

# गोंय विद्यापीठ

ताळगांव पठार,

गोंय - ४०३ २०६

फोन : + ९१ - ८६६९६०९०४८



(Accredited by NAAC with Grade A+)

## Goa University

Taleigao Plateau, Goa - 403 206

Tel : +91-8669609048

Email : registrar@unigoa.ac.in

Website : www.unigoa.ac.in

GU/Acad –PG/BoS -NEP/2025-26/30

Date: 04.07.2025

### CIRCULAR

Ref. No.: GU/Acad –PG/BoS -NEP/2025-26/227 dated 04.07.2025

In supersession to the above referred Circular, the syllabus of Semester III & IV of the **Master of Science in Pharmaceutical Chemistry** Programme approved by the Standing Committee of the Academic Council in its meeting held on 24<sup>th</sup> & 25<sup>th</sup> November 2025 is attached. The syllabus of Semester I & II approved earlier by the Academic Council on 13<sup>th</sup> & 14<sup>th</sup> 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 Pharmaceutical 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)  
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 Pharmaceutical Chemistry Programme.

Copy to:

1. Chairperson, BoS in Chemistry, Goa University.
2. Programme Director, M.Sc. Pharmaceutical 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 PHARMACEUTICAL CHEMISTRY

(Effective from the Academic Year 2025-26)

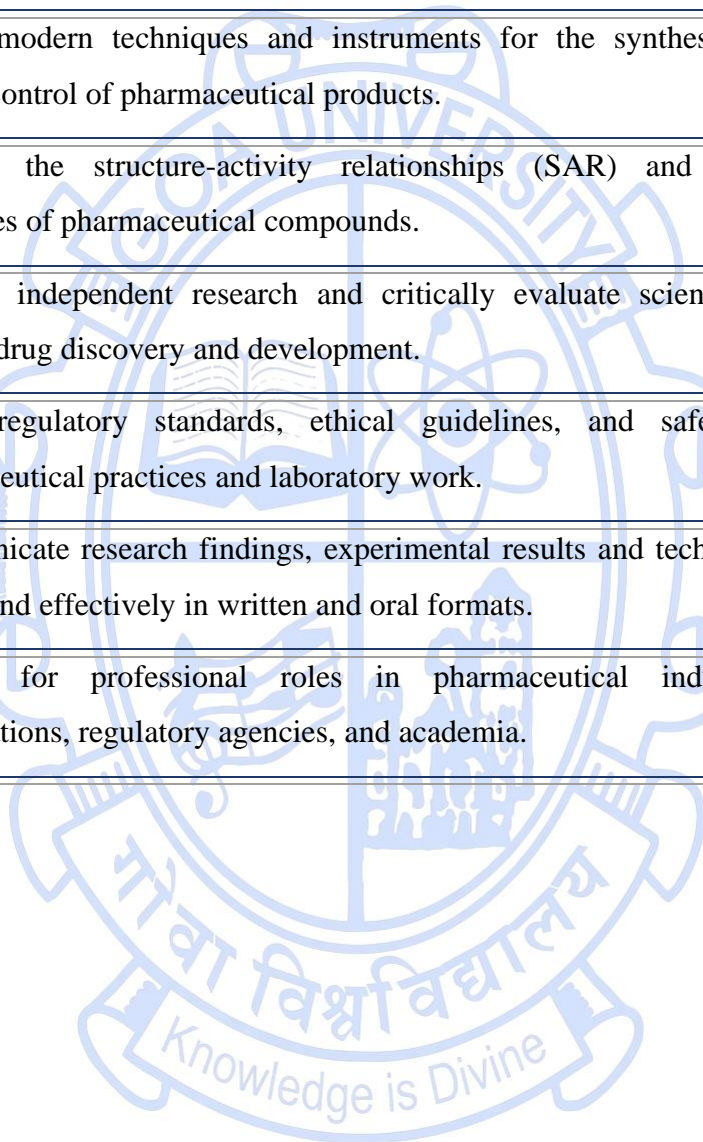
### ABOUT THE PROGRAMME

The M.Sc. Pharmaceutical Chemistry program is a two-year postgraduate course designed to provide an in-depth understanding of the chemical and analytical aspects of drug development and pharmaceutical sciences. The course integrates key concepts from organic, inorganic, medicinal, and analytical chemistry with pharmaceutical applications to equip students with the knowledge and skills required in modern drug discovery, development, and quality control. Emphasis is placed on the synthesis of medicinal compounds, structure-activity relationships, pharmacokinetics, drug formulation, and regulatory affairs. The curriculum includes theoretical instruction, laboratory training, and a research-based dissertation project to foster critical thinking, scientific inquiry, and technical proficiency. This program prepares graduates for careers in the pharmaceutical industry, research and development laboratories, regulatory agencies, and academic institutions, while also serving as a strong foundation for pursuing doctoral studies in related fields.

### OBJECTIVES OF THE PROGRAMME

1. To provide fundamental and advanced knowledge of pharmaceutical chemistry.
2. To develop skills in drug synthesis, analysis, and formulation.
3. To enhance laboratory techniques and research capabilities.
4. To prepare students for careers in pharmaceutical industries and research.

<b>PROGRAMME SPECIFIC OUTCOMES (PSO)</b>	
<b>PSO 1.</b>	Demonstrate a comprehensive understanding of pharmaceutical chemistry, including drug design, synthesis and evaluation.
<b>PSO 2.</b>	Apply advanced knowledge of organic, inorganic, medicinal, and analytical chemistry in pharmaceutical research and development.
<b>PSO 3.</b>	Utilize modern techniques and instruments for the synthesis, analysis, and quality control of pharmaceutical products.
<b>PSO 4.</b>	Analyze the structure-activity relationships (SAR) and pharmacokinetic properties of pharmaceutical compounds.
<b>PSO 5.</b>	Conduct independent research and critically evaluate scientific literature to support drug discovery and development.
<b>PSO 6.</b>	Apply regulatory standards, ethical guidelines, and safety protocols in pharmaceutical practices and laboratory work.
<b>PSO 7.</b>	Communicate research findings, experimental results and technical information clearly and effectively in written and oral formats.
<b>PSO 8.</b>	Prepare for professional roles in pharmaceutical industries, research organizations, regulatory agencies, and academia.



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

<b>Bridge Course</b>			
Sr. No.	Course Code	Title of the Course	Credits
1	<a href="#"><u>CHC-1000</u></a>	Bridge Course in mathematical concepts for chemistry	1
2	<a href="#"><u>CHC-1001</u></a>	Bridge Course in organic chemistry	1

<b>SEMESTER I</b>				
<b>Discipline Specific Core (DSC) Courses (16 credits)</b>				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	<a href="#"><u>CHO-5000</u></a>	Fundamental Concepts in Organic Chemistry	4	400
2	<a href="#"><u>CHH-5000</u></a>	Basics of Pharmaceutical Chemistry	4	400
3	<a href="#"><u>CHP-5000</u></a>	Fundamentals of Physical Chemistry	4	400
4	<a href="#"><u>CHA-5000</u></a>	Analytical Chemistry Techniques	4	400
<b>Total Credits for DSC Courses in Semester I</b>			<b>16</b>	
<b>Discipline Specific Elective (DSE) Course (4 credits)</b>				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	<a href="#"><u>CHH-5201</u></a>	Pharmaceutical Chemistry Practical - I	2	400
2	<a href="#"><u>CHH-5202</u></a>	Pharmaceutical Chemistry Practical - II	2	400
3	<a href="#"><u>CHO-5201</u></a>	Organic Chemistry Practical - I	2	400
4	<a href="#"><u>CHO-5202</u></a>	Organic Chemistry Practical - II	2	400
5	<a href="#"><u>CHP-5201</u></a>	Physical Chemistry Practical - I	2	400
6	<a href="#"><u>CHP-5202</u></a>	Physical Chemistry Practical - II	2	400
7	<a href="#"><u>CHA-5201</u></a>	Analytical Chemistry Practical - I	2	400
8	<a href="#"><u>CHA-5202</u></a>	Analytical Chemistry Practical - II	2	400
<b>Total Credits for DSE Courses in Semester I</b>			<b>4</b>	
<b>Total Credits in Semester I</b>			<b>20</b>	

<b>SEMESTER II</b>				
<b>Discipline Specific Core (DSC) Courses</b>				
<b>Sr. No.</b>	<b>Course Code</b>	<b>Title of the Course</b>	<b>Credits</b>	<b>Level</b>
1	<a href="#"><u>CHH-5001</u></a>	Advance Pharmaceutical Chemistry	4	500
2	<a href="#"><u>CHH-5002</u></a>	Drugs: Product Development, Formulation and Manufacture	4	500
3	<a href="#"><u>CHH-5003</u></a>	Drugs: Discovery, Design and Development	4	500
4	<a href="#"><u>CHH-5004</u></a>	Pharmacokinetics and Biopharmaceutics	4	500
<b>Total Credits for DSC Courses in Semester II</b>			<b>16</b>	
<b>Discipline Specific Elective (DSE) Courses (4 credits)</b>				
<b>Sr. No.</b>	<b>Course Code</b>	<b>Title of the Course</b>	<b>Credits</b>	<b>Level</b>
1	<a href="#"><u>CHH-5201</u></a>	Pharmaceutical Chemistry Practical - I	2	400
2	<a href="#"><u>CHH-5202</u></a>	Pharmaceutical Chemistry Practical - II	2	400
3	<a href="#"><u>CHO-5201</u></a>	Organic Chemistry Practical - I	2	400
4	<a href="#"><u>CHO-5202</u></a>	Organic Chemistry Practical - II	2	400
5	<a href="#"><u>CHP-5201</u></a>	Physical Chemistry Practical - I	2	400
6	<a href="#"><u>CHP-5202</u></a>	Physical Chemistry Practical - II	2	400
7	<a href="#"><u>CHA-5201</u></a>	Analytical Chemistry Practical - I	2	400
8	<a href="#"><u>CHA-5202</u></a>	Analytical Chemistry Practical - II	2	400
<b>Total Credits for DSE Courses in Semester II</b>			<b>4</b>	
<b>Total Credits in Semester II</b>			<b>20</b>	

<b>SEMESTER III</b>				
<b>Research Specific Elective (RSE) Courses (12 credits)</b>				
<b>Sr. No.</b>	<b>Course Code</b>	<b>Title of the Course</b>	<b>Credits</b>	<b>Level</b>
1	<a href="#">CHH-6000</a>	Pharmaceutical Chemistry Practical-III	4	500
2	<a href="#">CHH-6001</a>	Pharmaceutical Chemistry Practical-IV	4	500
3	<a href="#">CHH-6002</a>	Polymers in Pharmaceuticals and Novel Drug Delivery Systems	4	500
4	<a href="#">CHH-6003</a>	Bioorganic and Medicinal Chemistry	4	500
5	<a href="#">CHH-6004</a>	Drug Quality and Regulatory Affairs	4	500
6	<a href="#">CHH-6005</a>	API Process, Manufacture and Green Chemistry	4	500
7	<a href="#">CHH-6006</a>	Research Methodology in Pharmaceutical Chemistry and Instrumental Techniques	4	500
<b>Total Credits for RSE Courses in Semester III</b>			<b>12</b>	
<b>Discipline Specific Vocational Elective (DSVE) Courses (8 credits)</b>				
<b>Sr. No.</b>	<b>Course Code</b>	<b>Title of the Course</b>	<b>Credits</b>	<b>Level</b>
1	<a href="#">CHH-6401</a>	Pharmaceutical and Spectral Analysis	2T+2P	500
2	<a href="#">CHH-6402</a>	Pharmaceutical Calibration and Validation	2T+2P	500
3	<a href="#">CHH-6403</a>	Herbal Drug Technology and Cosmetology	2T+2P	500
4	<a href="#">CHH-6404</a>	Pharmaceutical Manufacturing Technology	2T+2P	500
<b>Total Credits for DSVE Courses in Semester III</b>			<b>8</b>	
<b>Total Credits in Semester III</b>			<b>20</b>	

<b>Discipline Specific Dissertation (DSD) (40 Credit Dissertation)</b>				
<b>Discipline Specific Dissertation (DSD)</b>				
<b>Sr. No.</b>	<b>Course Code</b>	<b>Title of the Course</b>	<b>Credits</b>	<b>Level</b>
1	<a href="#">CHH-6501</a>	Discipline Specific Dissertation (DSD)	40	500

