of materials using chemical methods and instrumental techniques.		PSO1, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Preparations / Estimation of Inorganic Compounds: (Any Nine)** a. Preparation of hexaamminecobalt(III) nitrate. b. Estimation of cobalt in hexaamminecobalt(III) nitrate by volumetric titration. c. Preparation of Potassium Trioxalatoferrate(III) Trihydrate d. Estimation of iron and oxalate by redox titration e. Synthesis of metal nanoparticles (Cu, Ag, Au, Ni) and determining the absorption maxima by UV-visible spectrophotometer. f. Estimation of amount of calcium in given sample by gravimetric method. g. Estimation of amount of nickel in given sample by gravimetric method. h. Estimation amount of zinc present in given sample by gravimetric method. i. Estimation of iron by colorimetric / spectrophotometry method. j. Estimation of barium by complexometric titration method. k. Estimation of manganese in presence of iron by complexometric titration method. (Powder X-Ray Diffraction (PXRD), Infrared (IR), UV-vis spectroscopy and magnetic studies is expected)	**40**	CO1, CO2, CO3	K2, K3, K4, K5
Module 2:	**2. Semi-micro qualitative analysis of cation and anion in a given inorganic mixture: (Any four mixture)** Mixture containing total six cations and/or anions.	**20**	CO3, CO4	K2, K3, K4, K5

	Cations : Pb^{2+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Ni^{2+}, Co^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, $(NH_4)^+$, K^+ **Anions:** Cl^-, Br^-, I^-, NO_2^-, NO_3^-, SO_3^{2-}, CO_3^{2-}, SO_4^{2-}, PO_4^{3-}, S^{2-}			
Pedagogy:	Students will be given pre-lab and post-lab assignments on theoretical aspects of laboratory experiments prior to the conduct of each experiment. Exams will be in the form of ISA, SEA which will involve performing given experiments and conduct of viva, systematic reporting of experiments, results and observations in laboratory report. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. J. Mendham, R.C. Denney, J.D. Barnes, M.J. K. Thomas, Vogel's Text Book of Quantitative Chemical Analysis, 6th Ed., Pearson, New Delhi, 2002. 2. G. Svehla, Vogel's Text Book of Qualitative Inorganic Analysis, 7th Ed., Pearson, New Delhi, 2011. 3. G. Brauer, Handbook of Preparative Inorganic Chemistry, Vol. 1 & 2, Academic Press, New York, 1963. 4. G. Pass & H. Sutcliffe, Practical Inorganic Chemistry, Preparations, Reactions and Instrumental Methods, 2nd Ed., Chapman & Hall, New York, 1974. 5. G. Marr, B. W. Rockett, Practical Inorganic Chemistry, Van Nostrand Reinhold, London, 1972. 6. A. J. Elias, General Chemistry Experiments, Revised Ed., University Press, Hyderabad, 2008. 7. W. L. Jolly, The Synthesis & Characterization of Inorganic Compounds, Prentice-Hall, INC, New Jersey, 1970.			
References/ Readings:	1. S. De Meo, J. Chem. Ed., 80 (2003) 796-798.			

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Title of the Course	Physical Chemistry Practical-I
Course Code	CHP-5201
Number of Credits	02
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

<table>
<tr><td>Pre-requisites for the Course:</td><td colspan="2">NIL</td></tr>
<tr><td>Course Objectives:</td><td colspan="2">To develop experimental skills on basic lab techniques in physical chemistry
To understand fundamental laboratory concepts and acquire skills for data acquisition, analysis and interpretation
To understand and follow safety protocols for handling chemicals, equipment and instruments.
To apply the practical laboratory concepts for synthesis, problem solving and critical thinking
To develop research skills through the principles of laboratory chemical research.</td></tr>
<tr><td rowspan="4">Course Outcomes:</td><td>Students will be able to:</td><td>Mapped to PSO</td></tr>
<tr><td>CO 1. Explain and perform various fundamental lab techniques and experiments.</td><td>PSO1</td></tr>
<tr><td>CO 2. Handle and operate basic laboratory equipment and use it for research work.</td><td>PSO1, PSO4</td></tr>
<tr><td>CO 3. Apply the laboratory knowledge and skills for their dissertation and research work.</td><td>PSO4, PSO5, PSO6, PSO7</td></tr>
</table>

	CO 4. Design synthesis and/or experimental methods.		PSO5, PSO6, PSO7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Non- instrumental Experiments (Any 08)** 1. To study the kinetics of hydrolysis of ethyl acetate and to determine a) Energy of activation b) Entropy of activation and c) Free energy change. 2. To determine the order of reaction between potassium persulphate and potassium iodide by graphical, fractional change and differential methods. 3. To study the three-component system such as acetic acid, chloroform and water and obtain tie line. 4. To determine the molecular weight of polyvinyl alcohol by viscosity measurement. 5. To study the electro-kinetics of rapid reaction between SO_4^{2-} and I^- in an aqueous solution. 6. To determine the buffer capacity of acidic buffer solution. 7. To determine the partial molal volume of ethanol-water mixture at a given temperature. 8. To measure energy content of various types of plastics using bomb calorimetry 9. To determine number average molecular weight of a polymer sample with an indirect titration method. 10. To investigate basic hydrolysis of ethyl acetate at four different temperatures and find out energy of activation 11. To construct a phase diagram for a two-component system by plotting cooling curves for mixtures of different compositions. 12. To find the surface tension of methyl alcohol, ethyl alcohol and n-hexane at room temperature and then calculate the atomic parachors of carbon, hydrogen and oxygen.	**32**	CO1, CO3, CO4	K2, K3, K4, K5
Module 2:	**2. Instrumental Experiments (Any 07)** 1. To determine the degree of hydrolysis of salt of weak base and strong acid using conductometer.	**28**	CO2, CO3, CO4	K3, K4, K5

	2. To determine the dissociation constants of a tribasic acid (Phosphoric acid obtain derivative plot to get equivalence point. 3. To determine formal redox potential of Fe^{2+}/Fe^{3+} and Ce^{3+}/Ce^{4+} system obtain derivative plot to get equivalence point. 4. To study spectrophotometric titration of ferrous ammonium sulphate with potassium permanganate (or dichromate vs permanganate) 5. To determine Avogadro's number by improved electroplating. 6. To determine the zeta potential of colloidal system and investigate the effect of different surfactants on stability of the colloids. 7. To verify the Kohlrausch's law for weak electrolyte by conductometry. 8. To determine the transport numbers of Cu^{2+} and SO_4^{2-} ions in $CuSO_4$ solution by Hittorf's method.			
Pedagogy:	Students will be given pre-lab and post-lab assignments on theoretical aspects of laboratory experiments prior to the conduct of each experiment. Exams will be in the form of ISA, SEA which will involve performing given experiments and conduct of viva, systematic reporting of experiments, results and observations in laboratory report. Sessions can preferably be interactive in nature to enable peer group learning.			
Texts:	1. V. D. Athawale, P. Mathur, Experimental Physical Chemistry, New Age International Publishers, 1st ed., New Delhi, 2001. 2. J.N. Gurtu, A. Gurtu, Advanced Physical Chemistry Experiments, Pragati Publications, 1st ed., Meerut, 2008. 3. A. Findlay & J. A. Kitchener, Practical Physical Chemistry, Longmans, Green and Co., 1st ed., London 1954. 4. F. Daniels & J. H. Mathews, Experimental Physical Chemistry, McGraw-Hill, 1st ed., New York, 1941.			
References/ Readings:	1. A. M. James, Practical Physical Chemistry, Prentice Hall Press, 3rd ed., 1974. 2. D.P. Shoemaker & C. W. Garland, Experiments in Physical Chemistry, McGraw-Hill, 1st ed., New York, 1962. 3. T. Kandow & F. Mafune, Progress in experimental and theoretical studies of clusters, World Scientific publishers, 1st ed., New Jersey, 2002. 4. C. Arora & S. Bhattacharya, Advanced Physical Chemistry Practical Guide, Bentham Science Publishers, 1st ed., UAE, 2022. 5. A. K. Hagi, L. Pogliani, A. C. F. Ribeiro, Practical applications of Physical Chemistry in food science and technology, 1st ed., Apple Academic Press, USA, 2021.			

Title of the Course	Physical Chemistry Practical-II
Course Code	CHP-5202
Number of Credits	02
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	NIL	
Course Objectives:	• To develop experimental skills on basic lab techniques in physical chemistry • To understand fundamental laboratory concepts and acquire skills for data acquisition, analysis and interpretation • To understand and follow safety protocols for handling chemicals, equipment and instruments. • To apply the practical laboratory concepts for synthesis, problem solving and critical thinking • To develop research skills through the principles of laboratory chemical research.	
Course Outcomes:	Students will be able to:	**Mapped to PSO**
	CO 1. Explain and perform various fundamental lab techniques and experiments.	PSO1
	CO 2. Handle and operate basic laboratory equipment and use it for research work.	PSO1, PSO4
	CO 3. Apply the laboratory knowledge and skills for their dissertation and research work.	PSO4, PSO5, PSO6, PSO7

	CO 4. Design synthesis and/or experimental methods.		PSO5, PSO6, PSO7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Non- instrumental Experiments (Any 09)** 1. To determine the radius of a molecule by viscosity measurements. 2. To determine ΔG, ΔH and ΔS of silver benzoate by solubility product method. 3. To investigate the adsorption of oxalic acid by activated charcoal and test the validity of Freundlich and Langmuir's isotherms. 4. To determine the molecular weight of a given polymer by turbidimetry. 5. To study the rate of reaction between ethyl bromoacetate and sodium thiosulphate kinetically. 6. To determine the percentage composition of a given mixture of two liquids by stalagmometer method. 7. To study the kinetics of hydrolysis of methyl acetate and to determine a) Energy of activation b) Entropy of activation and c) Free energy change. 8. To study the kinetics of the reaction between potassium persulphate ($K_2S_2O_8$), and potassium iodide (KI), and to determine a) Energy of activation b) Entropy of activation and c) Free energy change. 9. To determine the order of reaction for hydrolysis of ethyl acetate by graphical, fractional change and differential methods. 10. To determine the molecular weight of polystyrene by viscosity measurement.	**36**	CO1, CO3, CO4	K1, K2, K3, K4, K5
Module 2:	**2. Instrumental Experiments** 1. To determine the relative strength of chloroacetic acid and acetic acid by conductometry. 2. To determine the degree of hydrolysis of salt of weak base and strong acid using conductometry. 3. To determine the composition of a mixture of acetic acid, dichloroacetic acid and hydrochloric acid by conductometric titration. 4. To determine the dissociation constants of monobasic acid and dibasic acid and obtain derivative plot to get equivalence point.	**24**	CO2, CO3, CO4	K2, K3, K4, K5

	5. To determine the redox potential of Fe^{2+}/Fe^{3+} system by titrating it with standard $K_2Cr_2O_7$ solution. 6. To study the electrodeposition of metal.			
Pedagogy:	Students will be given pre-lab and post-lab assignments on theoretical aspects of laboratory experiments prior to the conduct of each experiment. Exams will be in the form of ISA, SEA which will involve performing given experiments and conduct of viva, systematic reporting of experiments, results and observations in laboratory report. Sessions can preferably be interactive in nature to enable peer group learning.			
Texts:	1. V. D. Athawale, P. Mathur, Experimental Physical Chemistry, New Age International Publishers, 1st ed., New Delhi, 2001. 2. J.N. Gurtu, A. Gurtu, Advanced Physical Chemistry Experiments, Pragati Publications, 1st ed., Meerut, 2008. 3. A. Findlay & J. A. Kitchener, Practical Physical Chemistry, Longmans, Green and Co., 1st ed., London 1954. 4. F. Daniels & J. H. Mathews, Experimental Physical Chemistry, McGraw-Hill, 1st ed., New York, 1941.			
References/ Readings:	1. A. M. James, Practical Physical Chemistry, Prentice Hall Press, USA 3rd ed., 1974. 2. D.P. Shoemaker & C. W. Garland, Experiments in Physical Chemistry, McGraw-Hill, 1st ed., New York, 1962. 3. T. Kandow & F. Mafune, Progress in experimental and theoretical studies of clusters, World Scientific publishers, 1st ed., New Jersey, 2002. 4. C. Arora & S. Bhattacharya, Advanced Physical Chemistry Practical Guide, Bentham Science Publishers, 1st ed., UAE, 2022. 5. A. K. Hagi, L. Pogliani, A. C. F. Ribeiro, Practical applications of Physical Chemistry in food science and technology, 1st ed., Apple Academic Press, USA, 2021.			

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Title of the Course	Analytical Chemistry Practical - I
Course Code	CHA-5201
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To perform various experimental techniques for analysis. • To learn data analysis, handling and interpretation of spectra. • To determine concentration of solutions. • To use techniques for qualitative and quantitative estimation.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO 1. explain data analysis, handling and interpretation of spectra.	PSO1, PSO3, PSO4
	CO 2. apply different techniques for qualitative and quantitative estimation.	PSO1, PSO4
	CO 3. determine concentration of solutions.	PSO1, PSO4
	CO 4. perform various experimental techniques for analysis.	PSO1, PSO2, PSO3, PSO4

Content:	This course consists of 8 units of experiments in various areas of Analytical chemistry. Minimum 15 experiments which include at least 01 experiment from each unit to be performed.	**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Statistics** a. Calibration of selected Volumetric apparatus b. Calibration of selected Laboratory instruments c. Preparation of standard solutions and standardisation.	4	CO1, CO3	K3, K4
Module 2:	**2. Colorimetry/ UV-Visible Spectrophotometry** a. Estimation of Iron from Pharmaceutical sample (Tablet/capsule) by thiocyanate method b. Estimation of phosphoric acid in cola drinks by molybdenum blue method. c. Estimation of KNO_3 by UV spectroscopy and $K_2Cr_2O_7$ by Visible spectroscopy d. Simultaneous determination and Verification of law of additivity of absorbances ($K_2Cr_2O_7$ and $KMnO_4$).	8	CO2, CO3	K3, K4, K5
Module 3:	**3. Flame Spectrophotometry and AES/AAS/ICP Spectroscopy** a. Estimation of Na and K in food supplements or cosmetic products. b. Estimation of Pb in water sample by AES/AAS/ICP. c. Estimation of Fe and Al in Iron ore sample by AES/AAS/ICP.	8	CO1, CO2	K4, K5
Module 4:	**4. Ion Exchange Chromatography and High-Performance Liquid Chromatography (HPLC)** a. Separation and Estimation of chloride and bromide using Ion exchange chromatography. b. Separation of anthracene and naphthalene using reverse phase chromatography c. Separation of benzaldehyde and benzyl alcohol using normal phase chromatography.	8	CO2, CO4	K4, K5
Module 5:	**5. Volumetric Titrations** a. Estimation of Ca in pharmaceutical tablet. b. Estimation of Al and Mg in antacid tablet. c. Estimation of CaO in cement.	8	CO3, CO4	K4, K5