<b>SEMESTER IV</b>				
<b>Generic Elective (GE) Courses (20 credits)</b>				
<b>Sr. No.</b>	<b>Course Code</b>	<b>Title of the Course</b>	<b>Credits</b>	<b>Level</b>
1	<a href="#"><u>CHH-6201</u></a>	Pharmacological and Toxicological Screening Techniques	4	500
2	<a href="#"><u>CHH-6202</u></a>	GMP, GLP & Pharmaceutical Technology	4	500
3	<a href="#"><u>CHH-6203</u></a>	Pharmaceutical Biotechnology and Forensic Science	4	500
4	<a href="#"><u>CHH-6204</u></a>	Advance Pharmaceutical Chemistry-II	4	500
5	<a href="#"><u>CHH-6205</u></a>	Pharmacotherapeutics	4	500
6	<a href="#"><u>CHH-6206</u></a>	Pharmaceutical Chemistry Practical – V	4	500
7	<a href="#"><u>CHH-6207</u></a>	Pharmaceutical Chemistry Practical – VI	4	500
8	<a href="#"><u>CHH-6208</u></a>	Pharmaceutical Chemistry Practical – VII	4	500
<b>Total Credits for GE Courses in Semester IV</b>			<b>20</b>	

<b>Discipline Specific Dissertation (DSD) (20 Credit Dissertation)</b>				
<b>Sr. No.</b>	<b>Course Code</b>	<b>Title of the Course</b>	<b>Credits</b>	<b>Level</b>
1	<a href="#"><u>CHH-6502</u></a>	Discipline Specific Dissertation (DSD)	<b>20</b>	<b>500</b>

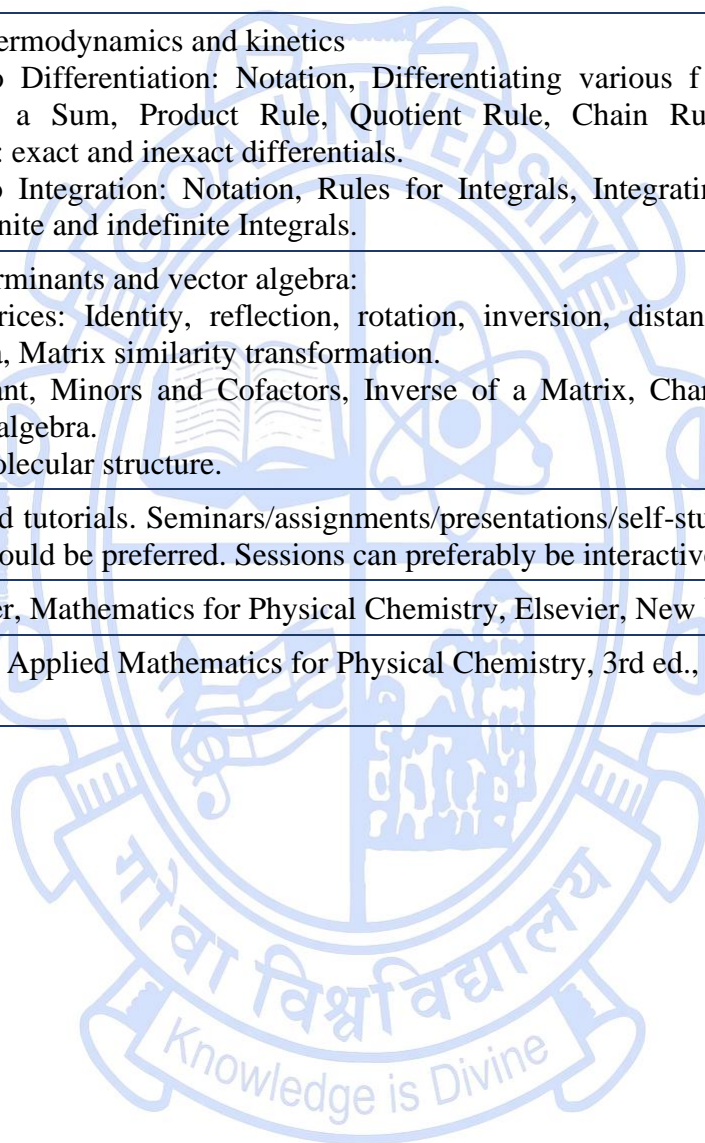
<b>Blooms Taxonomy Cognitive Levels</b>	
<b>Cognitive Level</b>	<b>Notations</b>
K1	Remembering
K2	Understanding
K3	Applying
K4	Analyzing
K5	Evaluating
K6	Create

## BRIDGE COURSES

<b>Title of the Course</b>	Bridge Course in Mathematical Concepts for Chemistry		
<b>Course Code</b>	CHC-1000		
<b>Number of Credits</b>	1		
<b>Theory/Practical</b>	Theory		
<b>Level</b>	400		
<b>Effective from AY</b>	2025-26		
<b>New Course</b>	No		
<b>Bridge Course/ Value added Course</b>	Yes		
<b>Course for advanced learners</b>	No		
<b>Pre-requisites for the Course:</b>	NIL		
<b>Course Objectives:</b>	To introduce mathematical concepts to the students of MSc Part-I (Chemistry).		
<b>Course Outcomes:</b>	Students will be able to solve problems based on:	<b>Mapped to PSO</b>	
	CO 1. Matrices in M.Sc. Chemistry	PSO1	
	CO 2. Determinants in M.Sc. Chemistry	PSO1	
	CO 3. Differential calculus in M.Sc. Chemistry	PSO1	
	CO 4. Integral calculus in M.Sc. Chemistry	PSO1	
<b>Content:</b>		<b>No of</b>	<b>Mapped Cognitive</b>

		hours	to CO	Level
<b>Module 1:</b>	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
<b>Module 2:</b>	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
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	Robert G. Mortimer, Mathematics for Physical Chemistry, Elsevier, New York. 4th ed., 2013			
<b>References/ Readings:</b>	James R. Barrante, Applied Mathematics for Physical Chemistry, 3rd ed., Prentice-Hall, New Jersey, 1998			

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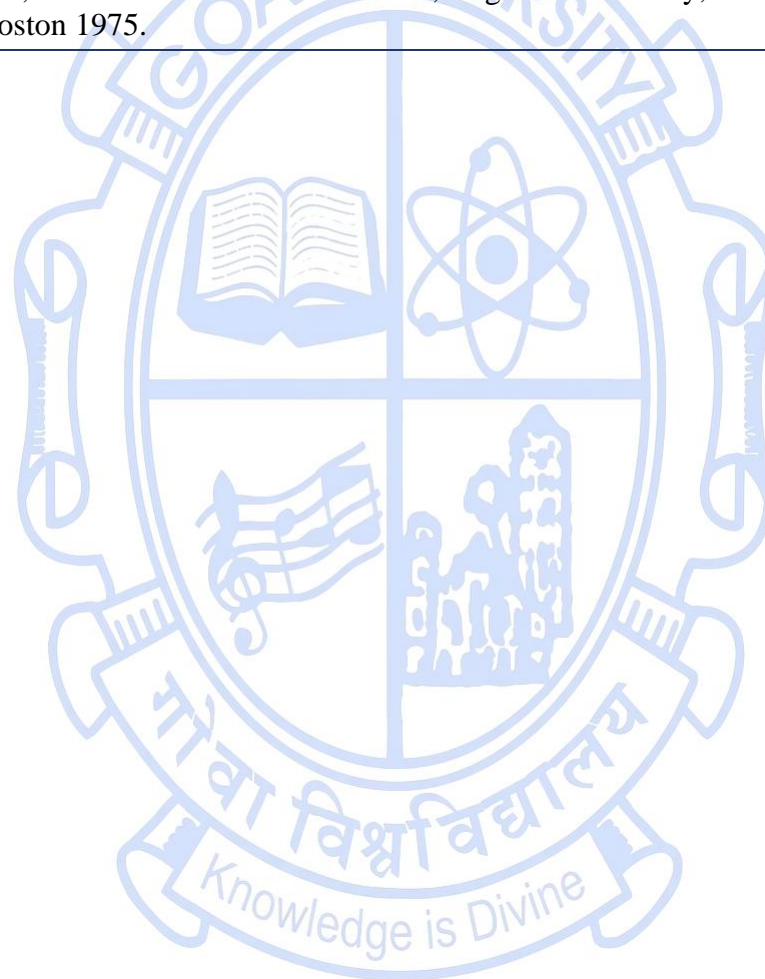


<b>Title of the Course</b>	Bridge Course in Organic Chemistry		
<b>Course Code</b>	CHC-1001		
<b>Number of Credits</b>	1		
<b>Theory/Practical</b>	Theory		
<b>Level</b>	400		
<b>Effective from AY</b>	2025-26		
<b>New Course</b>	No		
<b>Bridge Course/ Value added Course</b>	Yes		
<b>Course for advanced learners</b>	No		
<b>Pre-requisites for the Course:</b>	NIL		
<b>Course Objectives:</b>	<ul style="list-style-type: none"> <li>• To understand various principles of organic chemistry.</li> <li>• To apply the importance of chirality in organic syntheses.</li> <li>• To analyse stereoselective reactions.</li> <li>• To interpret oxidation and reduction reactions.</li> </ul>		
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>	
	CO 1. understand knowledge of basic reaction mechanisms in organic transformation.	PSO2	
	CO 2. apply chirality in organic synthesis.	PSO2	
	CO 3. compare configurations/ conformations of organic molecules.	PSO2	
	CO 4. assess oxidizing and reducing reagents in organic synthesis.	PSO2	
<b>Content:</b>		<b>No of</b>	<b>Mapped</b> <b>Cognitive</b>

		hours	to CO	Level
<b>Module 1:</b>	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
<b>Module 2:</b>	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
<b>Module 3:</b>	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
<b>Module 4:</b>	4. Oxidation and reduction reactions: Basic concepts, oxidizing and reducing reagents and some examples.	2	CO4	K3, K4
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. D. Nassipuri, Stereochemistry of Organic compounds - Principles and Application, 4th ed., Wiley Eastern Limited, New Academic Science Limited, Lucknow, India, 2013</li> <li>2. E. L. Eliel, Stereochemistry of carbon compounds, Tata MacGraw Hill Publishing Company Ltd., New Delhi, 1990.</li> <li>3. J. March, Advanced Organic Chemistry: Reaction, Mechanism and Structure, 4th ed., Wiley, USA, 2010.</li> <li>4. J. Clayden, N. Greeves, S. Warren &amp; Wothers, Organic Chemistry, 2nd ed., Oxford University Press, Oxford, 2012</li> <li>5. I. L. Finar Stereochemistry and Chemistry of Natural products, Vol. 2, 3rd ed., Longmans, ELBS London, 1963</li> <li>6. F. A. Carey and R.J. Sundberg, Advanced Organic Chemistry, Vol. I &amp; II. Plenum Press, New York, 1977</li> <li>7. E. S. Gould et al., Mechanism and structure in Organic Chemistry, Holt, Rinehart And Winston, New York, 1965</li> <li>8. F. A. Carey, Organic Chemistry, 4th ed., McGraw-Hill Higher Education, USA, 2000</li> </ol>			

	9. S. H. Pine, Organic Chemistry, 5th ed., McGraw-Hill International Education, New York, 2010
<b>References/ Readings:</b>	<ol style="list-style-type: none"><li>1. V. M. Potapov, Stereochemistry, MIR Publishers, Moscow, 1979</li><li>2. J. M. Harris &amp; C.C. Wamser, Fundamentals of Organic Reaction Mechanisms, John Wiley &amp; Sons. Inc. New Jersey, 1976.</li><li>3. F. M. Menger, D.J. Goldsmith &amp; L. Mendell, Organic Chemistry, A concise approach, 2nd ed., Addison Wesley Longman, Boston 1975.</li></ol>

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## SEMESTER I

### Discipline Specific Core Courses

<b>Title of the Course</b>	Fundamental Concepts in Organic Chemistry	
<b>Course Code</b>	CHO-5000	
<b>Number of Credits</b>	4	
<b>Theory/Practical</b>	Theory	
<b>Level</b>	400	
<b>Effective from AY</b>	2025-26	
<b>New Course</b>	Yes	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	NIL	
<b>Course Objectives:</b>	<ul style="list-style-type: none"><li>• To study the various concepts based on molecular orbital theory, Aromaticity, Acids and bases.</li><li>• To understand the concepts of stereochemistry and their significance in determining the structure, reactivity, and properties of organic molecules</li><li>• To understand the mechanistic aspects of various type of reactions in organic synthesis and the use of selective reagents in organic transformations.</li></ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>