Module 6:	**6. Solvent Extraction and spectrophotometry** a. Extraction of Cu as copper dithiocarbamate (DTC) using solvent extraction and estimation by spectrophotometry. b. Determination of Ni as dimethylglyoxime complex by spectrophotometry. c. Determination of silver as ion association complex with 1,10- phenanthroline and bromopyrogallol red.	8	CO3, CO4	K4, K5
Module 7:	**7. Demonstration and Interpretation Exercises** a. Thermal studies: TG/DTA and Isothermal weight loss studies of various hydrated solids like $CuSO_4·5H_2O$, $CaC_2O_4·H_2O$, $FeC_2O_4·2H_2O$. b. X-ray powder diffractometry: Calculation of lattice parameters from X-ray powder pattern of cubic system such as $NiMn_2O_4$, $CoFe_2O_4$. c. IR spectra of urea, benzoic acid, copper sulphate pentahydrate etc.	8	CO1, CO2	K3, K4
Module 8:	**8. Demonstration** a. Turbidimeter. b. KF instrument. c. Polarimeter. d. LCMS. e. NMR.	8	CO1, CO2	K3, K4
Pedagogy:	Prelab exercises / assignments / presentations / lab hand-out or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.			
Texts:	1. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, B. Sivasankar, Vogel's Text Book of Quantitative Chemical Analysis, 6th Ed., Pearson, New Delhi, 2009. 2. R. A. Day & A.L. Underwood, Quantitative Analysis, 6^{th} Ed., Pearson Education India, 2015. 3. J. Kenkel, Analytical Chemistry for Technicians, 3^{rd} Ed., Lewis publishers, USA, 2002. 4. R. M. Silverstein, F. X. Webster, D. Kiemle, D. Bryce, S. Samant, V. S. Nadkarni, Spectrometric Identification of Organic compounds, An Indian Adaptation, Wiley, India, 8th Ed., 2022 5. A. J. Elias, Collection of interesting chemistry experiments, University press, Hyderabad, 2002.			
References/ Readings:	1. G. D. Christian, Analytical chemistry, 5^{th} Ed., John Willey and Sons, USA, 1994 2. J. H. Kennedy, Analytical Chemistry: Principles, 2nd Ed., Saunders College Publishing, Philadelphia, 1990.			

	3. A. Kar, Pharmaceutical Drug Analysis, New Age International, India, 2005. 4. M. Asadi, Beet-Sugar Handbook, John Wiley & Sons, USA, 2006. 5. R. E. Ardrey, Liquid Chromatography - Mass Spectrometry: An Introduction, John Wiley & Sons, England, 2003.

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Title of the Course	Analytical Chemistry Practical - II
Course Code	CHA-5202
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	• To perform various experimental techniques for analysis. • To learn data analysis, handling and interpretation of spectra. • To determine concentrations of solution. • To use techniques for qualitative and quantitative estimation.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO 1. explain data analysis, handling and interpretation of spectra.	PSO1, PSO3, PSO4
	CO 2. apply different techniques for qualitative and quantitative estimation.	PSO1, PSO4
	CO 3. determine concentration of solutions.	PSO1, PSO4
	CO 4. perform various experimental techniques for analysis.	PSO1, PSO2, PSO3, PSO4

Content:	This course consists of 8 units of experiments in various areas of Analytical chemistry. Minimum 15 experiments which include at least 01 experiment from each unit to be performed.	**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. Statistics** a. Calibration of selected Volumetric apparatus b. Calibration of selected Laboratory instruments c. Preparation of standard solutions and standardisation.	4	CO1, CO3	K3, K4
Module 2:	**2. Titrimetric Analysis** a. Standardisation and estimation of Chloride using precipitation titration (Mohr's method) b. Analysis of commercial caustic soda by neutralisation method. c. Determination of sulphates by complexometric titration.	8	CO2, CO3	K3, K4, K5
Module 3:	**3. Flame Spectrophotometry and AES/AAS/ICP Spectroscopy** a. Estimation of sodium and potassium in food supplements or cosmetic products using flame photometer. b. Estimation of chromium in water sample by AES/AAS/ICP. c. Estimation of nickel, molybdenum in Hastelloy C-22 using AES/AAS/ICP.	8	CO1, CO2, CO3	K4, K5
Module 4:	**4. Natural product isolation and Ion Exchange Chromatography** a. Isolation of cinnamaldehyde from cinnamon. b. Isolation of caffeine from tea powder. c. Separation and estimation of cadmium and zinc.	8	CO2, CO4	K4, K5
Module 5:	**5. UV-Visible Spectrophotometry and High-Performance Liquid Chromatography (HPLC)** a. Estimation of KNO_3 and $K_2Cr_2O_7$ using UV- Visible spectroscopy. b. Separation of benzaldehyde and benzoic acid using reverse phase HPLC. c. Quantification of naphthalene in a sample using reverse phase HPLC.	8	CO3, CO4	K4, K5
Module 6:	**6. Solvent Extraction and spectrophotometry** a. Spectrophotometric determination of aspirin/phenacetin/caffeine in APC tablet using	8	CO3, CO4	K4, K5

	solvent extraction. b. Colorimetric determination of iron with salicylic acid. c. Determination of copper in brass sample by colorimetry.			
Module 7:	**7. Data Interpretation Exercises** a. NMR/Mass spectra. b. HPLC and GC chromatograph. c. XRD powder pattern of cubic systems. d. Thermogram of coordination compounds.	8	CO1, CO2	K3, K4
Module 8:	**8. Demonstration** a. Turbidimeter. b. KF instrument. c. Polarimeter. d. LCMS. e. NMR.	8	CO1, CO2	K3, K4
Pedagogy:	Prelab exercises / assignments / presentations / lab hand-out or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.			
Texts:	1. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, B. Sivasankar, Vogel's Text Book of Quantitative Chemical Analysis, 6th Ed., Pearson, New Delhi, 2009. 2. R. A. Day & A.L. Underwood, Quantitative Analysis, 6^{th} Ed., Pearson Education India, New-Delhi, 2015. 3. J. Kenkel, Analytical Chemistry for Technicians, 3^{rd} Ed., Lewis publishers, USA, 2002. 4. R. M. Silverstein, F. X. Webster, D. Kiemle, D. Bryce, S. Samant, V. S. Nadkarni, Spectrometric Identification of Organic compounds, An Indian Adaptation, Wiley, India, 8th Ed., 2022 5. A. J. Elias, Collection of interesting chemistry experiments, University press, Hyderabad, 2002. 6. A. Kar, Pharmaceutical Drug Analysis, New Age International, India, 2005.			
References/ Readings:	1. G. D. Christian, Analytical chemistry, 5^{th} Ed., John Willey and Sons, USA, 1994. 2. J. H. Kennedy, Analytical Chemistry: Principles, 2nd Ed., Saunders College Publishing, Philadelphia, 1990. 3. M. Asadi, Beet-Sugar Handbook, John Wiley & Sons, USA, 2006. 4. R. E. Ardrey, Liquid Chromatography - Mass Spectrometry: An Introduction, John Wiley & Sons, England, 2003.			

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SEMESTER III

Research Specific Elective (RSE) Courses

Title of the Course	Organic Chemistry Practical – III
Course Code	CHO-6000
Number of Credits	4
Theory/Practical	Practical
Level	500
Effective from AY	2026-27
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses
Course Objectives:	1. To perform ternary organic mixture separations, crystallization and purification. 2. To gain hands-on experience of laboratory techniques required for organic syntheses. 3. To monitor progress of reaction using chromatographic techniques 4. To separate mixture of products by chromatographic techniques

<table>
<tr><td rowspan="5">Course Outcomes:</td><td colspan="2">Students will be able to</td><td colspan="2">Mapped to PSO</td></tr>
<tr><td colspan="2">CO1. perform separation of organic components based on chemical nature, solubility and boiling points.</td><td colspan="2">PSO1, PSO2, PSO3, PO4</td></tr>
<tr><td colspan="2">CO2. evaluate stoichiometric requirements in organic syntheses</td><td colspan="2">PSO1, PSO2, PSO3</td></tr>
<tr><td colspan="2">CO3. monitor progress of reaction by chromatographic techniques</td><td colspan="2">PSO1, PSO2, PSO3</td></tr>
<tr><td colspan="2">CO4. analyse and purify reaction products by column chromatography</td><td colspan="2">PSO1, PSO2, PSO3</td></tr>
<tr><td>Content:</td><td></td><td>No of hours</td><td>Mapped to CO</td><td>Cognitive Level</td></tr>
<tr><td>Module 1:</td><td>Organic ternary mixture separation (minimum ten mixtures)
Three component mixture separation based upon differences in the physical and the chemical properties of the components. Elemental and functional group analysis, determination of physical constant and derivative preparation-its recrystallization and melting point/boiling point of any one compound.</td><td>60</td><td>CO1</td><td>K1, K2, K3, K4</td></tr>
<tr><td>Module 2:</td><td>Organic synthesis (Any six)
i. Benzil to hydrobenzoin ($NaBH_4$ reduction)
ii. Diels - Alder reaction of anthracene and maleic anhydride using microwave irradiation/Lewis acid
iii. Friedel- Crafts acylation of anisole
iv. 2-methyl benzimidazole from o-phenylene diamine
v. Dicoumarol from coumarin derivative
vi. Halogenation using NBS: preparation of 9 bromoanthracene (or benzylic bromides)</td><td>36</td><td>CO2</td><td>K1, K2, K3, K4</td></tr>
</table>

Approved by: Standing Committee of the Academic Council on 24th & 25th November 2025

	vii. Resolution of racemic phenyl ethylamine using tartaric acid viii. Ferric chloride oxidative coupling of 2-naphthol to [1,1' binaphthalene]-2,2'-diol] ix. Dimedone from mesityl oxide (Dieckmann condensation) x. 2-phenylindole from acetophenone (Fisher indole synthesis)			
Module 3:	**Polarimetry and column chromatography** *(Any 4 experiments from 'sections a and b')* i. Enantiomeric excess by Polarimetry Determination of optical rotation and enantiomeric excess of enantiomers and unknown mixtures of: a. Amino acids b. Drugs c. Carbohydrates d. Other readily available chiral compounds ii. Purification of organic compounds by column chromatography a. Mixture of ortho and para nitrophenols b. Mixture of benzil and benzoin c. Mixture of acetophenone and benzylideneacetophenone d. Mixture of benzophenone and benzanilide e. Other natural product mixtures	**24**	CO3, CO4	K1, K2, K3, K4
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanations revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.			
Texts:	1. A. I. Vogel, A. R. Tatchell, B. S. Furniss, A. J. Hannaford, Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Prentice Hall, Harlow, England, 2011. 2. N. K. Vishnoi, Advanced Practical Organic Chemistry, South Asia Books, New Delhi, India, 2010.			
References/	1. D. P. Shoemaker, Experimental Physical Chemistry, 5th Ed., McGraw-Hill, New York, USA, 1989.			

Readings:	2. G. J. Shugar, J. T. Ballinger, Chemical Technicians Ready Reference Handbook, 3rd Ed., McGraw-Hill Inc., New York, USA, 1996. 3. J. Mohan, Organic Analytical Chemistry, 1st Ed., Narosa Publishing House, New Delhi, India, 2014. 4. K. L. Williamson, K. M. Masters, Macroscale and Microscale Organic Experiments, 6th Ed., Cengage Learning, Boston, MA, USA, 2010. 5. K. Tanaka, Solvent-Free Organic Synthesis, 2nd Ed., Wiley-VCH, Weinheim, Germany, 2009. 6. L. F. Fieser, K. L. Williamson, Organic Experiments, 7th Ed., D. C. Heath, Lexington, MA, USA, 1992. 7. O. R. Rodig, C. E. Bell Jr., A. K. Clark, Organic Chemistry Laboratory: Standard and Microscale Experiments, 3rd Ed., Saunders College Publishing, Fort Worth, TX, USA, 2009. 8. R. K. Bansal, Laboratory Manual in Organic Chemistry, 5th Ed., New Age International, New Delhi, India, 2016. 9. S. Delvin, Green Chemistry, Sarup & Sons, New Delhi, India, 2005.
Web Resources:	https://www.orgsyn.org/

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Title of the Course	Organic Chemistry Practical – IV
Course Code	CHO-6001
Number of Credits	4
Theory/Practical	Practical
Level	500
Effective from AY	2026-27
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses
Course Objectives:	1. To provide students with a strong foundation in the theoretical principles of separation, purification, and synthesis of organic compounds. 2. To develop hands-on laboratory skills required for carrying out organic reactions, including separation, purification, identification, and synthesis. 3. To equip students with the ability to design and set up experiments for organic synthesis in a systematic and safe manner. 4. To foster the mechanistic aspects of organic reactions to enhance analytical thinking and problem-solving ability.

Approved by: Standing Committee of the Academic Council on 24th & 25th November 2025

Course Outcomes:	Students will be able to		**Mapped to PSO**	
	CO1. explain the theoretical aspects behind separation, purification and synthesis of organic compounds.		PSO1, POS2, PSO3	
	CO2. demonstrate the experimental skills for separation, purification, identification and synthesis of organic compounds		PSO1, POS2, PSO3	
	CO3. apply the mechanistic aspects of organic reactions and develop problem solving ability		PSO1, PSO2, PSO3	
	CO4. design experiments and experimental setups for performing the organic reactions.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Organic ternary mixture separation and identification** *(*Minimum ten mixtures) Three component mixture separation based upon differences in the physical and the chemical properties of the components. Elemental and functional group analysis and determination of physical constants of the individual compounds. Derivative preparation, its recrystallization and melting point of each component and characterization of each component and its derivative by melting point comparison.	**60**	CO1, CO2, CO3, CO4	K1, K2, K3, K4
Module 2:	**Organic synthesis** (Minimum 10 experiments) i. 1,2,3,4 - tetrahydrocarbazole from cyclohexanone (Fischer indole synthesis). ii. Resolution of racemic phenylethylamine using tartaric acid. iii. Trans - Stilbene by Wittig reaction. iv. Enamine alkylation: 2-methyl cyclohexanone pyrrolidine enamine with CH_3I. v. Chlorobenzylidene rhodanine (Perkin reaction). vi. Diels-Alder reaction of anthracene and maleic anhydride using conventional heating	**60**	CO2, CO3, CO4	K1, K2, K3, K4, K5

	vii. Oxidation of a primary / secondary alcohol to carbonyl compound by polymer supported chromic acid (Amberlyst A-26, chromate form). viii. Phenytoin from benzil and urea. ix. Isoborneol from camphor ($NaBH_4$ reduction) x. 3 -Methyl -2-phenyl-2-butanoI from 2-bromopropane and acetophenone xi. Triphenyl carbinol from benzophenone or ethyl benzoate (Grignard reaction). xii. Methyl orange/red from sulphanilic acid/anthranilic acid (diazotization). xiii. Reduction of Nitrobenzene to aniline by Sn/HCl. xiv. LAH reduction of Anthranilic acid. xv. Norborneol to norcarnphor using chromium trioxide/sulfuric acid xvi. Benzhydrol from benzaldehyde (Grignard reaction) xvii. Diethyl 4-butyl malonate by malonic ester condensation			
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanations revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.			
Texts:	1. A. I. Vogel, A. R. Tatchell, B. S. Furniss, A. J. Hannaford, Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Prentice Hall, Harlow, England, 2011. 2. N. K. Vishnoi, Advanced Practical Organic Chemistry, South Asia Books, New Delhi, India, 2010.			
References/ Readings:	1. D. P. Shoemaker, Experimental Physical Chemistry, 5th Ed., McGraw-Hill, New York, USA, 1989. 2. G. J. Shugar, J. T. Ballinger, Chemical Technicians Ready Reference Handbook, 3rd Ed., McGraw-Hill Inc., New York, USA, 1996. 3. J. Mohan, Organic Analytical Chemistry, 1st Ed., Narosa Publishing House, New Delhi, India, 2014. 4. K. L. Williamson, K. M. Masters, Macroscale and Microscale Organic Experiments, 6th Ed., Cengage Learning, Boston, MA, USA, 2010. 5. K. Tanaka, Solvent-Free Organic Synthesis, 2nd Ed., Wiley-VCH, Weinheim, Germany, 2009. 6. L. F. Fieser, K. L. Williamson, Organic Experiments, 7th Ed., D. C. Heath, Lexington, MA, USA, 1992.			

	7. O. R. Rodig, C. E. Bell Jr., A. K. Clark, Organic Chemistry Laboratory: Standard and Microscale Experiments, 3rd Ed., Saunders College Publishing, Fort Worth, TX, USA, 2009. 8. R. K. Bansal, Laboratory Manual in Organic Chemistry, 5th Ed., New Age International, New Delhi, India, 2016. 9. S. Delvin, Green Chemistry, Sarup & Sons, New Delhi, India, 2005.
Web Resources:	https://www.orgsyn.org/

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Title of the Course	Retrosynthesis and Heterocyclic Chemistry
Course Code	CHO-6002
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-27
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses	
Course Objectives:	1. To learn various strategies involved in retrosynthesis of organic molecules 2. To design retrosynthetic strategies for making new molecule 3. To understand the concepts in heterocyclic chemistry and its applications 4. To propose different routes for synthesis of heterocycles	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO1. explain disconnection approaches for making organic molecules	PSO1, PSO2, PSO3
	CO2. design retrosynthetic strategies for synthesis of organic molecules and heterocycles	PSO1, PSO2, PSO3, PSO4

	CO3. explain the concepts in heterocyclic chemistry and its applications		PSO1, PSO2, PSO3	
	CO4. create different routes for heterocyclic compounds synthesis		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Disconnection approach** One-group disconnection. Disconnection of simple alcohols and compounds derived from alcohols, disconnections of simple olefins, simple/aryl ketones and carboxylic acids. Two-group disconnection. Disconnection of 1,3-dioxygenated skeletons, β-hydroxy carbonyl compounds, α,β-unsaturated carbonyl compounds, 1,5-dicarbonyl compounds, Mannich reaction. 'Illogical' Two-group disconnection. Disconnection of the 1,2-dioxygenated skeleton, α-hydroxy carbonyl compounds, 1,2-diols, 'Illogical' electrophiles, disconnection for the 1,4-dioxygenated pattern in 1,4 dicarbonyl compounds, γ-hydroxy carbonyl compounds. Other 'Illogical' synthons, disconnection for the 1,6-dicarbonyl compounds, synthesis of lactones. *(General review problems to be discussed for above approaches)*	**15**	CO1, CO2	K1, K2, K3, K4, K5, K6
Module 2:	**Disconnection strategies** Disconnection of heteroatom and heterocyclic compounds such as ethers, amines, heterocycles, amino acids. Disconnection strategies of few pericyclic reactions. Convergent and divergent synthesis.	**15**	CO1, CO2	K1, K2, K3, K4, K5, K6

	Strategic devices for carbon-heteroatom bonds, polycyclic compounds: the common atom approach. Considering all possible disconnections. Alternative FGI's before disconnection- the cost of synthesis. Features which dominate strategy, functional group addition and molecules with unrelated functional groups.			
Module 3:	**Heterocyclic compounds** Introduction, classification and nomenclature of mono- and bicyclic heteroaromatic molecules Physical properties, dipole moment, acidity-basicity, aromaticity, electron density distribution and reactivity of furan, thiophene, pyrrole, indole, pyridine, pyridine-N-oxide, quinoline, isoquinoline, diazines and triazines, 1,3- and 1,2- azoles.	**15**	CO3, CO4	K1, K2, K3, K4
Module 4:	**Synthetic strategies for heterocycles** General methods of synthesis of the following: furan, thiophene, pyrrole, indole, pyridine, quinoline, isoquinoline, chromones, imidazoles, oxazoles, thiazoles	**15**	CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. J. A. Joule, K. Mills, G. F. Smith, Heterocyclic Chemistry, 3rd Ed., Stanley Thornes Publishers, U.K., 1995. 2. J. A. Joule, K. Mills, Heterocyclic Chemistry, 5th Ed., Wiley-Blackwell, Chichester, UK, 2010. 3. J. Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, 2nd Ed., Oxford University Press, Oxford, UK, 2012. 4. S. Warren, Designing Organic Synthesis, John Wiley & Sons, New York, USA, 2009.			
References/ Readings:	1. D. W. Young, Heterocyclic Chemistry, Longman Group Ltd., London, UK, 1975. 2. G. S. Zweifel, M. H. Nantz, P. Somfai, Modern Organic Synthesis: An Introduction, 3rd Ed., W. H. Freeman and Company, New York, NY, USA, 2022. 3. R. M. Acheson, An Introduction to the Chemistry of Heterocyclic Compounds, 3rd Ed., John Wiley and Sons, New York, NY, USA, 1977. 4. R. O. C. Norman, J. M. Coxon, Principles of Organic Synthesis, 3rd Ed., CRC Press Boca Raton, FL, USA, 2009.			

	5. T. L. Gilchrist, Heterocyclic Chemistry, Pitman Publishing, London, UK, 2005.

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Title of the Course	Chemistry of Natural Products
Course Code	CHO-6003
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-27
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses	
Course Objectives:	1. To study the main classes of natural products. 2. To comprehend the various methods used in natural product chemistry, including extraction, isolation, and structural elucidation. 3. To understand the key biosynthetic pathways for the biosynthesis of terpenes, alkaloids and steroids. 4. By combining the study of structural determination, reaction mechanisms, and synthetic methodologies, this course prepares students with the essential knowledge for advanced research in organic, pharmaceutical, and biological chemistry.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO1. identify different types of natural products	PSO1
	CO2. describe the properties and structure of natural products, their occurrence, biosynthetic pathways	PSO1, PSO2, PSO3

	CO3. describe the extraction methods, structural determination, and chemistry of biologically significant molecules.		PSO1, PSO2, PSO3, PSO4	
	CO4. explain the biogenesis and biosynthesis of natural products		PSO1, PSO2, PSO4, PSO5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1. Source and isolation of natural products** General methods of isolation: The modern distillation process, maceration, enfleurage, extraction by cold pressing and extraction with solvents **1.2. General methods of purification and structure elucidation of Natural Products** Fractionation of the crude extracts and purification of the individual compounds from the respective fractions using chemical and chromatographic techniques such as Column Chromatography, TLC, Preparative TLC, HPLC, etc. Chemical methods based on the functional groups present: Bicarbonate extraction, sodium bisulphite adduct formation, derivatization, etc. General approach to structure elucidation of the isolated pure compounds using UV, IR, NMR spectroscopy, MS spectrometry, optical polarimetry. **1.3. Structure elucidation by classical chemical methods** Terpenoids: alpha-cedrene Alkaloids: Morphine, thebaine and codeine Steroids: Cholesterol, bile acid	**15**	CO1, CO2	K1 K2 K3
Module 2:	**2.1. Structure elucidation by combination of chemical and spectral methods**	**15**	CO1 CO2	K2 K3 K4

	Terpenoids: alpha - and beta -vetivones, Ishwarone Hormones: Cecropia Juvenile hormone, brevicomin and frontalin Oxygen heterocycles: Aflatoxin-B1, rotenone **2.2. Structure elucidation involving stereochemistry, spectral and chemical methods** Terpenoids: Menthol and Hardwickiic acid Alkaloids: Reserpine			
Module 3:	**Synthesis of selected natural products, planning and execution** Terpenoids: Longifolene (E. J. Corey), Caryophyllene (E J Corey) Nootkatone (A. Yoshikoshi), Menthol (Tagasago) Alkaloids: Reserpine (R. B. Woodward), Morphine (Marshall Gates) Hormones: Cecropia JH (Edward), Progesterone Prostaglandins: Prostaglandin E2 (E. J. Corey) Antibiotics: Cephalosporin (R. B. Woodward)	**15**	CO2 CO3 CO4	K1 K2 K3 K5
Module 4:	**Biogenesis and biosynthesis of natural products** Terpenoids and Steroids: General approach towards biosynthesis of mono-, sesqui-, di-, tri-, tetraterpenoids and steroids through mevalonate pathway with special reference to the biosynthesis of terpenoids and steroids included in topics 1C-3. Alkaloids: The shikimate pathway formation of hydroxybenzoic acid derivatives, aromatic amino acids, L- phenylalanine, L-tyrosine, phenolic oxidative coupling, biosynthesis of thebaine, codeine and morphine.	**15**	CO2 CO3 CO4	K1 K2 K3 K4 K5 K6
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning			
Texts:	1. L. Finar, Organic Chemistry: Stereochemistry and the Chemistry of Natural Products, Pearson Education India, New Delhi, India, 2002.			

	2. R. O. C. Norman, J. M. Coxon, Principles of Organic Synthesis, 3rd Ed., CRC Press, Boca Raton, FL, USA, 2009.
References/ Readings:	1. Barton, D. H. R., Olis, Comprehensive Organic Chemistry, Pergamon Press, Oxford, UK, 1979. 2. D. Paul, Medicinal Natural Products: A Biosynthetic Approach, John Wiley and Sons, New York, NY, USA, 2002. 3. D. R. Dalton, The Alkaloids, M. Dekker, New York, NY, USA, 1979. 4. E. J. Corey, X.-M. Cheng, The Logic of Chemical Synthesis, Wiley Interscience, New York, NY, USA, 1995. 5. J. ApSimon, The Total Synthesis of Natural Products, John Wiley and Sons, New York, NY, USA, 1992. 6. K. C. Nicolaou, E. J. Sorensen, Classics in Total Synthesis, VCH, Weinheim, Germany, 1996. 7. K. Nakanishi, Natural Product Chemistry, Academic Press, Boston, MA, USA, 2013. 8. M. Paolo, Biosynthesis of Natural Products, Wiley, Hoboken, NJ, USA, 2010.

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Title of the Course	Polymer Chemistry: Concepts, Synthesis and Characterization of Polymers
Course Code	CHO-6004
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses	
Course Objectives:	1. To introduce the principles of polymer chemistry and methods of preparation of polymers. 2. To learn the major resources of monomer molecules. 3. To understand the characteristics of polymers and their applications 4. To use various techniques in polymer characterization.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO1. explain the basic principles of polymer chemistry	PSO1, PSO2
	CO2. apply the synthetic methodology for various monomers in polymer processes.	PSO1, PSO2
	CO3. evaluate industrial and environmental aspects of monomer production, including safety and sustainability considerations.	PSO1, PSO2, PSO3, PSO4

	CO4. analyze polymers using modern characterization techniques such as viscosity measurements, IR, NMR, DSC, TGA, GPC, and XRD.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1.1 Brief history of natural and synthetic polymers:** Classification & nomenclature of polymers, Functionality concept- linear, branched and cross-linked polymers. Introduction to biodegradable polymers. Number and weight average molecular weights, Molecular weight distribution, polydispersity, glassy state and glass transition temperature, crystallinity in polymers.	**6**	CO1	K1, K2
	1.2 Methods and Chemistry of polymerization: Bulk, solution, suspension, emulsion, addition, condensation polymerizations. Free-radical, ionic and co-ordination polymerization reactions and copolymerization. Introduction to controlled free radical polymerization. Carothers equation in condensation polymerizations.	**9**		
Module 2:	**Resources for monomers, manufacture of some important monomers and reagents:** Ethylene, propylene, butadiene, isoprene, styrene, divinyl benzene, acrylates, acrylonitrile, vinyl chloride, formaldehyde, adipic acid, urea, bisphenol-A, melamine, terephthalic acid, phthalic anhydride, dimethyl terephthalate, glycol, glycerol, ethylene oxide, epichlorohydrin, ϵ-caprolactum, di-isocyanates, pentaerythritol, allylic carbonate monomers.	**15**	CO1 CO2	K1, K2, K3,
Module 3:	**Synthesis, properties and applications of certain polymers:** Vinyl polymers- LDPE, HDPE, PVC, PVA, polyvinyl acetate, polyacrylates, methacrylates, polystyrene, teflon, ABS, SBR, SAN. Condensation polymers- nylons, polyesters, polyurethanes, polycarbonates. Thermoset polycarbonates like CR-39 cellulose esters- cellulose acetate, nitrates and acetate butyrates. Natural rubber, thermoset resins- phenol-formaldehyde, resols and novolacs, melamineformaldehyde, urea formaldehyde, epoxy resins - their curing.	**15**	CO1 CO2 CO3	K1, K2, K3, K4,
Module 4:	**Polymer Characterization:** End-group analysis, osmometry, viscometry, light scattering methods (static & dynamic), gel permeation chromatography (GPC) and	**15**	CO1 CO3	K1, K2, K3, K4,

	applications. IR spectroscopy, UV–Vis spectroscopy, NMR (^{1}H, ^{13}C), mass spectrometry for polymer analysis. DSC and TGA, X-ray diffraction (XRD): crystalline vs. amorphous domains, crystallite size.		CO4	K5, K6
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. J. A. Brydson, Plastic Materials, 3rd Ed., Newnes–Butterworths, London, UK, 1979. 2. J. R. Fried, Polymer Science and Technology, PHI Learning Pvt. Ltd., New Delhi, India, 2000. 3. J. Urbanski, Handbook of Analysis of Synthetic Polymers and Plastics, John Wiley & Sons, New York, NY, USA, 1977. 4. K. Y. Saunders, Organic Polymer Chemistry, Chapman and Hall, London, UK, 1976. 5. P. Bahadur, N. V. Sastry, Principles of Polymer Science, Narosa Publishing House, New Delhi, India, 2003. 6. R. Sinha, Outlines of Polymer Technology: Manufacture of Polymers, PHI Learning Pvt. Ltd., New Delhi, India, 2000. 7. R. W. Lenz, Organic Chemistry of Synthetic High Polymers, Interscience Publishers, New York, NY, USA, 1967. 8. V. R. Gowariker, N. V. Vishwanathan, J. Sreedhar, Polymer Science, 2nd Ed., New Age International Publishers, New Delhi, India, 2015.			
References/ Readings:	1. B. Smith, J. March, Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 6th Ed., Wiley, New York, NY, USA, 2006. 2. H. R. Kricheldorf (Ed.), Handbook of Polymer Synthesis, Parts A & B, Marcel Dekker Inc., New York, NY, USA, 1992. 3. P. C. Painter, M. M. Coleman, Fundamentals of Polymer Science: An Introductory Text, 2nd Ed., CRC Press, Boca Raton, FL, USA, 1997. 4. R. P. Brown, Handbook of Plastic Test Methods, 2nd Ed., George Godwin Ltd., London, UK, 1981.			