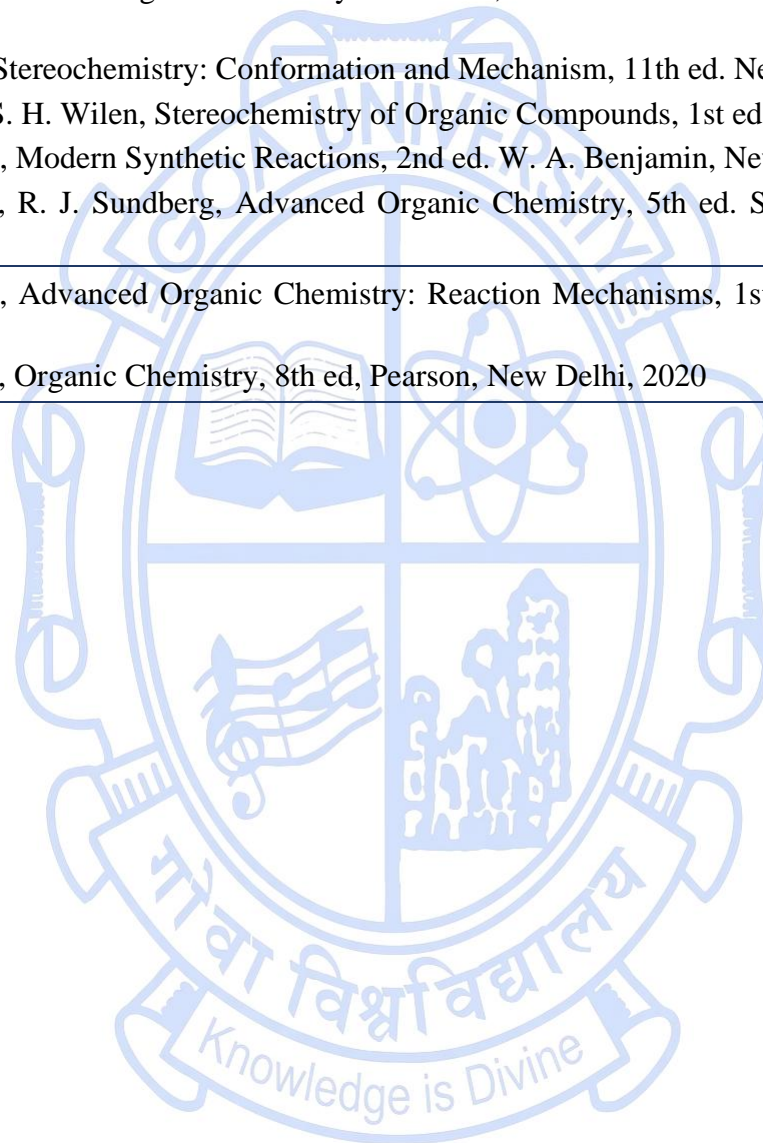
	CO 1. Understand the effect of delocalization of electrons & presence or absence of aromaticity in organic compounds.		PSO1, PSO 2	
	CO 2. Apply various concepts in stereochemistry to understand stereochemical outcome in a reaction.		PSO1, PSO 2	
	CO 3. Evaluate plausible mechanisms of organic reactions.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

	<p>diol, 2,3-dibromobutane etc.). <i>Erythro</i> and <i>threo</i> nomenclature.</p> <p>c. Topicity and Prostereoisomerism: Topicity of ligands and faces-homotopic, enantiotopic and diastereotopic, ligands and faces.</p> <p>d. Chemoselective, regioselective and stereoselective reactions with examples.</p> <p>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.</p> <p>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.</p>			
<b>Module 3:</b>	<p><b>3.1 Reaction Mechanism</b></p> <p>a. Structure, stability and reactivity of reactive intermediates (carbocations, carbanions, free radicals, carbenes, arynes and nitrenes)</p> <p>b. Types of mechanisms, types of reactions, thermodynamic and kinetic control.</p> <p>c. Methods of determining reaction mechanisms:</p> <ol style="list-style-type: none"> <li>Identification of products.</li> <li>Determination of the presence of intermediates (isolation, detection, trapping and addition of suspected intermediate.</li> <li>Isotopic labelling.</li> <li>Stereochemical evidence.</li> <li>Kinetic evidence and Isotope effect. (at least two examples to be covered for above methods)</li> </ol> <p><b>3.2 Selective reagents for Organic transformation</b></p> <p>a. Oxidation of organic compounds: PCC, PDC and MnO<sub>2</sub>, ozonolysis,</p>	<b>15</b>	CO <sub>2</sub> , CO <sub>3</sub>	K1, K2, K3, K4, K5

	peracids. b. Reduction of organic compounds: NaBH <sub>4</sub> , LAH, DIBAL reduction and reduction with borane and dialkylboranes. Clemmensen reduction, Birch reduction and Wolff-Kishner reduction			
<b>Module 4:</b>	<p><b>4.1 Aliphatic Nucleophilic substitution</b></p> <p>a. Nucleophilic substitutions with respect to mechanism and various factors affecting such reactions.</p> <p>b. The Neighbouring Group Participation (NGP)/ Anchimeric assistance: General approach to various NGP processes; NGP by unshared/lone pair of electrons; NGP by <math>\pi</math>-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)</p> <p><b>4.2 Elimination reactions</b></p> <p>a. The E<sub>2</sub>, E<sub>1</sub> and E<sub>1</sub>cB mechanisms. Orientation of the double bond, Saytzeff and Hofmann rule.</p> <p>b. Effects of substrate, base, leaving group and medium on:</p> <p>i. Overall reactivity</p> <p>ii. E<sub>1</sub> vs. E<sub>2</sub> vs. E<sub>1</sub>cB</p> <p>iii. Elimination vs substitution, mechanism and orientation in pyrolytic <i>syn</i> elimination (various examples involving cyclic and acyclic substrates to be studied).</p>	<b>15</b>	CO3. CO4	K1, K2, K3, K4, K5
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th ed. Pearson Education, New Delhi, 2010</li> <li>2. D. Nassipuri, Stereochemistry of Organic Compounds: Principles and Applications, 4th ed. New Age International, New Delhi, 2020</li> <li>3. J. Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, 2nd ed. Oxford University Press, Oxford, 2012</li> </ol>			

	<ol style="list-style-type: none"><li>4. J. March, Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 4th ed. Wiley Student Edition, New York, 2003.</li><li>5. P. S. Kalsi, Stereochemistry: Conformation and Mechanism, 11th ed. New Age International, New Delhi, 2022</li><li>6. E. L. Eliel, S. H. Wilen, Stereochemistry of Organic Compounds, 1st ed. John Wiley and Sons, New York, 1994</li><li>7. H. O. House, Modern Synthetic Reactions, 2nd ed. W. A. Benjamin, New York, 1965</li><li>8. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, 5th ed. Springer India Private Limited, New Delhi, 2007</li></ol>
<b>References/ Readings:</b>	<ol style="list-style-type: none"><li>1. R. Bruckner, Advanced Organic Chemistry: Reaction Mechanisms, 1st ed. Harcourt/Academic Press, San Diego, 2002.</li><li>2. P. Y. Bruice, Organic Chemistry, 8th ed, Pearson, New Delhi, 2020</li></ol>

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<b>Title of the Course</b>	Basics of Pharmaceutical Chemistry	
<b>Course Code</b>	CHH-5000	
<b>Number of Credits</b>	4	
<b>Theory/Practical</b>	Theory	
<b>Level</b>	400	
<b>Effective from AY</b>	2025-2026	
<b>New Course</b>	No	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	Nil	
<b>Course Objectives:</b>	<ul style="list-style-type: none"> <li>• To get introduced to pharmaceutical chemistry and terms involved.</li> <li>• To understand the various classes of drugs with examples.</li> <li>• To learn the Structure, IUPAC name and Mechanism of action of drugs.</li> <li>• To acquire knowledge of structure activity relationships and synthesis.</li> </ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	CO 1. Explain the various categories of drugs and their physico-chemical properties, metabolism and assay.	PSO 1
	CO 2. Explain the structures, synthesis and mechanism/mode of action of drugs.	PSO 2, PSO 3
	CO 3. Analyze the drugs based on nature, structure, bioactivity and its SAR.	PSO 4

	CO 4. Evaluate the case study of drugs for a particular disease.	PSO 6, PSO 8		
Content:	Pharmaceutical chemistry, physicochemical properties of drugs, drug metabolism and assay of drugs:	No of hours	Mapped to CO	Cognitive Level
<b>Module 1:</b>	<p>Role of chemistry in pharmacy: Introduction to pharmaceutical chemistry. Need to study pharmaceutical chemistry. Important terminologies: pharmacodynamics, pharmacokinetics, pharmacognosy, materia medica, toxicology, pharmacopoeia, pharmacophore, effect of functional groups on physiological activity of drugs: hydroxy, acidic, alkyl, aldehyde, ketone, cyano, halogens, ether and ester groups with examples.</p> <p>Physicochemical properties of drugs: effect of solubility, partition coefficient, ionization constant, surface active agents, chelation, hydrogen bonding, stereoisomers on the pharmacological action of drugs (specific example of API to be given). Drug action, drug metabolism-significance of drug metabolism. phase I, phase II pathways with reactions. Factors on which drug metabolism depends. Assay of drugs-chemical, biological and immunological assay.</p>	12	CO1, CO2, CO3	K1, K2, K3, K4
<b>Module 2:</b>	<p><b>Classification of chemotherapeutic drugs: Development of the following drugs including structure activity relationship (SAR), mechanisms of action (MA), chemical nomenclature, generic names (GN) and side effects (SE).</b></p> <p><b>Note: outline of synthesis (\$) of the selected drugs.</b></p> <p><b>Anti-Infective agents-I:</b></p> <p><b>Antiseptics and Disinfectants:</b> Alcohols, substituted phenols, Methenamine Mandelate, Chloramine-T, 8-hydroxy quinoline derivatives, Acridine derivatives, Mercurials like (Mercurochrome, Thiomersal) and Nitrofurantoin derivative, Triclosan\$. <b>Antitubercular agents-</b> Aminosalicylic acid, PAS, Pyrazinamide\$, Ethambutol\$, Clofazimine, <b>Antimalarials:</b> Life cycle of parasite, drug acting on different stages- Quinine, Chloroquine\$, Primaquine, Trimethoprim, Proguanil (MA), Cycloguanil, Drug combinations. <b>Antiamoebics:</b> General aspect of infection, Life cycle of parasite, Hydroxyl quinolines, Metronidazole\$, Lucanthone, <b>Anthelmintics:</b></p>	12	CO1, CO2	K2, K3, K4, K5

	Diethylcarbamazine, Niclosamide, Mebendazole\$, Oxamniquine.			
<b>Module 3:</b>	<p><b>Anti-Infective agents-II</b> Antivirals including drugs acting on HIV Idoxuridines, Amantadine Hydrochloride\$, Acyclovir. <b>Antineoplastics:</b> 6- Mercaptopurine, Thiotepe\$, Chlorambucil, Taxol. <b>Antifungal:</b> Antibiotics like Nystatin, Tolnaflata\$, Clotrimazole\$. <b>Sulfonamides and other antifolics:</b> Sulfonamides and other para-aminobenzoic acid antagonist, Sulfacetamide\$, Sulfamethoxazole, <b>Newer antibacterial agents:</b> Quinoline carboxylic acids such as Ciprofloxacin, Temafloxacin. <b>Hypoglycemics:</b> Insulin and various sulfonyl ureas like tolbutamide\$, Tolazamide, phenformin, Glipizide.</p>	<b>12</b>	CO2, CO3, CO4	K3, K4, K5, K6
<b>Module 4:</b>	<p><b>Anti-lipidemics, Diuretics, and diagnostic agents:</b> Anti-lipidemics: Clofibrate\$, nicotinic acid, boxidine. <b>Diuretics:</b> Acid forming osmotic diuretics, Mercurials-Meralurides, Sulfonamides-Acetazolamide\$, Chlorothiazide\$, Hydrochlorothiazide, Ethacrynic acid. <b>Synthetic sweetener:</b> Diagnostic agents Inorganic compounds- Iodoxyl, Iodophendylate. <b>Dyes:</b> Rose Bengal, Fluorescein, Aminohippuric acid\$.</p>	<b>12</b>	CO2, CO3, CO4	K2, K3, K4, K5
<b>Module 5:</b>	<p><b>Hypotensive agents, General and Local Anaesthetics:</b> <b>Hypotensive agents</b> acting on vascular smooth muscles: Nitrites, Amylnitrites, Glyceryl nitrite\$, Pentaerythritol tetranitrate, Isosorbide dinitrate. <b>General anaesthetics:</b> Ether, Nitrous oxide, Halothane\$, Ultra short acting Barbiturates-Thiopental sodium \$. <b>Local anaesthetics:</b> Cocaine, Benzocaine\$, Procaine (MA), Lidocaine\$, Purgatives and cathartics: Phenolphthalein, Castor oil.</p>	<b>12</b>	CO2, CO3, CO4	K3, K4, K5
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>Williams, D. A., &amp; Lemke, T. L. (2006). Foye's Principles of Medicinal Chemistry, 5<sup>th</sup> ed., Philadelphia, PA: Lippincott Williams &amp; Wilkins.</li> <li>Beale, J. M., &amp; Block, J. H. (2004). Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical</li> </ol>			