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Title of the Course	Advanced Synthetic Organic Chemistry
Course Code	CHO-6005
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses	
Course Objectives:	1. To understand the principles of organometallic chemistry, including types of metal–carbon bonds, bonding interactions, nomenclature, and stability in Organometallic compounds 2. To impart knowledge of the synthesis, structures, properties, and applications of organometallic compounds of main group element, 3. To learn the preparation, properties, and catalytic roles of transition metal organometallics (Cu, Pd, Ni, Rh, Ru, Au), and to understand mechanisms of C–C and C–heteroatom bond-forming reactions 4. To familiarize with modern synthetic methodologies including organocatalysis (NHCs, proline, imidazolidinones) and photoredox catalysis	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO1. classify organometallic compounds, describe σ and π bonding, and predict stability and reactivity of organometallic species.	PSO1, PSO3

	CO2. propose synthetic routes for main-group organometallic compounds and describe their aggregation and solubility properties		PSO1, PSO3, PSO4	
	CO3. explain transition metal catalysis mechanisms, and evaluate the use of specific transition metal reagents in organic synthesis.		PSO1, PSO2, PSO3, PSO4	
	CO4. apply knowledge of organocatalysis and photoredox catalysis to design modern synthetic routes, perform enantioselective transformations		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Concepts in organometallic chemistry** Introduction, classification of organometallic compounds based on hapticity and metal carbon bond (σ-bonding and π-bonding) and types of metal-carbon bonds with main-group metals and transition metals (ionic and covalent) *sigma* and *pi* bonding: linear π-systems , allylic π-systems and cyclic π system Orbital interactions and bonding Organic ligands, hapticity, nomenclature of organometallic compounds: a. binary type nomenclature b. substitutive nomenclature c. coordination nomenclature Stability: kinetic, thermodynamic & 18 electron rule electron counting and 18-electron rule (ionic method and neutral method), *β*-elimination	**15**	CO1	K1, K2, K3, K4
Module 2:	**Organometallic compounds of main group elements** General methods of preparation (direct, metal-halogen exchange, transmetalation, addition of metal hydrides and directed ortho-metalation) Structures and properties: organometallic and organolithium aggregates, solubility. Applications of alkali metals (lithium, sodium, potassium),	**15**	CO2	K1, K2, K3, K4, K5, K6

	General methods of preparation, properties and applications of organo-boranes, -aluminium and -silicon compounds			
Module 3:	**Role of transition metals in organic synthesis** General properties and characteristics of transition metal organometallic compounds Preparation and properties of copper, palladium, nickel, rhodium, ruthenium and gold reagents/organometallic compounds. General mechanism of C-C coupling reaction: Oxidative addition, transmetallation and reductive elimination. C-C coupling reaction, mechanisms and applications of Mizoroki Heck, Suzuki, Stille, Hiyama, Negishi, Sonogashira (with and without copper), Wacker, Kumada, Buchwald-Hartwig, carbonylation, cyanation reaction, allylic substitution, homogenous hydrogenation, metathesis (Ring closing and ring opening, tandem ring opening ring closing), carbonylation, Wacker oxidation, hydroformylation), organo copper compounds and Group 12: Zinc, mixed copper–zinc species, cadmium and mercury, properties and characteristics of organometallic compounds	**15**	CO3	K1, K2, K3, K4, K5, K6
Module 4:	**Organo and photoredox catalysis in organic synthesis** Organocatalysis: Proline, imidazolidinones, NHCs (N-heterocyclic carbenes) in organic transformation such as Aldol reaction, Mannich, Michael addition, NHCs in Stetter reaction etc., chiral NHCs used in enantioselective benzoin, Stetter, annulations. Photoredox Catalysis: Introduction, principles of photoredox catalysis, general mechanism: oxidative quenching cycle and reductive quenching cycle. Physical properties of photoredox catalysts: Redox potentials of the photo-excited species, generation of organic radicals by photoredox catalysis. Types of photoredox catalysts. Visible-light-mediated free radical synthesis: C-C Bond formation: Aza-Henry reaction, Mannich reaction, Strecker reaction.	**15**	CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			

Texts:	1. A. Edward, Comprehensive Organometallic Chemistry, 2nd Ed., Pergamon, 14 vols., Oxford, UK, 1995. 2. A. J. Pearson, Metallo-Organic Chemistry, John Wiley, New York, USA, 1985. 3. A. T. Biju, N-Heterocyclic Carbenes in Organocatalysis, Wiley-VCH, Weinheim, Germany, 2019. 4. A. Yamamoto, Organotransition Metal Chemistry – Fundamental Concepts and Applications, Wiley, New York, NY, USA, 1986. 5. C. Stephenson, T. Yoon, D. MacMillan, Visible Light Photocatalysis in Organic Chemistry, Wiley-VCH, Weinheim, Germany, 2018. 6. G. R. Stephenson, Transition Metal Organometallics for Organic Synthesis, Cambridge University Press, Cambridge, UK, 1991. 7. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., Oxford University Press, Oxford, UK, 2012. 8. L. S. Liebeskind (Ed.), Advances in Metal Organic Chemistry, JAI Press, Vols. 1 and 2, Greenwich, USA, 1989. 9. P. I. Dalko, Organocatalysis: From Concept to Application, Wiley-VCH, Weinheim, Germany, 2007. 10. R. H. Crabtree, The Organometallic Chemistry of the Transition Metals, Wiley, New York, NY, USA, 1994.
References/ Readings:	1. B. List, Asymmetric Organocatalysis: A Survival Guide to Medicinal Chemists, Wiley-VCH, Weinheim, Germany, 2025. 2. F. R. Hartley, Chemistry of Metal-Carbon Bond, Wiley, 6 vols., New York, NY, USA, 1982–1983. 3. J. P. Collman, L. S. Hegedus, J. R. Norton, R. G. Finke, Principles and Applications of Organotransition Metal Chemistry, University Science Books, Mill Valley, CA, USA, 1987. 4. M. Schlosser, Organometallics in Synthesis – A Manual, John Wiley, New York, USA, 1994. 5. W. Caruthers, I. Coldham, Modern Methods of Organic Synthesis, 4th Ed., Cambridge University Press, Cambridge, UK, 2016.

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Title of the Course	Research Methodology in Organic Chemistry
Course Code	CHO-6006
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-27
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses	
Course Objectives:	1. To understand the literature review process, safe laboratory practices and ethics in research. 2. To learn preparation and purification of organic compounds 3. To study the common software and databases in chemistry, and experimental techniques used in organic reaction. 4. To analyse and apply specific modern methodologies in chemical reaction.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO1. apply fundamentals of research	PSO1, PSO2, PS03, PSO4
	CO2. practice the concepts of laboratory safety along with good laboratory practices and use software's and databases in chemistry.	PSO1, PSO2, PS03, PSO4
	CO3. develop competence, expertise in performing routine experimental techniques, reaction	PSO1, PSO2, PS03,

	monitoring, work-up and handling moisture sensitive reactions		PSO4	
	CO4. apply the concepts of newer and sustainable techniques in organic synthesis.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Introduction, Literature Review, Academic Writing** Brief introduction to research methodology, concept and purpose, logical format of dissertation, types and components. Sources for identifying research problem. Literature Review: types of literature, sources of literature review, primary sources, secondary sources, databases. Research methods: significance, purpose and characteristics of research, research process, necessity and scope. Academic Writing: purpose, types and features, common mistakes, conflicts of Interest, publication misconduct, redundant publications, predatory publishers and journals. Key aspects of ethics in scientific conduct.	**15**	CO1	K1, K2, K3, K4
Module 2:	**2.1. Safe Laboratory Practices** Instructions for safe working and use of personal protective equipment (PPE). The purpose and importance of Safety Data Sheet (SDS), classification and handling of hazardous substances. Handling, storage, quenching, and disposal of chemicals, solvents and glassware. Experimental setup, choice of place and apparatus, precautions. Fire Hazards (Class A, B, C, D and K), fire extinguishers and emergency procedures.	**5**	CO2	K1, K2, K3, K4, K5, K6
	2.2. Software & Databases in Chemistry Data plotting, structure drawing, reference management software, literature survey programs, software for docking studies, SAR studies, CAMEO chemicals.	**10**		

	Introduction to chemistry databases. ACS guide to scholarly communication, arXiv, ASTM compass, Beilstein, bioRxiv, Cambridge Structural Database (CSD), ChemRxiv, ChemSpider, CRC Handbook of Chemistry and Physics, Drugbank, e-EROS (Encyclopedia of Reagents for Organic Synthesis), Kirk-Othmer Encyclopedia of Chemical Technology, Merck Index, NIST chemistry webbook, Organic Chemistry Portal, PubChem, PubMed, SciFinder-n, Scopus, Web of Science.			
Module 3:	**Experimental Techniques in Organic Synthesis** Planning and execution of organic reaction. Drying of solvents and synthesis of common reagents like Jones reagent, PCC, PDC, Wittig salts, Grignard, IBX-DMP, acid chlorides etc TLC and column chromatography; preparation, monitoring and product separation. Extraction, trituration, lyophilisation, purification techniques for organic compounds and sample preparation for spectral characterization. Quenching of common organic reagents like *n*-BuLi, DIBAL-H, $LiAH_4$ etc. Inert atmosphere reactions (Schlenk, N_2, Ar atmosphere etc.) Generation of reactive gases like CO, HCl etc	**15**	CO3	K1, K2, K3, K4, K5, K6
Module 4:	**Non-Conventional methods in Organic Synthesis** Microwave-assisted organic synthesis: principle, reaction acceleration and energy efficiency, applications in heterocyclic synthesis. Photocatalysis in organic synthesis: photoredox mechanism with one example, organic dyes and metal complexes as photocatalysts, visible light-mediated transformations. Sonication in organic synthesis: principle, ultrasound assisted bond formation and cleavage, role in green and solvent-free reactions. Electro-organic synthesis: anodic and cathodic transformations, electrosynthesis of heterocycles and natural products. Flow Chemistry: Microreactor technology and process intensification, applications in multistep synthesis and scalability.	**15**	CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some			

	of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.
Texts:	1. C. R. Kothari, Research Methodology: Methods & Techniques, 2nd Ed., New Age International, New Delhi, India, 2004. 2. I. Vogel, A. R. Tatchell, B. S. Furniss, A. J. Hannaford, Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Prentice Hall, Harlow, 2011. 3. Y. K. Singh, Fundamentals of Research Methodology & Statistics, New Age International, New Delhi, India, 2006.
References/ Readings:	1. American Chemical Society, Ethical Guidelines to Publication of Chemical Research, ACS Publications, Washington, DC, USA, 2015. 2. American Chemical Society, Safety in Academic Chemistry Laboratories, Vol. 1 and 2, American Chemical Society, Washington, DC, 2003. 3. D. D. Perrin, W. L. F. Armarego, Purification of Laboratory Chemicals, 4th Ed., Butterworth-Heinemann, Oxford, UK, 1997. 4. F. Darvas, G. Dormán, V. Hessel, S. V. Ley, Flow Chemistry – Fundamentals, De Gruyter Textbook, Berlin, Germany, 2021. 5. J. P. Tierney, P. Lidström, Microwave Assisted Organic Synthesis, CRC Press, Boca Raton, FL, USA, 2005. 6. J. Steinbach, Safety Assessment for Chemical Processes, Wiley-VCH, Weinheim, 1999. 7. J. Zhang, B. Tian, L. Wang, M. Xing, J. Lei, Photocatalysis: Fundamentals, Materials and Applications, Springer, Singapore, 2018. 8. P. G. Urben (Ed.), Bretherick's Handbook of Reactive Chemical Hazards, 8th Ed., Elsevier, Amsterdam, Netherlands, 2017. 9. P. Patnaik, A Comprehensive Guide to the Hazardous Properties of Chemical Substances, 3rd Ed., John Wiley & Sons, Hoboken, NJ, USA, 2007. 10. T. Fuchigami, S. Inagi, M. Atobe, Fundamentals and Applications of Organic Electrochemistry, Wiley, Hoboken, NJ, USA, 2014. 11. T. J. Mason, M. Vinatoru, Sonochemistry: Fundamentals and Evolution, De Gruyter, Berlin, Germany, 2023.

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Discipline Specific Vocational Elective (DSVE) Courses

Title of the Course	Medicinal Chemistry
Course Code	CHO-6401
Number of Credits	4 (2T + 2P)
Theory/Practical	Theory and Practicals
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses	
Course Objectives:	1. To understand the concepts of drug discovery and development 2. To learn drug screening, target identification, lead discovery, optimization. 3. To understand the molecular basis of drug design and drug action. 4. To know the importance of SAR (structure-activity relationship) of drugs.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO1. explain classes of drugs and their structure activity relationship with examples of some important class of drugs.	PSO1, PSO2, PSO3, PSO4
	CO2. explain the mechanism of action of the drugs.	PSO1, PSO2, PSO3, PSO4

	CO3. describe the therapeutic uses of drugs and specific side effects of 'Drug Substances'.		PSO1, PSO2, PSO3, PSO4	
	CO4. apply physico-chemical properties related to QSAR. Students will be able to describe various approaches in designing drug molecules including prodrug and combinatorial chemistry.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1: (Theory)	**Introduction to Drugs** Requirements of an ideal drug, sources of drugs, important terms used in the chemistry of drugs, classification and nomenclature of drugs, drugs and the medicinal chemists. **a. Drug Design:** Analogues and prodrugs, concept of lead compounds, features governing drug design, the method of variation, drug design through disjunction, conjunction, tailoring of drugs, cimetidine, a rational approach to drug design. **b. Drug Development:** Screening of natural products, isolation and purification, structure determination, structure-activity relationship, QSAR, synthetic analogues, natural products as leads for new pharmaceuticals, receptor theories, oxamniquine, a case study. **c. Mechanism of drug action** Introduction, enzyme stimulation, enzyme inhibition, membrane-active drugs, polymorphism and drug delivery. **d. New Developments in Drug Discovery** Introduction, Gene therapy, Drug resistance, Antisense drugs, Cytokines, drugs to combat AIDS.	**15**	CO1, CO2 CO3	K1 K2 K3 K4
Module 2: (Theory)	**Pharmacodynamic agents:** **Class, Structure and Synthesis of the following drugs:** **Carbamazepine, Mefenamic acid, Levodopa, Cetirizine, Haloperidol, Amlodipine, Acetazolamide, and Empagliflozin.**	**15**	CO2 CO3 CO4	K2 K3 K4 K5 K6

	Class, Structure and Mechanism of Action of the following drugs: Codeine, Naproxen, Phenytoin, Levodopa, Chlorpheniramine maleate, Benzodiazepine, Clozapine, Telmisartan, Propranolol, Furosemide, Metformin. **Class, Structure and SAR of the following drugs:** Morphine, Indomethacin, Valproate, Levodopa, Diphenhydramine, Chlorpromazine, Captopril, Warfarin, Nitroglycerin, Hydrochlorothiazide. **Chemotherapeutic agents:** Classification, Antibacterial agents- a) Sulfadiazine (SAR and Mechanism of action), Synthesis of Sulphamethoxazole. b) Antitubercular agents: 4-aminosalicylic acid (SAR), synthesis of Ethionamide. c) Antiviral agents- Ritonavir (mechanism of action), synthesis of Flavipiravir. d) Antifungal agents- Miconazole (mechanism of action), synthesis of Fluconazole. e) Antimalarial agents- Atovaquone (SAR), synthesis of Mefloquine. f) Anthelmintic agents- Niclosamide (SAR and mechanism of action), synthesis of albendazole g) Antiamoebic agents- Synthesis of Tinidazole h) Antibiotic agents- Synthesis and SAR of Ciprofloxacin			
PRACTICALS (2 CREDIT)				
Module 3: (Practicals)	(*Any 10 experiments*) 1. Diazotisation of *m*-nitroaniline and coupling to give an azo dye. 2. Preparation of Schiff bases from 2-aminophenol and p-bromobenzaldehyde 3. Preparation of Barbiturate from diethyl-n-butyl malonate. 4. Synthesis of Phenothiazine derivative. 5. Synthesis of Dichloramine-T and Chloramine-T. 6. Synthesis of Gramine from Indole. 7. To estimate the amount of Diazepam in the given solution by the UV-visible spectrophotometric method.	**60**	CO1 CO3	K1 K2 K3 K4 K5 K6

	8. To estimate the amount of Isoniazid in the given solution, the UV-visible spectrophotometric method. 9. Determination of % purity of a given sample of Chloramphenicol capsules IP by UV-visible spectrophotometric method 10. Determination of % purity of a given sample of propranolol HCl tablets IP by UV-visible spectrophotometric method 11. To identify the given sulpha drug among the Sulfadiazine, Sulfamethoxazole and Trimethoprim with the help of thin-layer chromatography and calculate its Rf value. 12. Record and analyse IR spectra of: Isoniazid, Nicotinic acid and Pyrazinamide. 13. Estimation of Ascorbic acid by the CAN method. 14. Some phytochemical tests/reactions of the following group of compounds (any five types): carbohydrate, cholesterol, fat-soluble vitamins, alkaloids, glycosides, tannins and antibiotics.			
Pedagogy:	Theory: Mainly lectures and tutorials. Prelab exercises/Seminars/term papers /assignments/presentations/self-study, or a combination of some of these, can also be used. The ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning. Practicals: Students should be provided with suitable lab handouts, pre- and post-lab assignments, and explanations that review the theoretical aspects of laboratory experiments prior to conducting each experiment.			
Texts:	1. A. Kar, Advanced Practical Medicinal Chemistry, New Age International Limited Publishers, 2004 2. Graham Patrick, An Introduction to Medicinal Chemistry, Oxford University Press, Oxford, 1998.			
References/ Readings:	1. D. J. Abraham (Ed.), Burger's Medicinal Chemistry and Drug Discovery, Vol. I, 6th Ed., John Wiley & Sons, Hoboken, NJ, USA, 2003. 2. Graham Patrick, An Introduction to Medicinal Chemistry, Oxford University Press, Oxford, UK, 1998. 3. Indian Pharmacopoeia, United States Pharmacopoeia, British Pharmacopoeia, European Pharmacopoeia, various editions. 4. J. Bassett, J. Mendham, R. C. Denny, Vogel's Textbook of Quantitative Chemical Analysis, revised by G. H. Jeffery, 6th Ed., Pearson Education, London, UK, 2007.			

	5. J. E. F. Reynolds, Martindale: The Extra Pharmacopoeia, The Pharmaceutical Press, London, UK, 1989. 6. K. A. Connors, Textbook of Pharmaceutical Analysis, 3rd Ed., Wiley-Interscience, New York, NY, USA, 1990. 7. Lednicer, D., Mitscher, L. A., Organic Chemistry of Drug Synthesis, Vols. I & II, John Wiley & Sons, New York, NY, USA. 8. M. E. Wolff (Ed.), Burger's Medicinal Chemistry, Parts I & II, 4th Ed., John Wiley & Sons, New York, NY, USA. 9. M. Jahangir, Pharmaceutical Laboratory Procedures, 1st Ed., Cengage Learning India Pvt. Ltd., New Delhi, India, 2010. 10. R. F. Doerge (Ed.), Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, 8th Ed., J. B. Lippincott Company, Philadelphia, PA, USA. 11. W. O. Foye, Principles of Medicinal Chemistry, 3rd Ed., K. M. Varghese and Co., Bombay, India.
Web Resources:	https://www.orgsyn.org/

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Title of the Course	Molecular Rearrangements in Organic Chemistry
Course Code	CHO-6402
Number of Credits	4 (2T + 2P)
Theory/Practical	Theory and Practicals
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses	
Course Objectives:	1. To provide theoretical foundation of molecular rearrangements in organic chemistry. 2. To strengthen conceptual understanding of organic reaction mechanisms to develop critical analysis and problem-solving skills. 3. To cultivate practical laboratory competencies essential for executing organic reactions, with emphasis on separation, purification, identification, and synthesis techniques. 4. To plan, design, and conduct experimental setups for organic synthesis in a structured and safety-oriented manner.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO 1. explain the theoretical principles and concepts underlying molecular rearrangements in organic chemistry.	PSO1, PSO2, PSO3
	CO 2. demonstrate practical laboratory skills for performing organic reactions, including separation, purification, identification, and synthesis of compounds.	PSO1, PSO2, PSO3

Approved by: Standing Committee of the Academic Council on 24th & 25th November 2025

	CO 3. apply mechanistic understanding to predict the rearranged product		PSO1, PSO2, PSO3	
	CO 4. design and execute experimental setups for organic synthesis in a systematic and safe manner.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1: (Theory)	**Molecular Rearrangements and their Synthetic Applications (***Examples from total synthesis to be emphasized)* Unifying principles and mechanisms of rearrangements taking place at an electron deficient and electron rich substrates. Rearrangements taking place at carbon: Arndt-Eistert, Wagner-Meerwein, benzil-benzilic acid, Pinacol-pinacolone, semipinacol, Tiffeneau Demjanov, dienone-phenol, Wittig, Favorskii, Stevens, Wolff, Baker-Venkatraman, Barton decarboxylation, Pummerer, di-π-methane, alkyne zipper, Carroll, Chan, Claisen and its variations, Cope, Rupe, Wallach, Fritsch-Buttenberg-Wiechell, Ramberg-Bäcklund Rearrangements at nitrogen: Hofmann, Curtius, Lossen, Schmidt, Beckmann, Neber, Stieglitz, Overman rearrangement Rearrangements at oxygen: Payne (including aza- and thia-Payne) rearrangement, hydroperoxide rearrangement- Criegee, Kornblum–DeLaMare, Baeyer–Villiger oxidation Aromatic rearrangements: Benzidine, Fries, Von Richter, Sommelet-Hauser, Smile's. Rearrangement on aniline derivatives- Bamberger, Fischer-Hepp, Orton, Hofmann-Martius, Reilly-Hickinbottom, rearrangements of *N*-arylazoanilines, Phenylnitramines, Phenylsulfamines. Rearrangements involving fragmentations: Eschenmoser fragmentation, Wharton fragmentation	**30**	CO1, CO4	K1, K2, K3, K4, K5, K6
PRACTICALS (2 CREDIT)				
Module 2:	**Two step Synthesis and Spectral analysis (Any 6 experiments)**	**48**	CO1,	K1, K2,

(Practicals)	i. Benzoin to benzillic acid ii. o-Hydroxyacetophenone to 2-phenylbenzo-4-pyrone iii. Benzophenone to benzanilide iv. Cyclohexanone to caprolactam v. Phthalimide to anthranillic acid vi. (+)-Pulegone to trans-puleginic acid vii. 2-Chlorocyclohexanone to methylcyclopentane carboxylate viii. Cyclododecanone to dodecanolide ix. Nitrobenzene to p-aminophenol		CO2 CO3, CO4	K3, K4, K5, K6
Module 3: (Practicals)	**Synthesis and Spectral analysis (Any 2 experiments)** i. Aniline to sulphanilic acid ii. Benzidine from hydrazobenzene iii. 2-Allylphenol to 2-(prop-1-enyl)phenol	**12**		
Pedagogy:	Theory: Mainly lectures and tutorials. Prelab exercise/Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning. Practicals: Students should be given suitable lab handouts, pre- and post-lab assignments and explanations revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.			
Texts:	1. A. I. Vogel, A. R. Tatchell, B. S. Furniss, A. J. Hannaford, Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Prentice Hall, Harlow, England, 2011. 2. N. K. Vishnoi, Advanced Practical Organic Chemistry, South Asia Books, New Delhi, India, 2010.			
References/ Readings:	1. J. Mohan, Organic Analytical Chemistry, Narosa Publishing House, New Delhi, India, 2014. 2. K. L. Williamson, K. M. Masters, Macroscale and Microscale Organic Experiments, 6th Ed., Cengage Learning, Boston, MA, USA, 2010. 3. K. Tanaka, Solvent-Free Organic Synthesis, 2nd Ed., Wiley-VCH, Weinheim, Germany, 2009. 4. L. F. Fieser, K. L. Williamson, Organic Experiments, 7th Ed., D. C. Heath, Lexington, MA, USA, 1992.			

	5. O. R. Rodig, C. E. Bell Jr., A. K. Clark, Organic Chemistry Laboratory: Standard and Microscale Experiments, 3rd Ed., Saunders College Publishing, Fort Worth, TX, USA, 2009. 6. R. K. Bansal, Laboratory Manual in Organic Chemistry, 5th Ed., New Age International, New Delhi, India, 2016. 7. S. Delvin, Green Chemistry, Sarup & Sons, New Delhi, India, 2005.
Web Resources:	https://www.orgsyn.org/

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Title of the Course	Processing of Polymers and Experiments in Polymer Chemistry
Course Code	CHO-6403
Number of Credits	4 (2T + 2P)
Theory/Practical	Theory and Practicals
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses	
Course Objectives:	1. To understand the role of various additives in modifying polymer properties and the fundamental techniques involved in polymer processing and compounding. 2. To learn about the mechanisms, causes, and effects of polymer degradation and explore the methods for polymer recycling and waste management. 3. To develop an understanding of the fundamental techniques involved in the synthesis of polymers and copolymers. 4. To learn laboratory techniques to depolymerize, chemically modify commercial polymers and perform the chemical/spectroscopic analysis.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO1. describe the functions, types, and examples of additives used in polymers. along with different processing techniques for shaping polymeric materials.	PSO1, PSO2
	CO2. identify mechanisms of polymer degradation and Evaluate recycling methods for	PSO1, PSO2, PSO3,

	sustainable approaches towards polymer waste management.		PSO5	
	CO3. synthesize thermosetting and thermoplastic polymers by condensation and addition polymerization methods.		PSO1, PSO2, PSO3	
	CO4. develop and apply protocols for synthesis, isolation and analysis of polymeric materials.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1: (Theory)	**1.1 Additives in polymers:** Lubricants, plasticizers, stabilizers, antioxidant, fire retardants, blowing agents, fillers, colorants, crosslinking agents, UV-Vis degradants etc., (properties and examples) **1.2 Polymer processing**: Introduction to compounding, and processing techniques like calendaring, casting, moulding and spinning in polymer processing	**15**	CO1	K1, K2, K3,
Module 2: (Theory)	**2.1 Recycling of Polymers:** Recycling techniques, size reduction, washing, identification and sorting of plastics, agglomeration, other methods of recycling and waste disposal options, chemical recycling, thermal conversion technologies. **2.2 Polymer degradation:** Definition, importance, and consequences of degradation. degradation mechanisms and stability of polymers, environmental and industrial relevance. Types of degradation thermal degradation, oxidative degradation, photodegradation, hydrolytic and enzymatic degradation and mechanical degradation.	**15**	CO2	K1, K2, K3, K4, K5, K6
PRACTICALS (2 CREDIT)				
Module 3: (Practicals)	**Any seven of the following** i. Preparation phenol-formaldehyde resin ii. Preparation of nylon-6,6 iii. Preparation of urea-formaldehyde by polycondensation iv. Preparation of PMMA by bulk polymerization v. Copolymerization of styrene with MMA by free radical solution technique	**28**	CO3, CO4	K1, K2, K3, K4, K5, K6

	vi. Preparation of aniline formaldehyde resin vii. Preparation of cellulose acetate viii. Preparation of polyaniline ix. Determination of acid value. x. Estimation of monomers. (Aniline, Phenol, Urea, Formaldehyde)			
Module 4: (Practicals)	**Any four of the following** i. Hydrolysis of polyvinyl acetate, isolation and chemical/spectroscopic analysis. ii. Film casting from polymer solution cellulose acetate iii. Microplastics from environment, Isolation and chemical/Spectroscopic analysis. iv. Functionalization of polystyrene, isolation and chemical/spectroscopic analysis. v. PET degradation to BHET monomer, isolation and chemical/spectroscopic analysis. vi. Isolation of Bisphenol-A from polycarbonates and chemical/spectroscopic analysis. vii. Functionalization of PVC Isolation and chemical/spectroscopic analysis. viii. Acylation of polyvinyl alcohol, isolation and chemical/spectroscopic analysis. Film casting from polymer solution cellophane	**32**	CO3 CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Theory: Mainly lectures and tutorials. Prelab excersise/Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning. Practicals: Students should be given suitable lab handouts, pre- and post-lab assignments and explanations revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.			
Texts:	1. D. Braun, H. Cherdron, W. Kern, Practical Molecular Organic Chemistry, 5th Ed., Harwood Academic Publishers, Amsterdam, Netherlands, 2013. 2. E. A. Collins, J. Bares, F. W. Billmeyer, Experiments in Polymer Science, 1st Ed., Wiley, New York, NY, USA, 1973.			