	<p>Chemistry, 11<sup>th</sup> ed., Philadelphia, PA: Lippincott Williams &amp; Wilkins.</p> <ol style="list-style-type: none"> <li>Abraham, D. J., &amp; Rotella, D. P. (2010). Burger's Medicinal Chemistry, Drug Discovery and Development, 7<sup>th</sup> ed., Vols. 1–6, Hoboken, NJ: John Wiley &amp; Sons.</li> <li>Shriram, D., &amp; Yogeshwari, P. (2007). Medicinal Chemistry, 1<sup>st</sup> ed., New Delhi: Pearson Education.</li> <li>Patrick, G. L. (2017). An Introduction to Medicinal Chemistry, 6<sup>th</sup> ed., Oxford, UK: Oxford University Press.</li> <li>Lednicer, D., &amp; Mitscher, L. A. (2005). The Organic Chemistry of Drug Synthesis, Vol. III, 1<sup>st</sup> ed., Hoboken, NJ: John Wiley &amp; Sons.</li> <li>Singh, H., &amp; Kapoor, V. K. (2010). Medicinal and Pharmaceutical Chemistry, 2<sup>nd</sup> ed., New Delhi: Vallabh Prakashan.</li> <li>Chatwal, G. R. (2002). Medicinal Chemistry (Organic Pharmaceutical Chemistry), 1<sup>st</sup> ed., Mumbai: Himalaya Publishing House.</li> </ol>
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>National Center for Biotechnology Information (NCBI) – PubChem</li> <li>Royal Society of Chemistry (RSC) - Chemical Biology</li> <li>ScienceDirect - Pharmaceutical Chemistry journals</li> <li>Wiley Online Library - Pharmaceutical Chemistry books and journals</li> <li>US Pharmacopeia (USP) - official standards for pharmaceuticals</li> </ol>
<b>Web Resources:</b>	<ol style="list-style-type: none"> <li><a href="https://www.pharmaguideline.com/2021/08/introduction-classification-dosage-forms.html">https://www.pharmaguideline.com/2021/08/introduction-classification-dosage-forms.html</a></li> <li><a href="https://www.upm-inc.com/preformulation-in-drug-studies">https://www.upm-inc.com/preformulation-in-drug-studies</a></li> <li><a href="https://www.ncbi.nlm.nih.gov/books/NBK518682/">https://www.ncbi.nlm.nih.gov/books/NBK518682/</a></li> <li><a href="https://www.ncbi.nlm.nih.gov/books/NBK568677/">https://www.ncbi.nlm.nih.gov/books/NBK568677/</a></li> </ol>

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<b>Title of the Course</b>	Fundamentals of Physical Chemistry	
<b>Course Code</b>	CHP-5000	
<b>Number of Credits</b>	04	
<b>Theory/Practical</b>	Theory	
<b>Level</b>	400	
<b>Effective from AY</b>	2025-26	
<b>New Course</b>	Yes	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	NIL	
<b>Course Objectives:</b>	<ul style="list-style-type: none"> <li>• To introduce various mathematical and computational concepts of chemistry</li> <li>• To gain knowledge of core concepts of physical chemistry i.e. thermodynamics, kinetics, quantum chemistry and electrochemistry</li> <li>• To inculcate critical thinking and apply the knowledge of physical chemistry concepts in problem solving</li> <li>• To understand and apply physical chemistry principles to other areas of chemistry</li> </ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	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

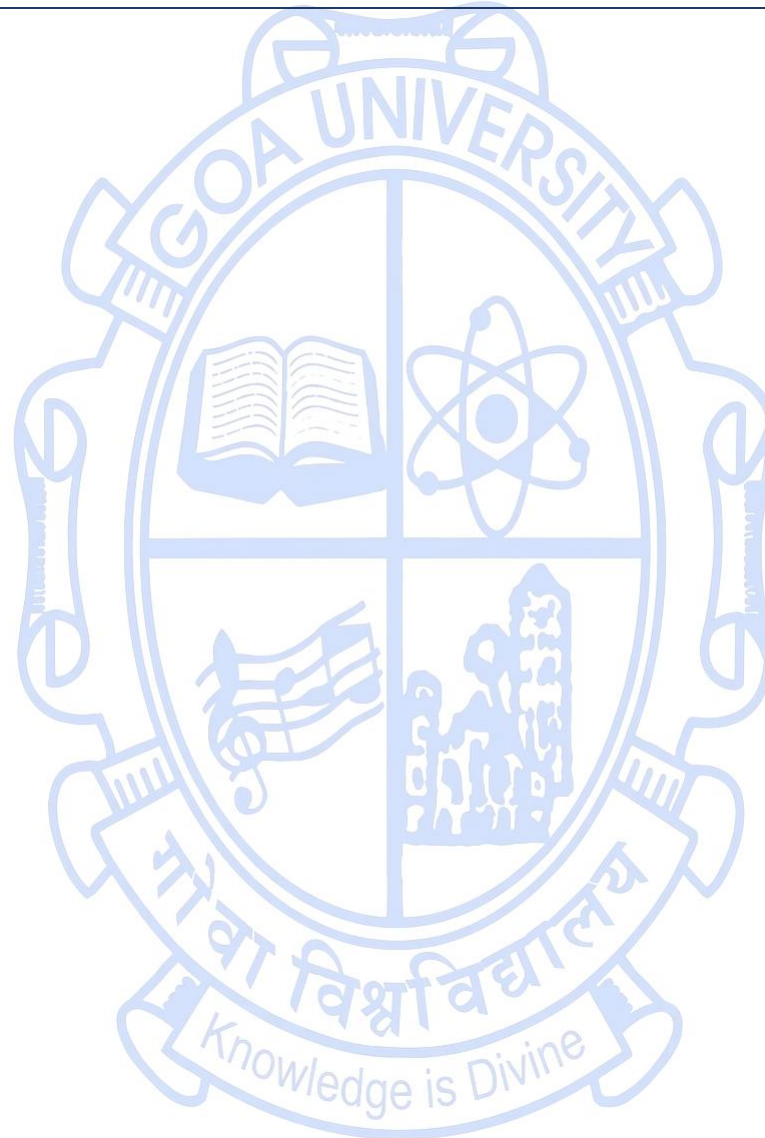
	CO 3. Demonstrate the concepts during the lab course in physical chemistry.		PSO3, PSO4, PSO5
	CO 4. Apply fundamentals of chemical kinetics and thermodynamics for understanding reaction processes and mechanisms		PSO3, PSO7
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>
<b>Module 1:</b>	<p><b>1. Mathematical Preparations</b></p> <p>a. Introduction to various functions and function plotting (exponential, logarithmic, trigonometric etc.), functions of many variables. complex numbers and complex functions.</p> <p>b. Linear equations, vectors, matrices and determinants.</p> <p>c. Basic rules of differentiation and integration, Partial differentiation, location and characterization of critical points of a function, Regression methods, curve fitting.</p> <p>d. Introduction to series, convergence and divergence, power series, Fourier series</p> <p>e. Probability (permutations and combinations).</p>	<b>10</b>	CO1, CO3 K1, K2, K3
<b>Module 2:</b>	<p><b>2. Quantum Chemistry</b></p> <p>a. Operators, Functions, Eigen value equations, Postulates.</p> <p>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).</p> <p>c. Hydrogen like atoms, Schrödinger equation and its solutions, atomic orbital wave functions and interpretation.</p> <p>d. Hückel MO theory, Secular equations, Secular determinant, delocalization energy, charge density, <math>\pi</math>-bond order, free valence, applications to C<sub>2</sub>H<sub>4</sub>, C<sub>3</sub>H<sub>5</sub> (radical), C<sub>4</sub>H<sub>6</sub>, C<sub>4</sub>H<sub>4</sub>, C<sub>6</sub>H<sub>6</sub>, C<sub>6</sub>H<sub>8</sub>.</p>	<b>20</b>	CO1, CO3 K1, K2, K5
<b>Module 3:</b>	<p><b>3. Thermodynamics</b></p> <p>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</p>	<b>12</b>	CO1, CO3, CO4 K1, K2, K3, K5

	<p>and their relations and significances. Maxwell relations. Thermodynamic equations of state.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>			
<b>Module 4:</b>	<p><b>4. Electrochemistry</b></p> <p>a. EMF series, cell potential: Nernst equation, Cells at equilibrium. Determination of thermodynamic functions.</p> <p>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.</p> <p>c. Electroplating and electroless plating, electrosynthesis.</p> <p>d. Concepts of acid-base aqueous and non-aqueous solvents, hard and soft acid-base concept and applications.</p>	<b>9</b>	CO1, CO2, CO3	K1, K2, K3, K5, K6
<b>Module 5:</b>	<p><b>5. Chemical Kinetics</b></p> <p>a. General introduction to various types of order of reaction including fractional order, molecularity of the reaction.</p> <p>b. Introduction to reversible and irreversible reactions and reactions leading to equilibrium. van't Hoff's equation and analysis of Gibbs free energy of</p>	<b>9</b>	CO1, CO3, CO4	K1, K2, K3, K4, K5

	<p>equilibrium reactions.</p> <p>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.</p> <p>d. Comparative study of transition state and collision state theory.</p> <p>e. Reaction Mechanisms: elementary reactions, consecutive elementary reactions, steady state approximation, the rate determining step and pre-equilibria.</p> <p>f. Free radical reactions, complex reactions such as acetaldehyde decomposition and reaction between H<sub>2</sub> and Br<sub>2</sub>. Homogeneous reactions and acid-base catalysis.</p> <p>g. Elementary enzyme reactions. Lineweaver-Burk plot and its analysis.</p>			
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. P. W. Atkins and J. D. Paula, Physical Chemistry, 8th ed., Oxford University Press, New Delhi. 2007</li> <li>2. G. M. Barrow, Physical Chemistry, 5th ed., Tata McGraw Hill, New Delhi. 2016</li> <li>3. J. E. House, Principles of Chemical Kinetics, 2nd ed., Academic Press, Elsevier Burlington, USA, 2007</li> <li>4. I. N. Levine, Quantum Chemistry, 7th ed., Prentice-Hall, New Delhi. 1999.</li> <li>5. S. Glasstone, Text Book of Physical Chemistry, D. Van Nostrand Company, New York, Reprint 1942.</li> </ol>			
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. B. R. Puri, L. R. Sharma and M. S. Pathania, Principles of Physical Chemistry, 49<sup>th</sup> ed., Vishal Publishing Co., New Delhi, 2020</li> <li>2. A. Saggion, R. Faraldo, M. Pierno, Thermodynamics - Fundamental Principles and Applications, Springer, Switzerland, 2019</li> <li>3. J. Bockris, A. K.N. Reddy, M. E. Gamboa-Aldeco, Modern Electrochemistry: Fundamentals of Electroics, Vol. 2A, 2<sup>nd</sup> ed., Kluwer Academic Publishers, New York, 2002</li> <li>4. J. Bockris, A. Reddy, Modern Electrochemistry: Ionics, Vol. 1, 2<sup>nd</sup> ed., , 2<sup>nd</sup> Ed., Kluwer Academic Publishers, New York, 2002</li> <li>5. J. E. House, Principles of Chemical Kinetics, 2<sup>nd</sup> ed., Academic Press, Burlington MA, 2007</li> <li>6. J. P. Lowe, K. Peterson, Quantum Chemistry, 3<sup>rd</sup> ed., Elsevier, Burlington MA, 2006</li> </ol>			

7. R. G. Mortimer, Physical Chemistry, 3<sup>rd</sup> ed., Elsevier, Burlington MA, 2008

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<b>Title of the Course</b>	Analytical Chemistry Techniques	
<b>Course Code</b>	CHA-5000	
<b>Number of Credits</b>	4	
<b>Theory/Practical</b>	Theory	
<b>Level</b>	400	
<b>Effective from AY</b>	2025-26	
<b>New Course</b>	Yes	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	NIL	
<b>Course Objectives:</b>	<ul style="list-style-type: none"> <li>• To learn various methods of data handling in analysis.</li> <li>• To explain the significance of sampling and calibration techniques.</li> <li>• To understand principles and applications of various types of techniques</li> <li>• To train the students to deduce structures based on IR, NMR, MS combined data.</li> </ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	CO 1. Analyze the role of statistical tools for determination of error and organize data management for systematic interpretation.	PSO1
	CO 2. Apply the sampling and calibration methods for obtaining reliable results.	PSO1
	CO 3. Explain basic principles and scope of different methods of separation and Techniques of analysis	PSO2

	CO 4. Solve problems based on IR, NMR, MS combined spectral data.		PSO3, PSO5	
Content:		No of hours	Mapped to CO	Cognitive Level
<b>Module 1:</b>	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	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	CO2	K3
	1.3. Introduction to Thermoanalytical techniques: Principle, instrumentation and applications of Thermogravimetric Analysis (TGA), Differential Thermal Analysis (DTA), and Differential Scanning Calorimetry (DSC). Numericals based on TGA.	5	CO3	K2
<b>Module 2:</b>	2.1. Introduction to Chromatographic Techniques: 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	K2
	2.2. 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	K2
	2.3. Gas and Liquid Chromatography: Introduction; Instrumental Modules; Separation System; Choice of Conditions of Analysis; Sample Inlet Systems;	7	CO3	K2

	Detectors; Practical Considerations in Qualitative and Quantitative Analysis; Coupled Systems-introduction to GCMS, GCIR, LCMS: Applicability, interpretation and numericals.			
<b>Module 3:</b>	3.1. Introduction to 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	K5
	4.2. Applications of UV-Vis spectroscopy for qualitative analysis: Calculating $\lambda_{max}$ for Conjugated Dienes, Trienes, polyenes, $\alpha,\beta$ -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	K5
<b>Module 4:</b>	4.1. Raman Spectroscopy: Theory, Basic instrumentation and Structural analysis using Raman Spectra. Mass Spectrometry: Principle, Instrumentation and various fragmentation patterns.	5	CO3, CO4	K2, K5
	4.2. Proton and Carbon NMR Spectroscopy: Theory of NMR, Instrumentation, Chemical shift, factors influencing chemical shift, solvents used in NMR, spin-spin	5	CO4	K5

	splitting, coupling constant calculation, factors influencing coupling constant.			
	4.3. Conjoint spectrometry problems: Structural elucidation of organic molecules using IR, UV, NMR and MS.	5	CO4	K5
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. G. D. Christian, Analytical Chemistry, 6th ed., Wiley, Singapore, 2004.</li> <li>2. G. W. Ewing, Instrumental Methods of Chemical Analysis, 5th ed., McGraw- Hill Int., New York, 1985.</li> <li>3. W. Kemp, Organic Spectroscopy, 3rd ed., Palgrave, New York, 1991.</li> <li>4. D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, Fundamentals of Analytical Chemistry, 9th ed., Cengage learning, USA, 2014.</li> <li>5. R. M. Silverstein, F. X. Webster, Spectrometric identification of Organic Compounds, 6th ed., Wiley, USA, 1998.</li> <li>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</li> <li>7. F. J. Holler, D. A. Skoog, S. R. Crouch, Principles of Instrumental Analysis, 6th ed., Thomson Books, London, 2007.</li> <li>8. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Instrumental methods of Analysis, 7th ed., HCBS Publishing, India, 2004.</li> <li>9. C. N. Banwell, E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th ed., Tata McGraw- Hill, India, 2006.</li> <li>10. P. S. Kalsi, Spectroscopy of Organic Compounds, 2nd ed., New Age International, New Delhi, 2000.</li> </ol>			
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. J. H. Kennedy, Analytical Chemistry: Principles, 2nd ed., Saunders College Publishing, Philadelphia, 1990.</li> <li>2. H. Gunzler, A. Williams, Handbook of Analytical Techniques, 1st ed., Wiley, Germany, 2001.</li> <li>3. E. Pretsch, P. Buhlmann, C. Affolter, Structural Determination of Organic Compounds, 2nd ed., Springer, Germany, 2005.</li> <li>4. L. D. Field, S. Sternhell, J. R. Kalman; Organic Structures from Spectra, 4th ed., Wiley, Singapore, 2007.</li> <li>5. R. A. Day, A. L. Underwood, Quantitative Analysis, 6th ed., Prentice Hall, USA, 2001.</li> <li>6. B. K Sharma, Instrumental methods of chemical analysis, Goel Publishing House, Meerut, 2004.</li> <li>7. K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, 6th ed., Wiley, USA, 2009.</li> <li>8. P. J. Larkin, Infrared and Raman Spectroscopy: principles and spectral interpretation, 2<sup>nd</sup> ed., Elsevier, Netherlands, 2018.</li> </ol>			

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## SEMESTER II

### Discipline Specific Core Courses

<b>Title of the Course</b>	Advance Pharmaceutical Chemistry	
<b>Course Code</b>	CHH-5001	
<b>Number of Credits</b>	4	
<b>Theory/Practical</b>	Theory	
<b>Level</b>	500	
<b>Effective from AY</b>	2025-2026	
<b>New Course</b>	No	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	Should have studied Pharmaceutical Chemistry at Semester I of level 400.	
<b>Course Objectives:</b>	<ul style="list-style-type: none"><li>• To learn major classes of drugs w.r.t. IUPAC nomenclature, structure and functional groups.</li><li>• To understand the SAR of selected drugs and their Mechanism of action.</li><li>• To get acquainted with the synthesis of selected drug molecules.</li><li>• To evaluate biological response of the drugs</li></ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	CO 1. Explain the differences between drug molecules and their application by IUPAC name, physical and chemical properties.	PSO 1

	CO 2. Distinguish the structures, synthesis, reactions and reactivity of substitution reactions.		PSO 2, PSO 3
	CO 3. Relate structural features in drugs to its biological activity.		PSO 4, PSO6
	CO 4. Illustrate the application of drug molecules toward human and the environment.		PSO 6, PSO 8
<b>Content:</b>	<b>Classification of Chemotherapeutic Drugs: Development of the following drugs including structure activity relationship (SAR), mechanisms of action (MA), chemical nomenclature, generic names (GN) and side effects (SE).</b> <b>Note: Outline of synthesis (\$) of the selected drugs.</b>	<b>No of hours</b>	<b>Mapped to CO</b> <b>Cognitive Level</b>
<b>Module 1:</b>	<b>Cholinergic and adrenergic agents, general anaesthetics and hypotensive agents</b> Classification of cholinergic agents: Drugs acting on cholinergic nervous system: Bethanechol\$, Methacholine\$, Neostigmine, Pyridostigmine, Parathion, Malathion, Atropine, Dicyclomine\$, Tropicamide\$, Papaverine. Classification of adrenergic agents, drugs acting on adrenergic nervous system: Methyldopa\$, Guanethidine, Ephedrine, Amphetamine, Tranylcypramine, Pargyline, Norepinephrine, Epinephrine, Pronethalol, Propranolol\$, Atenolol\$, Metoprolol.	<b>12</b>	CO1, CO2  K1, K2, K3, K4
<b>Module 2:</b>	<b>Drugs acting on the central nervous system: Hypnotics and Sedatives:</b> Chloral hydrate, Phenobarbital\$, Secobarbital, Thiopental\$, Nitrazepam. <b>Drugs acting as anticonvulsants:</b> Phenytoin\$, phenacemide, Clonazepam, Phensuximide, Phenobarbital, (classification of barbiturates), Primidone, Carbamazepine\$. <b>Psychotherapeutic agents:</b> Phenothiazines such as Chlorpromazine, Chlordiazepoxide\$, Oxazepam, Diazepam\$, Imipramine, Nialamide, Tranylcypramine, Pargyline. <b>CNS stimulants:</b> Phenmetrazine, Nikethamide\$, Iproniazid, Picrotoxins, Tetrazole, Amphetamine.	<b>12</b>	CO1, CO2  K2, K3, K4, K5
<b>Module 3:</b>	<b>Antihistaminic, antiemetic, antiulcer drugs, Drugs used in parkinsonism and Alzheimer's</b> Diphenhydramine, Triprolidine, Cyclizine, Promethazine\$, Cimetidine, Omeprazole, Ranitidine, Sumatriptan, Ondansetron. <b>Drugs used in Parkinsonism:</b> Bztropine mesylate, Levodopa, Carbidopa, Amantadine hydrochloride <b>Drugs for Alzheimer's diseases:</b> Serine, Velnacrine, Aniracetam.	<b>10</b>	CO2, CO3  K3, K4, K5

<b>Module 4:</b>	<b>Cardiovascular drugs, antihypertensive agents, and antibiotics:</b> Digitoxin, Quinidine, Procainamide, Verapamil. Antihypertensive agents which elicit their action through autonomous nervous system previously described under 1 and 2, Clonidine, Hydralazine, ACE inhibitors- Enalapril and related drugs vasodilators such as Nitroglycerine, Isoxsuprine, Nylidrin. <b>Antibiotics:</b> Penicillin and semisynthetic penicillin and Cephalosporins, Amoxicillin, Cloxacillin, Streptomycin, Chloramphenicol, Tetracycline and derivatives, Erythromycin.	<b>10</b>	CO3, CO4	K4, K5
<b>Module 5:</b>	<b>Analgesic, Antipyretic and Inflammatory agents:</b> Analgesics, antipyretics and anti-inflammatory agents: Sodiumsalicylate, Acetaminophen\$, Phenacetin, Phenylbutazone, Oxyphenbutazone\$, Naproxen\$, Probenecid, Allopurinol, Ibuprofen, Diclofenac\$. <b>Narcotic analgesic agents:</b> Morphine, Codeine, Meperidine, Methadone, Dextropropoxyphene. <b>Non-narcotic analgesic agents:</b> Dextropropoxyphene, Levallorphan.	<b>10</b>	CO3, CO4	K3, K4, K5
<b>Module 6:</b>	<b>Neglected Tropical diseases.</b> Background, overview of neglected tropical diseases, (poverty diseases) Human schistosomiasis, african trypanosomiasis (chagas), leishmaniasis, sleeping sickness. Nitroheterocycles, Benznidazole, Nifurtimox\$.	<b>06</b>	CO2 CO3	K3, K4
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. Williams, D. A., &amp; Lemke, T. L. (2006). Foye's Principles of Medicinal Chemistry (5<sup>th</sup> ed.). Philadelphia, PA: Lippincott Williams &amp; Wilkins.</li> <li>2. Beale, J. M., &amp; Block, J. H. (2004). Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry (11<sup>th</sup> ed.). Philadelphia, PA: Lippincott Williams &amp; Wilkins.</li> <li>3. Abraham, D. J., &amp; Rotella, D. P., (2010). Burger's Medicinal Chemistry, Drug Discovery and Development (7<sup>th</sup> ed., Vol. 1–6). Hoboken, N. J: John Wiley &amp; Sons.</li> </ol>			
<b>References / Readings:</b>	<ol style="list-style-type: none"> <li>1. Shriram, D., &amp; Yogeshwari, P. (2007). Medicinal Chemistry (1<sup>st</sup> ed.). New Delhi: Pearson Education.</li> <li>2. Patrick, G. L. (2017). An Introduction to Medicinal Chemistry (6<sup>th</sup> ed.). Oxford, UK: Oxford University Press.</li> <li>3. Lednicer, D., &amp; Mitscher, L. A. (2005). The Organic Chemistry of Drug Synthesis (Vol. III). Hoboken, N. J: John</li> </ol>			

	<p>Wiley &amp; Sons.</p> <ol style="list-style-type: none"> <li>4. Singh, H., &amp; Kapoor, V. K. (2010). Medicinal and Pharmaceutical Chemistry (2<sup>nd</sup> ed.). New Delhi: Vallabh Prakashan.</li> <li>5. Chatwal, G. R. (2002). Medicinal Chemistry (Organic Pharmaceutical Chemistry) (1<sup>st</sup> ed.). Mumbai: Himalaya Publishing House.</li> <li>6. Wang, Yanli, Evan Bolton, Svetlana Dracheva, Karen Karapetyan, Benjamin A. Shoemaker, Tugba O. Suzek, Jiyao Wang, Jewen Xiao, Jian Zhang, and Stephen H. Bryant. "An overview of the PubChem BioAssay resource." <i>Nucleic acids research</i> 38, no. suppl_1 (2010): D255-D266.</li> <li>7. Campbell, I. B., Macdonald, S. J., &amp; Procopiou, P. A. (2018). Medicinal chemistry in drug discovery in big pharma: past, present and future. <i>Drug Discovery Today</i>, 23(2), 219-234.</li> <li>8. Beale JM, Block J, Hill R. Organic medicinal and pharmaceutical chemistry. Philadelphia: Lippincott Williams &amp; Wilkins; 2010.</li> <li>9. Williams, Roger L., Project Team, and U. S. P. Staff. "Official USP Reference Standards: Metrology concepts, overview, and scientific issues and opportunities." <i>Journal of pharmaceutical and biomedical analysis</i> 40.1 (2006): 3-15.</li> </ol>
<b>Web Resources:</b>	<ol style="list-style-type: none"> <li>1. <a href="https://www.pharmaguideline.com/2021/08/introduction-classification-dosage-forms.html">https://www.pharmaguideline.com/2021/08/introduction-classification-dosage-forms.html</a></li> <li>2. <a href="https://www.upm-inc.com/preformulation-in-drug-studies">https://www.upm-inc.com/preformulation-in-drug-studies</a></li> <li>3. <a href="https://www.ncbi.nlm.nih.gov/books/NBK518682/">https://www.ncbi.nlm.nih.gov/books/NBK518682/</a></li> <li>4. <a href="https://www.ncbi.nlm.nih.gov/books/NBK568677/">https://www.ncbi.nlm.nih.gov/books/NBK568677/</a></li> </ol>