	3. E. M. McCaffery, Laboratory Preparations for Macromolecular Chemistry, 1st Ed., McGraw-Hill, New York, NY, USA, 1970. 4. J. R. Fried, Polymer Science and Technology, PHI Learning Pvt. Ltd., New Delhi, India, 2000. 5. P. Bahadur, N. V. Sastry, Principles of Polymer Science, Narosa Publishing House, New Delhi, India, 2003. 6. R. Sinha, Outlines of Polymer Technology: Manufacture of Polymers, PHI Learning Pvt. Ltd., New Delhi, India, 2000. 7. S. H. Pinner, A Practical Course in Polymer Chemistry, 1st Ed., Pergamon Press, Oxford, UK, 1961. 8. V. R. Gowariker, N. V. Vishwanathan, J. Sreedhar, Polymer Science, 2nd Ed., New Age International Publishers, New Delhi, India, 2015.
References/ Readings:	1. C. A. Finch, Sir Geoffrey Allen (Ed.), Comprehensive Polymer Science: The Synthesis, Reactions and Applications of Polymers, Pergamon Press, Vols. 1–7, Oxford, UK, 1989. 2. D. Braun, H. Cherdron, W. Kern, Technologies of Polymer Synthesis and Characterization, 5th Ed., Wiley-VCH, Weinheim, Germany, 2013. 3. N. P. Cheremisinoff (Ed.), Handbook of Polymer Science and Technology, Marcel Dekker Inc., Vols. 1–4, New York, NY, USA, 1989. 4. R. Sinha, Outlines of Polymer Technology: Processing Polymers, PHI Learning Pvt. Ltd., New Delhi, India, 2003. 5. S. R. Sandler, M. Karo, Polymer Synthesis, 2nd Ed., Academic Press, New York, NY, USA, 1992.

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SEMESTER IV

Generic Elective (GE) Courses

Title of the Course	Bioorganic Chemistry
Course Code	CHO-6201
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-27
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses	
Course Objectives:	1. To understand the structure, and functional properties of proteins, lipids, carbohydrates, and nucleic acids. 2. To study the chemical reactions, analysis methods, and nutritional significance of biomolecules. 3. To explore the synthesis, structural features, and biological roles of nucleotides and carbohydrates. 4. To learn foundation for applications of biomolecules in food chemistry and biochemistry.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO1. explain the structure, folding, denaturation, and functional properties of proteins.	PSO1, PSO2, PSO4

	CO2. describe the classification, structure, reactions, and nutritional role of lipids.		PSO1, PSO2, PSO4	
	CO3. analyze the chemistry, configuration, and synthesis of carbohydrates, oligosaccharides, and glycoconjugates.		PSO1, PSO2, PSO3	
	CO4. apply the structure, nomenclature, synthesis, and biological functions of nucleic acids.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Chemistry of Proteins** Introduction of amino acid and role of polar, non-polar, acidic and basic side chains and also their properties, and Isoelectric point Introduction of peptide, dipeptides and proteins. Types of proteins structures (primary, secondary, tertiary, and quaternary, hydrogen bonding between side chains, salt bridges between side chains, hydrophobic - non-polar interactions, disulfide linkage Protein folding, denaturation, functional properties of proteins. Food proteins – source of nutrients and analysis of proteins and amino acids. Other methods used in the study of food proteins	**15**	CO1	K1, K2, K3, K4
Module 2:	**Chemistry of Major Components of Food** Fats: Fats in nutrition. Lipids: Classes of lipids, fatty acids, monoglycerides, diglycerides, triglycerides, polar lipids. Reaction of fats- oxidative and hydrolytic rancidity. Analysis of Fats in food- for e.g. chocolate. Other methods used in the study of food lipids to be discussed.	**15**	CO2	K1, K2, K3, K4
Module 3:	**Carbohydrate Chemistry** classification, configuration and conformation, Natural and synthetic monosaccharides, chemical and physical properties, oligo and polysaccharides, carbohydrate containing	**15**	CO3	K1, K2, K3, K4

	molecules: Complex glycosides, carbohydrate antibiotics, nucleic acids, glycoproteins, peptidoglycans, glycolipids, chemical synthesis of oligosaccharides, donor-acceptor concept, anomeric effect, preparation of glycosyl halides, preparation of oligosaccharides by glycal assembly method and n-pentenyl glycoside methods. Glycoconjugates: DNA binding of glycoconjugates, Structure of polysaccharides including starch, cellulose, glycogen and chitin.			
Module 4:	**Structure of components of nucleic acids** Bases, sugars, nucleosides and nucleotides. Nomenclature of nucleosides and nucleotides, structure of polynucleotides (DNA and RNA), Structures of A, G, C, T, U adenosine, ADP and ATP. Factors stabilizing, biological roles of DNA and RNA; concept of heredity: genetic code, replication, transcription and translation.	**15**	CO4	K1, K2, K3, K4
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. C. O. Wilson, O. Gisvold, R. F. Deorge, Textbook of Organic, Medicinal and Pharmaceutical Chemistry, 7th Ed., J. B. Lippincott Company, Philadelphia, PA, USA, 1977. 2. D. L. Nelson, M. M. Cox, Lehninger Principles of Biochemistry, 7th Ed., W. H. Freeman and Co., International Edition, 2017. 3. J. M. Berg, J. L. Tymoczko, L. Stryer, Biochemistry, 9th Ed., W. H. Freeman and Co., New York, NY, USA, 2019. 4. R. K. Murray, D. K. Granner, P. A. Mayes, V. W. Rodwell, Harper's Illustrated Biochemistry, Lange Medical Books / McGraw-Hill, New York, NY, USA, 2009. 5. Sidney M. Hecht, Bioorganic Chemistry: Carbohydrates, Oxford University Press, Oxford, UK, 1999. 6. T. A. Brown, Biochemistry, 1st Indian Ed., Viva Books, New Delhi, India, 2018.			
References/ Readings:	1. D. Voet and J. G. Voet, Biochemistry, 4th Ed., Wiley, New York, 2010. 2. S. Kaushik and A. Singh, Biomolecules: From Genes to Proteins, 1st Indian Ed., De Gruyter, Berlin and Boston, 2023.			

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Title of the Course	Reagents in Organic Synthesis
Course Code	CHO-6202
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses	
Course Objectives:	1. To introduce modern reagents for cyanation, reduction, oxidation, halogenation, and formylation reactions. 2. To study transition metal reagents and ligands for activation of non-active bonds. 3. To understand the principles and applications of asymmetric synthesis, including reagent-, substrate-, and auxiliary-controlled methods. 4. To explore organocatalysis and the use of chiral building blocks in enantioselective synthesis.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO1. explain the mechanisms and scope of modern reagents in cyanation, reduction, oxidation, formylation, halogenation, and Mitsunobu reactions.	PSO1, PSO2, PSO3, PSO4
	CO2. understand and apply transition metal catalyzed activation of non-active bonds and the role of ligands in catalysis.	PSO1, PSO2, PSO3, PSO4

	CO3. design and perform asymmetric synthesis using reagent-, substrate-, and auxiliary-controlled strategies.		PSO1, PSO2, PSO3, PSO4	
	CO4. utilize organocatalysts and chiral building blocks to achieve enantioselective transformations.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Use of Reagents in organic synthesis** Cyanation: TMSCN, palladium catalysed cyanation reaction, acetone cyanohydrin Reduction: Borane-amine complexes, silanes and hydrogenation catalysts. Oxidation: organic peroxides, hypervalent iodine compounds, N-oxides, TEMPO and other oxidizing agents. Mitsunobu reaction: 1,1′-(Azodicarbonyl)dipiperidine (ADDP), Tetramethylazodicarboxamide (TMAD), 4-(Dimethylamino)-phenyldiphenylphosphine, diphenyl-2-pyridyl phosphine, Tri-tert-butylphosphine. Formylation: Duff reaction, Rieche reaction, 2,2,2-Trifluoroethyl formate (TFEF) and 1-formyl-1*H*-Benzotriazole, Zincke's aldehyde synthesis. Halogenation: Dibromoisocyanuric acid (DBI), 1,3-Diiodo-5,5-dimethylhydantoin (DIH), fluorinating reagents, Togni reagent, Umemoto reagent, CF_3I, Ruppert-Prakash reagent. Pyridine iodine monochloride, I_2, bromotrichloromethane and cyanuric chloride.	**15**	CO1	K1, K2, K3, K4, K5, K6
Module 2:	**2.1 Transition Metal Reagents for Activation of Non-active bonds:** Pd, Ru, Rh, Ir, Ni reagents **2.2 Ligands in Organic Synthesis:** Definition and classification of ligands, σ-donor and π-acceptor properties, steric and electronic effects of ligands. structure, examples, denticity, key features, properties and applications of phosphine ligands, n-heterocyclic carbene (NHC) ligands, diketone ligands, salen ligands, amine ligands, imine ligands, pyridine ligands, phenanthroline ligands, binaphthyl ligands,	**15**	CO2	K1, K2, K3, K4, K5, K6

Module 3:	**Asymmetric synthesis:** Definition, importance, mechanism, energy consideration, advantages and limitations, reagentcontrolled methods, substrate controlled methods, auxiliary controlled methods, use of chiral reagents, asymmetric reduction - use of lithium aluminium hydride and borate reagents. synthesis and applications of oxazaborolidines, IPC-BBN, IPC_2BH, (S)-BINAP-DIAMINE and (R)-BINAL-H. Use of (R,R)-DIPAMP, (S,S)-CHIRAPHOS, (R,R)-DIOP, SAMP, RAMP, D-Proline, S-PBMgCl, (-)-$BOAlCl_2$, (+) and (-)-DET.	**15**	CO3	K1, K2, K3, K4, K5, K6
Module 4:	**4.1 Reagents in organocatalysis**: Amino acids (such as proline), cinchona alkaloids in asymmetric transformations, chiral phosphoric acids, chiral diols, chiral phase-transfer catalysts. **4.2 Chiral building blocks:** Carboxylic acids, esters, amides, alcohols, amines, amino alcohols, isocyanates. **4.3 Optical resolving agents for separation of enantiomers** Cinchonidine derivatives, amino acids and derivatives, menthol, strychnine and analogues.	**15**	CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry: Part A & B, 5th Ed., Springer, New York, NY, USA, 2007. H. O. House, Modern Synthetic Reactions, 2nd Ed., W. A. Benjamin, New York, NY, USA, 1972. 2. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., Oxford University Press, Oxford, UK, 2012. 3. M. B. Smith, J. March, Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 6th Ed., Wiley, New York, NY, USA, 2006. 4. P. Y. Bruice, Organic Chemistry, 8th Ed., Prentice Hall, New York, NY, USA, 2016. 5. W. Caruthers, Modern Methods in Organic Synthesis, 4th Ed., Cambridge University Press, Cambridge, UK, 2004.			
References/ Readings:	1. B. List, Asymmetric Organocatalysis, Springer, Berlin, Germany, 2002. 2. D. Astruc, Modern Organometallic Chemistry, Wiley, New York, NY, USA, 2007. 3. E. M. Carreira, L. Kvaerno, Classics in Stereoselective Synthesis, Wiley-VCH, Weinheim, Germany, 2009.			

	4. F. Calderazzo, A. Guerri, Transition Metal Reagents in Organic Synthesis, Elsevier, Amsterdam, Netherlands, 2005. 5. I. Ojima, Catalytic Asymmetric Synthesis, 3rd Ed., Wiley, New York, NY, USA, 2010. 6. J. Chatt, Organometallic Compounds: Ligand Effects and Applications, Oxford University Press, Oxford, UK, 2002. 7. K. Takai, Modern Carbon-Carbon Bond Forming Reactions, Wiley, New York, NY, USA, 2000. 8. M. S. Singh, S. Kumar, Asymmetric Synthesis: Methods and Protocols, Springer, Berlin/Boston, Germany, 2015. 9. R. H. Crabtree, The Organometallic Chemistry of the Transition Metals, 6th Ed., Wiley, New York, NY, USA, 2014. 10. R. Noyori, Asymmetric Catalysis in Organic Synthesis, Wiley, New York, NY, USA, 1994. 11. T. Wirth, Hypervalent Iodine Chemistry, Springer, Berlin/Boston, Germany, 2016.

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Title of the Course	Concepts in Green Chemistry
Course Code	CHO-6203
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses	
Course Objectives:	1. To understand the fundamental principles and concepts of green chemistry and sustainable development. 2. To explore green technologies and environmentally benign methods in chemical synthesis. 3. To explain industrial applications of green chemistry approaches for waste reduction and resource efficiency. 4. To evaluate alternative energy sources, greener solvents, and catalytic systems for sustainable chemical processes.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO1. explain the twelve principles of green chemistry, atom economy, and strategies for waste minimization	PSO1, PSO2, PSO3, PSO4
	CO2. apply green chemistry concepts to industrial processes, including catalysis, renewable feedstocks, and environmentally benign solvents	PSO1, PSO2, PSO3, PSO4
	CO3. analyze environmental performance using life cycle assessment, eco-labeling, and green	PSO1, PSO2, PSO3,

	process metrics.		PSO4	
	CO4. evaluate and compare greener technologies such as microwave-assisted synthesis, electrochemistry, sonochemistry, and flow chemistry		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**1. 1. Principles and Concepts of Green Chemistry** Twelve green chemistry principles, sustainable development and green chemistry. Atom economy: atom economic reactions- rearrangement and addition reactions. Atom un-economic reactions- substitution, elimination and Wittig reactions. Reducing toxicity. **1.2. Waste: Production, Problems and Prevention** Introduction, Some problems caused by waste, sources of waste from the chemical industry and the cost of waste. Waste minimization techniques: the team approach and process design for waste minimization, minimizing waste from existing processes. On-site waste treatment: Physical, chemical and biotreatment. Design for degradation: degradation and surfactants, DDT, polymers and some rules for degradation. Polymer recycling: separation and sorting, incineration, mechanical recycling and chemical recycling to monomers. Waste Valorization: Agro-waste to biofuels, glycerol (from biodiesel) to propylene glycol, epichlorohydrin, molasses (sugar industry) to ethanol, citric acid.	**15**	CO1	K1, K2, K3, K4
Module 2:	**2.1 Measuring and Controlling Environmental Performance** The importance of measurement: Lactic acid production, safer gasoline. Life cycle assessment and green process metrics.	**15**	CO2	K1, K2, K3, K4, K5, K6