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<b>Title of the Course</b>	Drugs: Product Development, Formulation and Manufacture
<b>Course Code</b>	CHH-5002
<b>Number of Credits</b>	4
<b>Theory/Practical</b>	Theory
<b>Level</b>	500
<b>Effective from AY</b>	2025-2026
<b>New Course</b>	No
<b>Bridge Course/ Value added Course</b>	No
<b>Course for advanced learners</b>	No

<b>Pre-requisites for the Course:</b>	Should have studied Pharmaceutical Chemistry at Semester I of Level 400.	
<b>Course Objectives:</b>	<ul style="list-style-type: none"> <li>• To understand the basic principles of drug development process.</li> <li>• To study the concept of pilot plant &amp; scale-up techniques and manufacturing methods for dosage forms.</li> <li>• To learn the key unit operations, biopharmaceutical manufacturing, and Quality by Design (QbD).</li> <li>• To examine the dosage forms, their manufacturing processes, administration routes, and quality control.</li> </ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	CO 1. Explain the concepts related to drug development, preformulation and the regulatory aspects of pharmaceutical products.	PSO 1
	CO 2. Classify the scale-up techniques, pilot plant benefits, and industrial manufacturing methods for various dosage forms.	PSO 2, PSO 3
	CO 3. Illustrate key unit operations, biopharmaceutical manufacturing techniques, and the	PSO 4

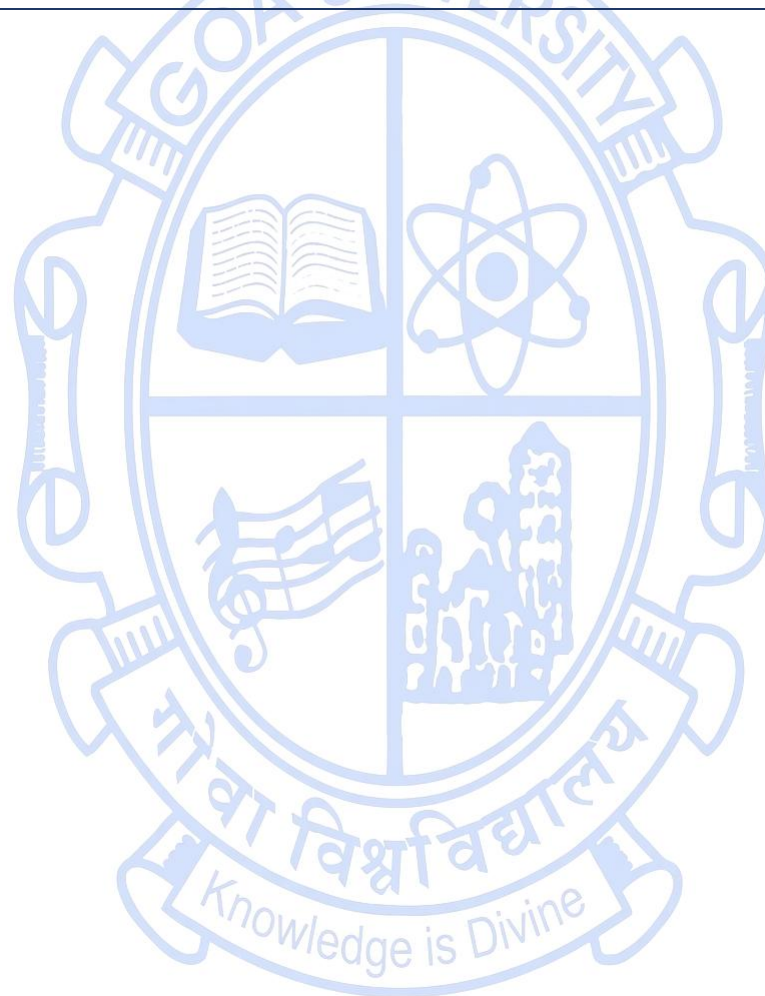
	fundamentals of Quality by Design (QbD) in pharmaceutical productions			
	CO 4. Evaluate the different types of dosage forms, their manufacturing processes, routes of administration, and quality control evaluation.		PSO 6, PSO 8	
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	<p><b>Introduction and classification:</b> Introduction to drugs, dosage forms &amp; drug delivery system: definitions of common terms. development of dosage forms: four stage development including preformulation. Preformulation studies, objectives, factors to be considered, study protocol, including prototype development, scale up studies and commercialization. For example, analyzing polymorphs using ultraviolet, infra-red, solid-state NMR, DSC-DTA and X-ray crystallography. Drug regulation and control, pharmacopoeias-formularies, sources of drug, drug nomenclature, routes of administration of drugs products their advantages and disadvantages, need for a dosage form, classification of dosage forms &amp; brief description, study of excipients.</p>	<b>15</b>	CO1, CO2	K1, K2, K3
<b>Module 2:</b>	<p><b>Pilot plant</b> Scale up techniques, benefits of pilot plant- broad guidelines of process development and general consideration. Industrial manufacturing method and flow charts of Sulfamethoxazole, Rifampicin, Chloramphenicol maleate, Actinobolin, BTZO43, Piperaquine, Propranolol hydrochloride.</p>	<b>15</b>	CO1, CO2	K2, K3, K4
<b>Module 3:</b>	<p><b>Pharmaceutical manufacturing operations</b> Brief discussion on unit operations and types of equipments/machines used. Unit operations like size reduction, mixing/blending, drying, compression, granulation, coating etc. Three most frequently used unit operations within biopharmaceutical manufacturing, that includes chromatography, virus filtration, and tangential flow filtration (TFF). Quality by design (QbD): Fundamentals of pharmaceutical quality by design, identification of critical quality attributes, critical material attributes, critical process parameters and quality risk management.</p>	<b>15</b>	CO2, CO3	K3, K4

<b>Module 4:</b>	<b>Dosage forms-formulation components, manufacturing and quality control evaluation, routes of drug administration.</b> Types of dosage forms: Liquids-monophase & biophase including ENT preparation, sprays. Semisolid eg. ointment, creams, gels, liniment, paste, lotion etc. Solid dosage forms: Tablets-Types of tablets, capsules, granules, powders, pastilles, lozenges. Sterile dosage forms: Injectables and ophthalmic preparations, Suppositories etc.	<b>15</b>	CO3, CO4	K3, K4, K5
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>Allen, L. V. Jr., Popovich, N. G., &amp; Ansel, H. C. (2005). <i>Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems</i> (8<sup>th</sup> ed.). Philadelphia, PA: Lippincott Williams &amp; Wilkins.</li> <li>Khar, R. K., (2020). <i>Lachman/Lieberman's The Theory and Practice of Industrial Pharmacy</i> (4th ed.). New Delhi: CBS Publishers &amp; Distributors Pvt. Ltd.</li> <li>Banker, G. S., &amp; Rhodes, C. T. (2002). <i>Modern Pharmaceutics</i> (4<sup>th</sup> ed.). New York, NY: Marcel Dekker, Inc.</li> </ol>			
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>Carter, S. J. (2007). <i>Dispensing for Pharmaceutical Students</i> (12<sup>th</sup> ed.). New Delhi: CBS Publishers &amp; Distributors Pvt. Ltd.</li> <li>Remington, J. P. (1990). <i>Remington's Pharmaceutical Sciences</i> (18<sup>th</sup> ed.). Easton, PA: Mack Publishing Company.</li> <li>Aulton, M. E., &amp; Taylor, K. (2001). <i>Aulton's Pharmaceutics: The Science of Dosage Form Design</i> (2<sup>nd</sup> ed.). Edinburgh: Churchill Livingstone, Elsevier Health Sciences Division.</li> <li>Thunga, Girish, Sudeep Kumar Agrawal, Mahendra Joshi, Muddukrishna Badamane Sathyanarayana, Vamshi Krishna Tippavajhala, and Girish Pai Kulyadi. "Solid Dosage Forms: A Detailed Research on Non-conforming Product Quality." <i>Indian Journal of Pharmaceutical Education &amp; Research</i> 54 (2020).</li> <li>Ahirwar, Kailash, and Rahul Shukla. "Preformulation studies: a versatile tool in formulation design." In <i>Drug Formulation Design</i>. IntechOpen, 2023.</li> <li>Shah, Gourav, Piyush Kamble, Rohini Shinde, and Kanchan Ghatge. "Advances in Technology Transfer for the Pharmaceutical Industries: An Overview." <i>Research Journal of Pharmacy and Technology</i> 7, no. 6 (2014): 719-726.</li> <li>Djuris, Jelena, Svetlana Ibric, and Zorica Đurić. "Quality by design in the pharmaceutical development." <i>Computer-aided applications in pharmaceutical technology</i>. Woodhead Publishing, 2024. 1-21.</li> </ol>			

**Web Resources:**

1. <https://www.pharmaguideline.com/2021/08/introduction-classification-dosage-forms.html>
2. <https://www.upm-inc.com/preformulation-in-drug-studies>
3. <https://www.ncbi.nlm.nih.gov/books/NBK518682/>
4. <https://www.ncbi.nlm.nih.gov/books/NBK568677/>

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<b>Title of the Course</b>	Drugs: Discovery, Design and Development
<b>Course Code</b>	CHH-5003
<b>Number of Credits</b>	04
<b>Theory/Practical</b>	Theory
<b>Level</b>	500
<b>Effective from AY</b>	2025-26
<b>New Course</b>	No
<b>Bridge Course/ Value added Course</b>	No
<b>Course for advanced learners</b>	No

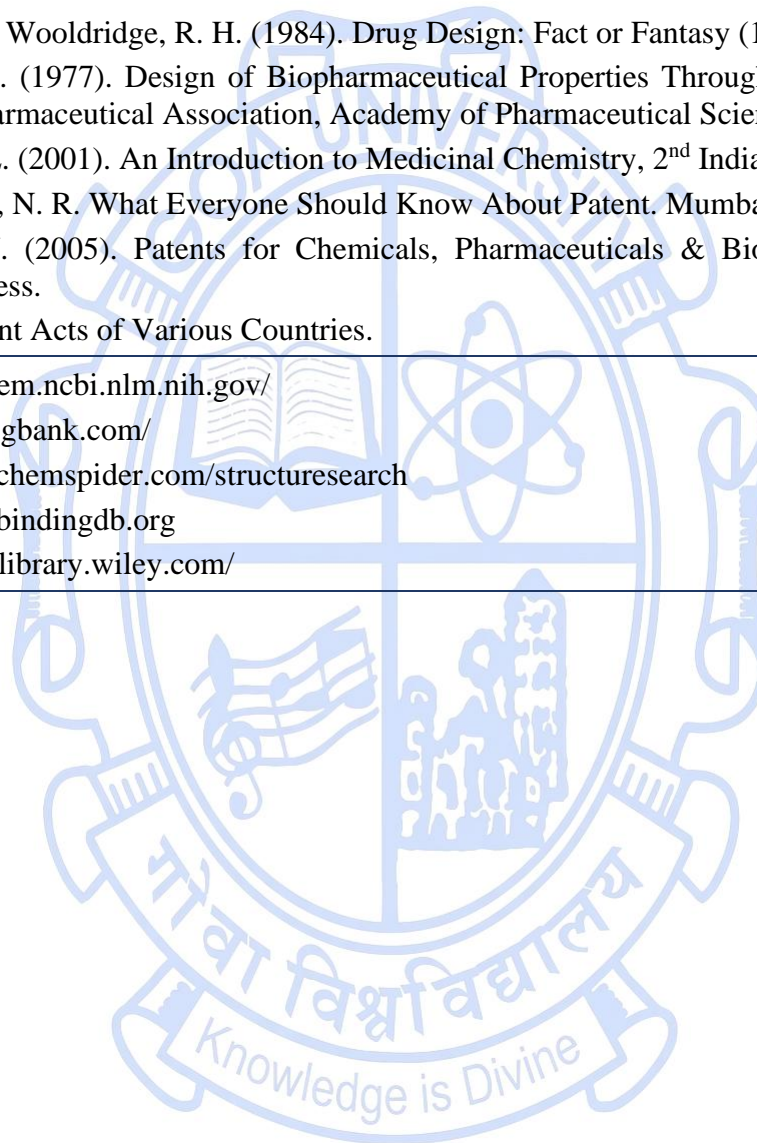
<b>Pre-requisites for the Course:</b>	Should have studied Pharmaceutical Chemistry at Semester I of Level 400.	
<b>Course Objectives:</b>	<ul style="list-style-type: none"> <li>• To introduce the various theories of drug action.</li> <li>• To understand the Structure Activity Relationship studies citing various examples.</li> <li>• To acquaint the concepts of drug designing by molecular modelling.</li> <li>• To learn various terms involved in patenting and IPR.</li> </ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	CO 1. Describe the various methods and types of drug designing, QSAR and enzyme inhibitors	PSO1, PSO2
	CO 2. Differentiate physio-chemical properties, enzyme inhibitors and IPR	PSO1, PSO2