	Environmental management systems: ISO and European Eco-Management and Audit Scheme, eco-labels, green chemical supply, Strategies, Legislation and Integrated Pollution Prevention and Control **2.2. Catalytic processes and Green Chemistry** Heterogeneous catalysts: Basics of heterogeneous catalysis, zeolites and the bulk chemical industry, heterogeneous catalysis in the fine chemical and pharmaceutical industries. Catalytic converters. Homogeneous catalysis: Transition metal catalysts with phosphine ligands, greener Lewis acids and asymmetric catalysis. Phase transfer catalysis: Hazard reduction, C-C bond formation and oxidation using hydrogen peroxide, micellar catalysis and aqueous PTC for greener reactions. Biocatalysis and photocatalysis: enzymes for industrial catalysis, whole-cell biocatalysts, Immobilized enzymes. Visible-light photocatalysis for C–C bond formation, oxidation, and reduction			
Module 3:	**3.1. Organic Solvents: Environmentally Benign Solutions** Solvent selection: Preferred, undesirable and alternatives Organic solvents and volatile organic components, solvent free systems. Supercritical fluids: supercritical carbon dioxide and supercritical water. Water as a reaction solvent and water-based coatings. Ionic liquids as catalysts and solvents. Fluorous biphase solvents. Deep eutectic solvents **3.2. Renewable Resources** Biomass as a renewable resource, Energy: Fossil fuels, biomass, solar power, fuel cells and other forms of renewable energy. Chemicals and polymers from renewable feedstock: production of 5-HMF, levulinic acid, furfural, succinic acid from biomass, green synthesis of bioplastics like PHA and PLA from biomass feedstocks.	**15**	CO1, CO3	K1, K2, K3, K4, K5, K6

	i.Alternative economies: the syngas economy and the biorefinery.			
Module 4:	**4.1. Greener Technologies and Alternative Energy Sources** Design for energy efficiency Photochemical reactions: advantages of and challenges faced by photochemical processes, examples of photochemical reactions. Chemistry using Microwaves: microwave heating and microwave-assisted reactions. Sonochemistry and green chemistry examples. Knoevenagel condensation, oxidation of alcohols using H_2O_2, ultrasound-promoted Michael addition, ultrasound-enhanced Suzuki coupling Electrochemical synthesis: examples like azobenzene synthesis, amination of arenes (C–N coupling), electroreduction of nitro compounds to amines, etc Flow chemistry: diazotization, nitration, isocyanates from amines, etc **4.2. Industrial case studies** A brighter shade of green: synthesis of stilbene intermediates for optical brighteners. Greening of acetic acid manufacture, EPDM rubbers and vitamin C. Leather manufacture: tanning and fat liquoring. Dyeing to be green: some manufacturing and products improvement and dye application. Polyethene: Radical process, Ziegler Natta and metallocene catalysis. Eco-friendly pesticides.	**15**	CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			

Texts:	1. A. Loupy, Microwaves in Organic Synthesis, Wiley-VCH, Weinheim, Germany, 2002. 2. A. S. Matlack, Introduction to Green Chemistry, Marcel Dekker, Inc., New York, NY, USA, 2001. 3. F. Darvas, G. Dormán, V. Hessel, Flow Chemistry – Fundamentals, 1st Ed., De Gruyter, Berlin, Germany, 2014. 4. F. Z. Dörwald, Organic Synthesis on Solid Phase, Wiley-VCH, Weinheim, Germany, 2002. 5. K. Tanaka, Solvent-Free Organic Synthesis, Wiley-VCH GmbH & Co. KGaA, Weinheim, Germany, 2003. 6. M. Lancaster, Green Chemistry, The Royal Society of Chemistry, Cambridge, UK, 2002. 7. P. T. Anastas, T. C. Williamson, Green Chemistry: Frontiers in Benign Chemical Synthesis and Processes, Oxford University Press, Oxford, UK, 1998. 8. P. Wasserscheid, T. Welton, Ionic Liquids in Synthesis, Wiley-VCH, Weinheim, Germany, 2003. 9. R. Sanghi, M. M. Srivastava, Green Chemistry: Environment Friendly Alternatives, Narosa Publishing House, New Delhi, India, 2007. 10. V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, Ane Books India, New Delhi, India, 2006.
References/ Readings:	1. C.-J. Li, T.-H. Chan, Organic Reactions in Aqueous Media, John Wiley & Sons, Inc., New York, NY, USA, 2001. 2. P. G. Jessop, W. Leitner, Chemical Synthesis Using Supercritical Fluids, Wiley-VCH, Weinheim, Germany, 1999. 3. P. T. Anastas, J. C. Warner, Green Chemistry: Theory and Practice, Oxford University Press, New York, NY, USA, 1998. 4. R. van Eldik, F. G. Klarner, High Pressure Chemistry, Wiley-VCH, Weinheim, Germany, 2002. 5. S. Delvin, Green Chemistry, IVY Publishing House, Delhi, India, 2006. 6. V. K. Ahluwalia, M. Kidwai, New Trends in Green Chemistry, Anamaya Publishers, New Delhi, India, 2004.

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Title of the Course	Applied Organic Chemistry
Course Code	CHO-6204
Number of Credits	4
Theory/Practical	Theory
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses	
Course Objectives:	1. To understand the significance of functional dyes, metal–organic frameworks and impurities in organic drugs 2. To familiarise learners with methods of identification and analysis of functional dyes, metal–organic frameworks, and impurities in drugs. 3. To understand classification schemes and structural diversity of metal–organic frameworks 4. To equip learners with the skills required to design appropriate strategies for the synthesis of metal–organic frameworks.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO1. apply impurity profiling techniques to identify and analyze impurities in active pharmaceutical ingredients.	PSO4
	CO2. explain the principles, mechanisms, and applications of functional dyes in imaging technologies, displays, electronic materials, and biomedical applications	PSO4

	CO3. analyze the structure, synthesis, and stability of MOFs for their applications in catalysis, hydrogen storage, and stimuli-responsive systems.		PSO4	
	CO4. explain the structure, functions, and mechanisms of proteins, enzymes, and coenzymes in biological processes.		PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Impurity profiling in drug APIs:** Introduction of active pharmaceutical ingredients (API), various aspects of the estimation of impurities in drugs, Impurities in API and classification of impurities in drugs, nature, and origin of the impurities in drug substance, role and aims of impurity profiling in drug research, development and production; methods for impurity profiling. Impurity profiling of some groups of drugs: Case study of selected examples. impurity profiling in steroid drugs synthesis. Identification of novel rapamycin derivatives as low-level impurities in active pharmaceutical ingredients. Identification and characterization of four process related impurities in retigabine.	**15**	CO1	K1, K2, K3
Module 2:	**Functional Dyes:** Introduction, interactions of functional dyes, functional dyes by application, imaging, laser printing and photocopying, thermal printing, dyes for ink-jet printing, other imaging technologies, invisible imaging, optical data storage, other technologies, displays, cathode ray tube, liquid crystal displays, organic light-emitting devices, electrochromic displays, electronic materials, organic semiconductors, solar cells, nonlinear optical dyes, laser dyes, biomedical applications, fluorescent sensors and probes, photodynamic therapy	**15**	CO2	K1, K2, K3
Module 3:	**Metal-Organic Frameworks:** metal-organic frameworks and porous organic materials coordination polymers, porous and cavity-containing structures, metallic clusters of MOFs, design and synthesis of MOFs, factors affecting synthesis of MOFs; solvents, effect of temperature and pH,	**15**	CO3	K1, K2, K3, K4

	factors affecting the stability of MOFs, major applications: catalysis and hydrogen storage			
Module 4:	**Proteins, Enzymes and Coenzymes** Proteins- Biological importance, peptide synthesis by solid phase and solution phase methods. Enzymes- Definition, classification, mechanism of enzyme action- lock & key model, induced fit theory and substate strain theory and mechanism of enzyme catalysis. reactions catalysed by enzymes; nucleophillic displacement on a phosphorus atom, multiple displacement reactions and the coupling of ATP cleavage to endergonic processes. Transfer of sulphate, addition and elimination reactions, enolic intermediates in isomerization reactions, b-cleavage and condensation, some isomerization and rearrangement reactions. enzyme catalysed carboxylation and decarboxylation Coenzymes- Introduction, classification, structure and biological functions of coenzyme a, thiamine pyrophosphate (TPP), pyridoxal phosphate, flavin adenine nucleotide FAD, FADH and adenosine triphosphate (ATP)	**15**	CO4	K1, K2, K3
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.			
Texts:	1. A. Lehninger, D. L. Nelson, M. M. Cox, Principles of Biochemistry, 5th Ed., W. H. Freeman, New York, NY, USA, 2008. 2. P. Lloyd-Williams, F. Albericio, E. Giralt, Chemical Approaches to the Synthesis of Peptides and Proteins, 1st Ed., CRC Press, Boca Raton, FL, USA, 1997. 3. T. Bugg, An Introduction to Enzyme and Coenzyme Chemistry, 2nd Ed., Blackwell Science, Oxford, UK, 2004.			
References/ Readings:	1. D. Farruseng, Metal-Organic Frameworks: Applications from Catalysis to Gas Storage, Wiley-VCH, Weinheim, Germany, 2011. 2. H. García, S. Navalón, Metal-Organic Frameworks, Wiley-VCH, Weinheim, Germany, 2018. 3. K. T. Liu, C. H. Chen, Determination of Impurities in Pharmaceuticals: Why and How?, In Quality Management and Quality Control – New Trends and Developments, IntechOpen, London, UK, 2019.			

	4. R. Banerjee, Functional Supramolecular Materials from Surfaces to MOFs, The Royal Society of Chemistry, London, UK, 2017. 5. R. J. Smith, M. L. Webb, Analysis of Drug Impurities, Blackwell Publishing, Oxford, UK, 2007. 6. S. Doonan, Peptides and Proteins, 1st Ed., RSC Publishing House, London, UK, 2002. 7. S. Görög, Identification and Determination of Impurities in Drugs, 1st Ed., Elsevier Science, Amsterdam, Netherlands, 2000. 8. S. Kaskel, The Chemistry of Metal-Organic Frameworks – Synthesis, Characterization, and Applications, Wiley-VCH, Weinheim, Germany, 2016.
Web Resources:	1. Alsante, Karen M., Peter Boutros, Michel A. Couturier, Robert C. Friedmann, Jeffrey W. Harwood, George J. Horan, Andrew J. Jensen et al. "Pharmaceutical impurity identification: a case study using a multidisciplinary approach. " Journal of Pharmaceutical Sciences 93, no. 9 (2004): 2296-2309. https://doi.org/10.1002/jps.20120 2. Wang, X., Zhou, H., Zheng, J., Huang, C., Liu, W., Yu, L., & Zeng, S. (2012). Identification and characterization of four process-related impurities in retigabine. Journal of pharmaceutical and biomedical analysis, 71, 148-151. https://doi.org/10.1016/j.jpba.2012.07.035 3. Zech, S. G., Carr, M., Mohemmad, Q. K., Narasimhan, N. I., Murray, C., Rozamus, L. W., & Dalgarno, D. C. (2011). Identification of novel rapamycin derivatives as low-level impurities in active pharmaceutical ingredients. The Journal of Antibiotics, 64(9), 649-654. https://doi.org/10.1038/ja.2011.61

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Title of the Course	Organic Chemistry Practical – V
Course Code	CHO-6205
Number of Credits	4
Theory/Practical	Practical
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses	
Course Objectives:	1. To understand stoichiometric requirements in organic synthesis 2. To explain the principles of Green experimental techniques and identify the associated safety protocols required for performing organic synthesis 3. To understand the methods for purifying final products from reaction mixtures 4. To develop the ability to apply key reactions and their transformations in organic synthesis to build practical skills	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO1. gain knowledge on safe handling protocols for various techniques used in organic synthesis	PSO1, PSO2, PSO3
	CO2. evaluate stoichiometric requirements in organic syntheses	PSO1, PSO2, PSO3
	CO3. apply appropriate purification techniques to isolate and recover product(s) from a	PSO1, PSO2, PSO3

	reaction mixture			
	CO4. apply Green chemistry techniques for organic synthesis		PSO1, PSO2, PSO3, PSO4	
Content:	*Any 20 experiments.*	**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Ultrasound assisted organic synthesis** i. Oxidation of any one alcohol (benzyl alcohol, cyclohexanol etc) using $KMnO_4$ in hexane. ii. Aldol dimerization of α–tetralone catalysed by basic alumina. iii. 2-chloro-N-aryl anthranilic acid from 2-chlorobenzoic acid and 2-chloroaniline. iv. Butyraldehyde from 1-chlorobutane by the reaction of Li and dimethyl formamide. v. One-pot synthesis of 3-nitro-2*H*-chromenes by the reaction of *o*-hydroxy benzaldehyde and nitro styrene. vi. Cannizarro reaction of benzaldehyde under heterogeneous condition catalyzed by barium hydroxide	**120**	CO1, CO2, CO3, CO4	K1, K2, K3, K4
Module 2:	**Phase transfer catalysis in organic synthesis** i. Darzens condensation of cyclohexanone with chloroacetonitrile to provide 1 oxaspiro-[2,5]-octane-2-carbonitrile. ii. *Syn*–dihydroxylation of cyclooctene or cyclohexene with $KMnO_4$ solution. iii. Oxidation of benzyl alcohol with hypochlorite solution. iv. 3,4-diphenyl-7-hydroxycoumarin by the reaction of 2-hydroxy-4-methoxy benzophenone with phenylacetyl chloride. v. Flavone from o-hydroxyacetophenone and benzoylchloride. vi. 2,2-dichlorobicyclo[4.1.0]heptane from cyclohexene and chloroform in presence of NaOH. vii. Toluene to benzoic acid by alkaline $KMnO_4$. viii. Salicylaldehyde from phenol and chloroform.		CO1, CO2, CO3, CO4	K1, K2, K3, K4

	ix. 2-Benzoyl-3,5-dimethyl benzofuran from 2-hydroxy-5-methyl acetophenone and phenacyl bromide			
Module 3:	**Microwave assisted organic synthesis** i. Esterification of benzoic acid ii. Alkylation of ethyl acetoacetate iii. Solvent free *N*-alkylation of saccharin iv. Fries rearrangement of *p*-cresyl acetate v. Synthesis of tetrapyrrolic macrocycle under dry media conditions from benzaldehyde and pyrrole. vi. Synthesis of 1,4–dihydropyridine in presence of silicagel from substituted aldehydes and ethylacetoacetate. vii. 3-Methyl-1-phenyl-5-pyrazolone from EAA and phenylhydrazine.		CO1, CO2, CO3, CO4	K1, K2, K3, K4
Module 4:	**Photochemical reactions** i. Dimerization of cinnamic acid to truxillic acid. ii. Cyclisation of coumarin derivative in solid state/water. iii. Benzopinacol by reduction of benzophenone in isopropyl alcohol. iv. Isomerisation of trans-azobenzene to cis-azobenzene. v. Bromination of dibenzyl: Preparation of 1,2-dibromo-1,2-cliphenyl ethane. vi. Preparation of 9-hydroxy xanthene.		CO1, CO2, CO3, CO4	K1, K2, K3, K4
Module 5:	i. Michael addition of cyclohexenone to ascorbic acid in aqueous phase. ii. Michael addition reaction of chalcone and ethylacetoacetate in aqueous phase. iii. Citronellal from citronellol using PCC on alumina (solid-phase reaction). iv. Phenylbenzoate by Baeyer Villiger oxidation of benzophenone (solid-phase reaction). v. $NaBH_4$ reduction of benzophenone to diphenyl carbinol (solid-phase reaction). vi. Claisen rearrangement of allylphenyl ether to 2-allyl phenol (solvent-free synthesis). vii. Synthesis of dicoumarol (solvent-free synthesis).		CO1, CO2, CO3, CO4	K1, K2, K3, K4
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanations revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.			