	CO 3. Illustrate the drug designing process, QSAR methods and intellectual property rights.		PO3, PO4	
	CO 4. Design new drugs using molecular modelling software.		PO4, PO5	
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	<p><b>Introduction to drug design, lead compounds and pro-drug concept</b></p> <p>Development of new drugs: Introduction, procedure followed in drug design, the search for lead compounds, molecular modification of lead compounds, prodrugs and soft drugs.</p> <p>Prodrug; introduction, prodrug formation of compounds containing various chemical groups, multiple prodrug formation, soft drugs; design of soft drugs.</p>	<b>12</b>	CO1, CO3	K2, K3, K4
<b>Module 2:</b>	<p><b>SAR and QSAR Studies in drug discovery</b></p> <p>Structure-activity relationship (SAR): Factors effecting bioactivity, resonance, inductive effect, isosterism, bioisosterism, spatial considerations, biological properties of simple functional groups. 4-5 illustrative examples depicting structural activity relationship studies.</p> <p>Theories of drug activity, occupancy theory, rate theory, induced-fit theory. Quantitative structure-activity relationship (QSAR): history and development of QSAR, drug receptor interactions, the additivity of group contributions, physico-chemical parameters, lipophilicity parameters, electronic parameter, ionization constants, steric parameters, chelation parameters, redox potential, indicator-variables, quantitative models.</p>	<b>12</b>	CO1, CO2, CO3	K2, K3, K4, K5
<b>Module 3:</b>	<p><b>QSAR approaches in drug designing and modern methods in discovery</b></p> <p>Hansch analysis- Advantages and drawbacks. Free- Wilson analysis, Advantages and drawbacks. Their application, relationship between Hansch and Free-Wilson analysis (the mixed approach), non-linear relationship, Introduction to other QSAR approaches- free topliss method-postulates and illustration. Introduction to molecular modelling using computers and docking using software's (Hex, Autodock).</p>	<b>12</b>	CO1, CO3	K2, K3, K4, K5
<b>Module 4:</b>	<b>Designing of enzyme inhibitors as drugs</b>	<b>12</b>	CO1,	K2, K3,

	Structure-based drug design: Process, deactivation of certain drugs necessary for T-cell functioning, determination of the active site with reference to chymotrypsin and inhibitors such as 9-alkylpurines, 9-mercaptapurines and allopurines. Active site directed irreversible and suicide enzyme inactivators.		CO2 CO3.	K4
<b>Module 5:</b>	<b>Development of new drugs</b> High throughput screening, drug design software's (Hex, Autodock) and its applications. Intellectual property rights, patents, industrial designs, geographical indications, trademarks, trade secrets. Patentable inventions and importance of patents in pharmaceutical industry, eg: Pembrolizumab. Trade related aspects of intellectual property rights (TRIPS), international & regional agreements. Patent writing for different types of inventions (formulations, synergic, process, technology, polymorph and biotechnology).	<b>12</b>	CO2, CO3, CO4	K2, K3, K4
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. Pandeya, S. S., &amp; Dimmock, J. R. (2007). An Introduction to Drug Design (1<sup>st</sup> ed.). New Delhi: New Age International (P) Ltd. Publishers.</li> <li>2. Wolff, M. E., (1997). Burger's Medicinal Chemistry and Drug Discovery, Vol. I (Chapters 9 &amp; 14). New York, N. Y: John Wiley &amp; Sons.</li> <li>3. Gringauz, A. (1997). Introduction to Medicinal Chemistry: How Drugs Act and Why (1<sup>st</sup> ed.). New York, NY: Wiley-VCH.</li> <li>4. Lednicer, D., &amp; Mitscher, L. A. (2005). The Organic Chemistry of Drug Synthesis, Volumes I–V. Hoboken, NJ: John Wiley &amp; Sons.</li> </ol>			
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. Silverman, R. B. (2014). The Organic Chemistry of Drug Design and Drug Action (3<sup>rd</sup> ed.). London: Academic Press.</li> <li>2. Leach, A. R. (2001). Molecular Modelling: Principles and Applications (2<sup>nd</sup> ed.). Delhi: Pearson Education India.</li> <li>3. Bailey, N. T. J. (1995). Statistical Methods in Biology (3<sup>rd</sup> ed.). Cambridge, UK: Cambridge University Press.</li> <li>4. Krogsgaard-Larsen, P., Madsen, U., &amp; Liljefors, T. (1996). A Textbook of Drug Design and Development (2<sup>nd</sup> ed.).</li> </ol>			

	<p>Boca Raton, FL: CRC Press.</p> <ol style="list-style-type: none"> <li>5. Jolles, G., &amp; Wooldridge, R. H. (1984). Drug Design: Fact or Fantasy (1<sup>st</sup> ed.). London: Academic Press.</li> <li>6. Roche, E. B. (1977). Design of Biopharmaceutical Properties Through Prodrugs and Analogs. Washington, DC: American Pharmaceutical Association, Academy of Pharmaceutical Sciences.</li> <li>7. Patrick, G. L. (2001). An Introduction to Medicinal Chemistry, 2<sup>nd</sup> Indian ed., New Delhi: Oxford University Press.</li> <li>8. Subbaraman, N. R. What Everyone Should Know About Patent. Mumbai: Pharma Book Syndicate.</li> <li>9. Grubb, P. W. (2005). Patents for Chemicals, Pharmaceuticals &amp; Biotechnology, 4<sup>th</sup> ed., Oxford, UK: Oxford University Press.</li> <li>10. Current Patent Acts of Various Countries.</li> </ol>
<b>Web Resources:</b>	<ol style="list-style-type: none"> <li>1. <a href="https://pubchem.ncbi.nlm.nih.gov/">https://pubchem.ncbi.nlm.nih.gov/</a></li> <li>2. <a href="https://go.drugbank.com/">https://go.drugbank.com/</a></li> <li>3. <a href="https://www.chemspider.com/structuresearch">https://www.chemspider.com/structuresearch</a></li> <li>4. <a href="https://www.bindingdb.org">https://www.bindingdb.org</a></li> <li>5. <a href="https://onlinelibrary.wiley.com/">https://onlinelibrary.wiley.com/</a></li> </ol>

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<b>Title of the Course</b>	Pharmacokinetics and Biopharmaceutics	
<b>Course Code</b>	CHH-5004	
<b>Number of Credits</b>	04	
<b>Theory/Practical</b>	Theory	
<b>Level</b>	500	
<b>Effective from AY</b>	2025-26	
<b>New Course</b>	No	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	Should have studied Pharmaceutical Chemistry at Semester I of Level 400.	
<b>Course Objectives:</b>	<ul style="list-style-type: none"> <li>• To learn the principles of pharmacokinetics (absorption, distribution, metabolism, and excretion) and biopharmaceutics.</li> <li>• To understand pharmacokinetic models to predict drug concentrations and optimize dosing regimens.</li> <li>• To analyze the impact of biopharmaceutical properties on drug absorption and bioavailability.</li> <li>• To evaluate the role of pharmacokinetics and biopharmaceutics in drug development and therapy.</li> </ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	CO 1. Explain the drug absorption mechanism, drug excretion with the bioavailability and bioequivalence interaction with drugs.	PSO1, PSO2
	CO 2. Describe the various types of drug metabolism and drug excretion, linear and non-	PSO1, PSO2

	linear pharmacokinetics using different methods			
	CO 3. Illustrate the different classes of drug molecules using equations/methods.			PSO2, PSO3
	CO 4. Analyze the application of pharmacokinetics models for drug molecules			PSO4, PSO6
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	<b>Introduction to biopharmaceutics and pharmacokinetics:</b> Definitions, ADME, concentration time profile, plotting the data, different fluid compartments and blood flow rate compartment models, biological half-life, elimination rate constant. Drug research.	<b>8</b>	CO1, CO2	K1, K2, K3, K4
<b>Module 2:</b>	<b>Drug Absorption, Dissolution and Distribution.</b> GIT absorption of drugs: Techniques, mechanisms of drug absorption, factors affecting drug absorption: Biological, physiological, physico-chemical and pharmaceutical. Noyes-study of various approaches to improve dissolution of poorly soluble drugs, In-vitro dissolution testing models, In-vitro and in-vivo correlation. Factors affecting drug distribution; volume of distribution, protein binding factors affecting, significance and kinetics of protein binding.	<b>12</b>	CO1, CO2	K2, K3, K4
<b>Module 3:</b>	<b>Drug Metabolism and Excretion</b> Metabolism of drugs, Xenobiotics, Drug metabolizing organs and enzymes (microsomal & non-microsomal), Chemical pathways - Phase I reactions (Oxidative, reductive and hydrolytic reactions) and Phase II reactions (Conjugation reaction: Glucuronidation, aminoacid, methylation, sulphonation). Significance of cytochrome P450 oxidation reduction cycle, factors affecting biotransformation of drugs. Renal excretion glomerular filtration, active tubular secretion, active (or) passive tubular reabsorption. Factors affecting renal excretions of drugs. Non renal excretions biliary, pulmonary, salivary, mammary, skin/dermal, gastrointestinal and genital excretions of drugs such as Fluconazole, carbamazepine, phenytoin, lead.	<b>12</b>	CO1, CO2	K3, K4, K5
<b>Module 4:</b>	<b>Bioavailability and Bioequivalence studies</b>	<b>12</b>	CO1,	K2, K3,

	<p>Objectives and considerations in bioavailability studies: Definitions, federal requirements, methods of determination of bioavailability using blood and urinary excretion data. Protocol design for bioavailability assessment. Concept of equivalence.</p> <p>Methods for bioequivalence determination: Measurements of bioavailability, determination of the rate of absorption, bioequivalence studies and its importance. Biopharmaceutical classification of drugs, importance of biopharmaceuticals.</p>		CO2, CO3	K4
<b>Module 5:</b>	<p><b>Pharmacokinetics:</b></p> <p>Pharmacokinetic characterization of drugs: Pharmacokinetics of drugs following one/two compartment open models with first order elimination kinetics as applied to rapid intravenous injection, intravenous transfusion and oral administration. Determination of absorption rate constant using Wagner- Nelson, Loo Riegelman methods.</p> <p>Non-Linear pharmacokinetics: Various causes of non-linearity, Michaelis-Menten kinetics, In- vivo estimation of Km and Vm. Case studies on Amoxicillin, Rifampicin, intravenous Verapamil. Physiologic pharmacokinetics models: Mean Residence Time; Statistical moment theory; application and limitations of physiologic pharmacokinetic models.</p> <p>Chronopharmacokinetics, drug toxicity and forensic pharmacokinetics, kinetics of maternal-fetal drug transfer, pharmacokinetics v/s pharmacological/ clinical response, metabolic kinetics.</p>	<b>16</b>	CO2, CO3, CO4	K3, K4, K5
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>Gibaldi, M. (1991). Biopharmaceutics and Clinical Pharmacokinetics (4<sup>th</sup> ed.). Philadelphia, PA: Lea &amp; Febiger.</li> <li>Brahmankar, D. M., &amp; Jaiswal, S. B. (1998). Biopharmaceutics and Pharmacokinetics: A Treatise (1<sup>st</sup> ed.). New Delhi: Vallabh Prakashan.</li> <li>Shargel, L., &amp; Yu, A. B. C. (1985). Applied Biopharmaceutics and Pharmacokinetics (2<sup>nd</sup> ed.). Norwalk, CT: Appleton-Century-Crofts.</li> </ol>			