Texts:	1. V. K. Ahluwalia, R. Aggarwal, Organic Synthesis, Narosa Publishing House, New Delhi, India, 2001. 2. D. L. Pavia, G. M. Lampman, G. S. Kriz, Introduction to Organic Laboratory Techniques, 2nd Ed., Saunders College Publishing, Fort Worth, TX, USA, 1995. 3. P. T. Anastas, T. C. Williamson, Green Chemistry: Frontiers in Benign Chemical Synthesis and Processes, Oxford University Press, Oxford, UK, 1998.
References/ Readings:	1. A. Loupy, Microwaves in Organic Synthesis, 2nd Ed., Wiley–VCH Verlag, Weinheim, Germany, 2002. 2. A. S. Matlack, Introduction to Green Chemistry, Marcel Dekker, Inc., New York, NY, USA, 2001 3. D. W. Mayo, R. M. Pike, P. K. Trumper, Microscale Organic Laboratory, 3rd Ed., John Wiley and Sons, Inc., New York, NY, USA, 1994. 4. J. Kopeckey, Organic Photochemistry, VCH Publishers, Weinheim, Germany, 1992. 5. K. L. Williamson, Macroscale and Microscale Organic Experiments, 2nd Ed., D. C. Heath,, Lexington, MA, USA, 1994. 6. K. Tanaka, Solvent-Free Organic Synthesis, Wiley–VCH GmbH & Co. KGaA, Weinheim, Germany, 2003. 7. V. K. Ahluwalia, M. Kidwai, New Trends in Green Chemistry, Anamaya Publishers, New Delhi, India, 2004.
Web Resources:	https://www.orgsyn.org/

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Title of the Course	Organic Chemistry Practical – VI
Course Code	CHO-6206
Number of Credits	4
Theory/Practical	Practical
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses	
Course Objectives:	1. To understand the Green experimental techniques, including safety protocols for performing organic synthesis 2. To gain knowledge for the purification of final products from reaction mixtures 3. To learn practical skills in organic synthesis through key reactions and their transformations in the area of green synthesis and Natural Product chemistry. 4. To understand stoichiometric requirements in organic synthesis.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO1. Explain the principles and importance of green experimental techniques and demonstrate adherence to safety protocols in organic synthesis.	PSO1, PSO2, PSO3
	CO2. Apply appropriate purification methods (solvent-free conditions, room temperature reactions) to isolate and characterise final products obtained from reaction mixtures.	PSO1, PSO2, PSO3

	CO3. Calculate and analyse stoichiometric requirements to optimise reagent usage and minimise waste in organic synthesis		PSO1, PSO2, PSO3	
	CO4. Design and perform organic synthesis experiments using green chemistry approaches and evaluate their efficiency in the context of natural product chemistry.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Green Methods for functional group transformations (Any 6)** i. Nitration of phenol using copper/calcium nitrate in a microwave. ii. Bromination of acetanilide using KBr, CAN in a water-ethanol mixture. iii. Photoreduction of benzophenone to benzopinacol. iv. Synthesis of Adipic acid from Cyclohexene using hydrogen peroxide. v. Acetylation of aminonaphthols using acetic acid and zinc dust vi. Dehydration of 2-methylcyclohexanol using montmorillonite KSF Clay. vii. Catalytic Oxidation of benzyl alcohol to benzaldehyde using Hydrogen Peroxide. viii. Transesterification in the green synthesis of Biodiesel. ix. Enzymatic reduction of ethylacetoacetate using Baker's yeast.	**24**	CO1, CO2, CO3, CO4	K1 K2 K3 K4
Module 2:	**Green synthesis of reactions and reagents:(Any 6)** i. Clay catalysed Pechmann condensation for the synthesis of 7-hydroxy-4-methyl coumarin. ii. Multicomponent Biginelli Synthesis of 3,4-dihydropyrimidinone. iii. Photocatalysed synthesis of Benzopinacolone. iv. Diels-Alder reaction of furan and maleic anhydride in water. v. Aldol condensation between ketone and aldehyde via Mechano-Grinding. vi. Solvent-free Wittig reaction using potassium phosphate as a base. vii. Friedel Crafts alkylation using Graphite as a catalyst. viii. Grignard reaction using MeTHF as a solvent. ix. Pyridine-free Knoevenagel-Doebner condensation. x. Green synthesis of Bismuth nanoparticles and their application. xi. Green Synthesis of Copper nanoparticles and their application.	**36**	CO1, CO2, CO3, CO4	K1 K2 K3 K4

	xii. Synthesis of Tetrabutylammonium tribromide (TBATB). xiii. Extraction of papain enzyme from papaya and its application. xiv. Synthesis of Ionic liquid, 1-methyl-3-pentyl-imidazolium bromide [pmIm]Br. xv. Supercritical CO_2 for the extraction of *D*-Limonene. xvi. Preparation of DES-Choline chloride and urea and its application.			
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanations, revising the theoretical aspects of laboratory experiments before conducting each experiment.			
Texts:	1. D. L. Pavia, G. M. Lampman, G. S. Kriz, Introduction to Organic Laboratory Techniques, 2nd Ed., Saunders College Publishing, Fort Worth, TX, USA, 1995. 2. P. T. Anastas, T. C. Williamson, Green Chemistry: Frontiers in Benign Chemical Synthesis and Processes, Oxford University Press, Oxford, UK, 1998. 3. V. K. Ahluwalia, R. Aggarwal, Organic Synthesis, Narosa Publishing House, New Delhi, India, 2001.			
References/ Readings:	1. A. S. Matlack, Introduction to Green Chemistry, Marcel Dekker, Inc., New York, NY, USA, 2001. 2. D. W. Mayo, R. M. Pike, P. K. Trumper, Microscale Organic Laboratory, 3rd Ed., John Wiley and Sons, Inc., New York, NY, USA, 1994. 3. K. L. Williamson, D. C. Heath, Macroscale and Microscale Organic Experiments, 2nd Ed., D. C. Heath and Company, Lexington, MA, USA, 1994. 4. K. Tanaka, Solvent-Free Organic Synthesis, Wiley–VCH GmbH & Co. KGaA, Weinheim, Germany, 2003. 5. V. K. Ahluwalia, M. Kidwai, New Trends in Green Chemistry, Anamaya Publishers, New Delhi, India, 2004.			
Web Resources:	1. https://www.orgsyn.org/ 2. https://doi.org/10.1016/j.scp.2021.100547			

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Title of the Course	Organic Chemistry Practical – VII
Course Code	CHO-6207
Number of Credits	4
Theory/Practical	Practical
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 courses	
Course Objectives:	1. To understand divergent and convergent synthetic strategies and reaction mechanisms used in modern organic synthesis. 2. To develop a conceptual understanding of multistep synthesis used in modern organic synthesis. 3. To familiarize students with the use of spectroscopic techniques (UV–Vis, IR, NMR, MS) for structural elucidation of synthesized compounds. 4. To correlate chemical tests with instrumental data to confirm compound identity and purity.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO1. carry out single-step and multistep organic syntheses using classical and modern synthetic methods under controlled laboratory conditions.	PSO1, PSO2, PSO3
	CO2. apply divergent synthetic planning and multicomponent synthesis to derive organic	PSO1, PSO2, PSO3

	compounds.			
	CO3. interpret IR, UV–Vis, NMR, and mass spectral data for the structural identification of synthesized and isolated organic compounds.		PSO1, PSO2, PSO3	
	CO4. perform chemical tests with instrumental data to confirm compound identity and purity.		PSO1, PSO2, PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	**Divergent Synthesis-I (Any two)** i. Acetophenone to Ethyl benzene by Wolf Kishner/Clemmensen's reduction ii. Acetophenone to *m*-nitro acetophenone by nitration iii. Acetophenone into Schiff base using aromatic amine iv. Acetophenone to benzoic acid and iodoform **Divergent Synthesis-II (Any two)** i. Acetanilide to *p*-nitroacetanilide ii. Acetanilide to *p*-nitroaniline iii. Acetanilide to *p*-bromoacetanilide iv. Acetanilide to aniline **Divergent Synthesis-III (Any two)** i. Benzaldehyde to benzylalcohol ii. Benzaldehyde to benzoic acid iii. Benzaldehyde to oxime iv. Benzaldehyde to hydrazone v. Benzaldehyde to cinnamic acid	**24**	CO1, CO2	K1, K2, K3, K4
Module 2:	**Organic synthesis and identification through organic spotting (Any Four)** i. Methylbenzoate to benzoic acid ii. Borneol to camphor iii. Aniline to tribromoaniline iv. *p*-Nitroacetophenone to *p*-nitrobenzoic acid	**32**	CO1, CO4	K1, K2, K3, K4

	v. *m*-Nitro aniline from *m*-dinitro benzene vi. *p*-Chlorotoluene from *p*-Toluidine vii. Nitrobenzene to m-dinitrobromobenzene viii. Bromobenzene to p-nitro bromobenzene ix. Acetophenone to benzoic acid			
Module 3:	**Multistep Synthesis and Identification (Chemical/Spectroscopic)** (Any Four) i. Benzamide to aniline to acetanilide ii. Nitroaromatic compounds to amines to amide derivatives iii. Methylbenzoate to *p*-nitromethylbenzoate to *p*-nitrobenzoic acid iv. Benzaldehyde to cinnamic acid to styrene v. Aniline to diazoaminobenzene to *p*-aminobenzene vi. Phenol to *p*-nitrophenol to *p*-nitroanisole vii. Benzaldehyde to dibenzylideneacetone to 1,5-diphenyl-3-styryl-2-pyrazoline viii. Benzaldehyde to *m*-nitrobenzaldehyde to *m*-nitrophenyl methanol ix. One pot synthesis: MCR convergent Synthesis I a. 4-Nitro toluene to 4-amino toluene b. Synthesis of amidoalkyl-2-naphthol from 4-amino toluene and of 2-hydroxy benzaldehyde x. One pot synthesis: MCR convergent synthesis II a. 4-nitro anisole to 4-amino anisole b. 4-nitro toluene to 3-acyl nitro toluene c. Synthesis of N-(1-(2-methyl-5-nitrophenyl) ethyl) aniline from 4-amino anisole, 3-acyl nitro toluene and $NaBH_4$ xi. One pot synthesis: MCR Convergent Synthesis III a. 4-Nitro toluene to 4-amino toluene b. Phenol into 2-hydroxy benzaldehyde c. Synthesis of amidoalkyl-2-Naphthol from 2-Naphthol, 4-amino toluene and 2-hydroxy benzaldehyde xii. Succinic acid to Succinic anhydride to succinimide	**64**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6

	xiii. Benzamide to benzonitrile to benzoic acid
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanations revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.
Texts:	1. A. I. Vogel, Elementary Practical Organic Chemistry: Part 1 – Small Scale Preparations, 2nd Ed., Pearson, New Delhi, India, 2010. 2. B. N. Campbell Jr., M. M. Ali, Organic Chemistry Experiments, Brooks Cole, USA, 1994. 3. B. S. Furniss, Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Longman, London, UK, 1989. 4. D. L. Pavia, G. M. Lampman, G. S. Kriz, R. G. Engel, A Microscale Approach to Organic Laboratory Techniques, 5th Ed., Wadsworth Publishing, Belmont, USA, 2012. 5. D. W. Mayo, R. M. Pike, S. S. Butcher, Microscale Organic Laboratory, John Wiley & Sons, New York, NY, USA, 1989. 6. F. G. Mann, B. C. Saunders, Practical Organic Chemistry, 4th Ed., Pearson, New Delhi, India, 2009. 7. J. C. Gilbert, S. F. Martin, Experimental Organic Chemistry: A Miniscale and Microscale Approach, 5th Ed., Brooks Cole, USA, 2011. 8. K. L. Williamson, K. M. Masters, Macroscale and Microscale Organic Experiments, 6th Ed., Brooks Cole, USA, 2011. 9. N. K. Vishnoi, Advanced Practical Organic Chemistry, 3rd Ed., Vikas Publishing, New Delhi, India, 2009. 10. R. K. Bansal, Laboratory Manual of Organic Chemistry, Wiley Eastern, New Delhi, India, 1994.
References/ Readings:	1. E. S. Gould, Mechanism and Structure in Organic Chemistry, Holt, Rinehart and Winston, New York, NY, USA, 1965. 2. M. B. Smith, J. March, Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 6th Ed., Wiley, New York, NY, USA, 2006.
Web Resources:	https://www.orgsyn.org/

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DISSERTATION (40 Credits)

Title of the Course	Discipline Specific Dissertation (DSD)
Course Code	CHO-6501
Number of Credits	40
Theory/Practical	Practical
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 Courses	
Course Objectives:	To develop the skills of preparing and conducting independent research.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO 1. explain the reactions used in organic synthesis.	PSO1
	CO 2. use appropriate chemical methods to prepare target compounds.	PSO2
	CO 3. analyze and interpret experimental data to draw meaningful conclusions.	PSO3
	CO 4. design and conduct independent research projects using appropriate chemical methodologies.	PSO4

Approved by: Standing Committee of the Academic Council on 24th & 25th November 2025

Content		No of hours	Mapped to CO	Cognitive Level
Module 1:	As per OA-35A	**1200**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Dissertation carried out individually by each student throughout the academic year.			
Texts:	As required for the development of review and methodology.			
Reference/readings	As required for the development of review and methodology.			
Web Resources	As required for the development of review and methodology.			

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DISSERTATION (20 Credits)

Title of the Course	Discipline Specific Dissertation (DSD)
Course Code	CHO-6502
Number of Credits	20
Theory/Practical	Practical
Level	500
Effective from AY	2026-27
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Level 400 Courses	
Course Objectives:	To develop the skills of preparing and conducting independent research.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO 1. explain the reactions used in organic synthesis.	PSO1
	CO 2. use appropriate chemical methods to prepare target compounds.	PSO2
	CO 3. analyze and interpret experimental data to draw meaningful conclusions.	PSO3
	CO 4. design and conduct independent research projects using appropriate chemical methodologies.	PSO4

Content		No of hours	Mapped to CO	Cognitive Level
Module 1:	As per OA-35A	**600**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Dissertation carried out individually by each student throughout the academic year.			
Texts:	As required for the development of review and methodology.			
Reference/readings	As required for the development of review and methodology.			
Web Resources	As required for the development of review and methodology.			

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