	4. Swarbrick, J. (1970). <i>Current Concepts in Pharmaceutical Sciences: Biopharmaceutics</i> (1 <sup>st</sup> ed.). Philadelphia, PA: Lea & Febiger.
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. Abdou, H. M. (1989). <i>Dissolution, Bioavailability and Bioequivalence</i> (1<sup>st</sup> ed.). Easton, PA: Mack Publishing Company.</li> <li>2. Notari, R. E. (1987). <i>Biopharmaceutics and Clinical Pharmacokinetics: An Introduction</i> (4<sup>th</sup> ed.). New York, NY &amp; Basel, Switzerland: Marcel Dekker Inc.</li> <li>3. Wagner, J. G., &amp; Pernarowski, M. (1971). <i>Biopharmaceutics and Relevant Pharmacokinetics</i> (1<sup>st</sup> ed.). Hamilton, IL: Drug Intelligence Publications.</li> <li>4. Swarbrick, J., &amp; Boylan, J. C., (2002). <i>Encyclopedia of Pharmaceutical Technology, Vol. I</i> (2<sup>nd</sup> ed.). New York, NY: Marcel Dekker Inc.</li> <li>5. Niazi, S. K. (2010). <i>Textbook of Biopharmaceutics and Clinical Pharmacokinetics</i> (1<sup>st</sup> ed.). Hyderabad: BSP Books Pvt. Ltd.</li> <li>6. Niazi, S. K. (2007). <i>Handbook of Bioequivalence Testing</i> (1<sup>st</sup> ed.). Boca Raton, FL: CRC Press.</li> <li>7. Jaiswal, S. B., &amp; Bramhankar, D. M. (2006). <i>Biopharmaceutics and pharmacokinetics a treatise. 1stEdn, VallabhPrakashan, 296-297.</i></li> <li>8. Bollish, S. J. (1981). <i>Applied biopharmaceutics and pharmacokinetics.</i></li> <li>9. <i>Biopharmaceutics and Clinical Pharmacokinetics</i> by Milo Gibaldi, 4<sup>th</sup> ed., 1991.</li> </ol>
<b>Web Resources:</b>	<ol style="list-style-type: none"> <li>1. <a href="https://accesspharmacy.mhmedical.com/book.aspx?bookid=1592">https://accesspharmacy.mhmedical.com/book.aspx?bookid=1592</a>.</li> <li>2. <a href="https://link.springer.com/chapter/10.1007/978-3-319-99593-9_1">https://link.springer.com/chapter/10.1007/978-3-319-99593-9_1</a></li> <li>3. <a href="https://pharmdbm.com/biopharmaceutics-and-pharmacokinetics-6th-semester/">https://pharmdbm.com/biopharmaceutics-and-pharmacokinetics-6th-semester/</a></li> <li>4. <a href="https://www.scribd.com/document/329195113/BHRAMANKAR-Biopharmaceutics">https://www.scribd.com/document/329195113/BHRAMANKAR-Biopharmaceutics</a>.</li> </ol>

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## SEMESTER I & II

### Discipline Specific Elective Courses

<b>Title of the Course</b>	Pharmaceutical Chemistry Practical - I	
<b>Course Code</b>	CHH-5201	
<b>Number of Credits</b>	2	
<b>Theory/Practical</b>	Practical	
<b>Level</b>	400	
<b>Effective from AY</b>	2025-2026	
<b>New Course</b>	No	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	Nil	
<b>Course Objectives:</b>	<ul style="list-style-type: none"><li>• To learn synthesis of medicinal compound.</li><li>• To understand application of drug molecules in human beings and animals.</li><li>• To evaluate biological response of the drugs towards human bodies.</li><li>• To acquire hands on training in laboratory techniques.</li></ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	CO 1. Explain working principle and handling techniques of instruments.	PSO 1, PSO 3
	CO 2. Distinguish the qualitative and quantitative tests of the drug molecule.	PSO 2, PSO 4

	CO 3. Develop the synthesis method/route and characterization of the drug compounds.		PSO 5, PSO 6
	CO 4. Apply and validate the analytical method of drugs towards industrial or research purpose.		PSO 7, PSO 8
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b> <b>Cognitive Level</b>
<b>Module 1:</b>	<b>1) Qualitative and Quantitative tests of (Any 1)</b> 1. Purified Water as per IP Monograph 2. Ibuprofen as per IP Monograph	<b>10</b>	CO1, CO2 K1, K2, K3
<b>Module 2:</b>	<b>2) Titrimetric Assay of the following bulk drugs:(4 x 2 = 8) (Any2)</b> 1. Pheniramine Maleate 2. Salbutamol 3. Ofloxacin	<b>08</b>	CO2, CO3 K2, K3, K4
<b>Module 3:</b>	<b>3) UV Spectrophotometric Assay of the following drugs (in different dosage forms): (4 x 4= 16) (Any 4)</b> Rifampicin, Meloxicam, Salbutamol, Ofloxacin, Isoniazid, Diazepam, Acyclovir, Bisacodyl, Tinidazole	<b>16</b>	CO2, CO3 K2, K4, K5
<b>Module 4:</b>	<b>4) Synthesis of following bioactive or drug molecules (2x3 = 6 hours) Any 2</b> 1. 3-Acetylcoumarin 2. 2-Phenylbenzimidazole 3. 2,3-Diphenyl Quinoxaline	<b>06</b>	CO2, CO3 K3, K4
<b>Module 5:</b>	<b>5) Multistep synthesis (Any one)</b> 1. Flavone from 2-hydroxyacetophenone 2. Paracetamol from Acetanilide	<b>08</b>	CO2, CO3 K3, K5
<b>Module 6:</b>	<b>6) Dissolution experiment:</b> To study the dissolution rate of sustained release Theophylline tablets IP.	<b>06</b>	CO3, CO4 K3, K5

<b>Module 7:</b>	<b>7) High Performance liquid Chromatographic experiment:</b> To separate a mixture of Paracetamol and Caffeine using reverse phase high performance liquid chromatography.	<b>06</b>	CO3, CO4	K5, K6
<b>Pedagogy:</b>	Pre-lab and Post-lab exercises. Demonstrations of experiments. Explanation of Procedures.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>Vogel, A. I., Tatchell, A. R., &amp; Hannaford, B. S. F. (2011). Vogel's Textbook of Practical Organic Chemistry, 5<sup>th</sup> ed., Harlow, England: Prentice Hall.</li> <li>Connors, K. A. (1990). Textbook of Pharmaceutical Analysis, 3<sup>rd</sup> ed., New York, NY: Wiley-Inter science.</li> <li>Bassett, J., Mendham, J., &amp; Denny, R. C. (Revised by G. H. Jeffery). (2007). Vogel's Textbook of Quantitative Chemical Analysis, 6<sup>th</sup> ed., New Delhi, India: Pearson Education.</li> </ol>			
<b>References/ Readings:</b>	Pharmacopoeias: <ol style="list-style-type: none"> <li>Indian Pharmacopoeia, 9<sup>th</sup> ed., Ghaziabad: Indian Pharmacopoeia Commission.</li> <li>United States Pharmacopeia (USP-NF, Issue 1, May 2024) Rockville, MD: United States Pharmacopoeial Convention.</li> <li>British Pharmacopoeia (BP 2025, Jan. 2025), London: Medicines and Healthcare Products Regulatory Agency (MHRA).</li> <li>European Pharmacopoeia (Ph. Eur.), 11<sup>th</sup> ed., 2022, Strasbourg: European Directorate for the Quality of Medicines &amp; HealthCare (EDQM), Council of Europe.</li> <li>Reynolds, J. E. F., (1993), Martindale: The Extra Pharmacopoeia, 30<sup>th</sup> ed., London, The Pharmaceutical Press.</li> <li>Moini, J. (2010). Pharmaceutical Laboratory Procedures, 1<sup>st</sup> ed., New Delhi: Cengage Learning India Pvt. Ltd.</li> </ol>			
<b>Web Resources:</b>	<ol style="list-style-type: none"> <li><a href="https://qps.nhsrindia.org/sites/default/files/2022-01/INDIAN%20PHARMACOPOEIA%202010%20Volume%201.pdf">https://qps.nhsrindia.org/sites/default/files/2022-01/INDIAN%20PHARMACOPOEIA%202010%20Volume%201.pdf</a></li> <li><a href="https://docsdrive.com/pdfs/insightknowledge/IPHARMA-IK/2018/1-12.pdf">https://docsdrive.com/pdfs/insightknowledge/IPHARMA-IK/2018/1-12.pdf</a></li> <li><a href="https://www.sciencedirect.com/science/article/pii/S1878535222007882">https://www.sciencedirect.com/science/article/pii/S1878535222007882</a> <a href="https://assets.thermofisher.cn/TFS-Assets/CMD/Application-Notes/an-72709-lc-ibuprofen-drug-products-an72709-en.pdf">https://assets.thermofisher.cn/TFS-Assets/CMD/Application-Notes/an-72709-lc-ibuprofen-drug-products-an72709-en.pdf</a></li> <li>Indian Pharmacopoeia (IP) – 2010 Vol.2 (PDF)</li> </ol>			

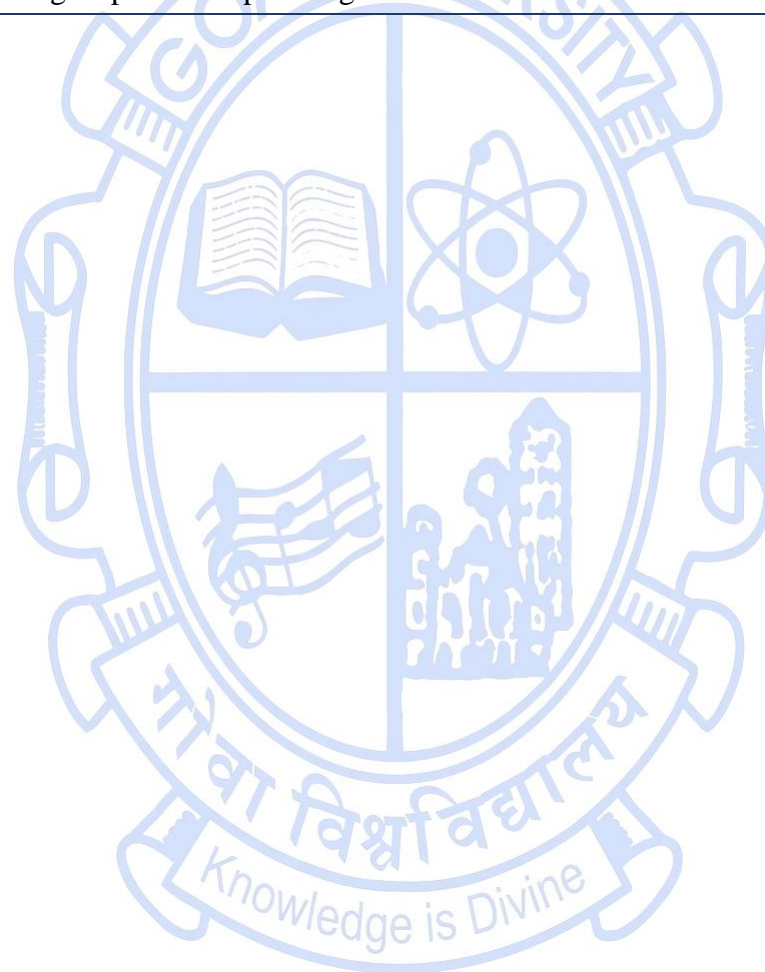
<https://qps.nhsrindia.org/sites/default/files/2022-01/INDIAN%20PHARMACOPOEIA%202010%20Volume%202.pdf>.

5. Acid-Base Titrimetric Assay - <https://www.researchgate.net/publication/286194403>.

6. UV Spectrophotometric Estimation -<https://www.researchgate.net/publication/340052113>.

7. Dissolution Testing-<https://www.pharmaguideline.com/2010/02/dissolution-testing-of-tablets.html>

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<b>Title of the Course</b>	Pharmaceutical Chemistry Practical - II	
<b>Course Code</b>	CHH-5202	
<b>Number of Credits</b>	2	
<b>Theory/Practical</b>	Practical	
<b>Level</b>	400	
<b>Effective from AY</b>	2025-2026	
<b>New Course</b>	No	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	Nil	
<b>Course Objectives:</b>	<ul style="list-style-type: none"> <li>• To acquire hands on training in laboratory techniques.</li> <li>• To learn organic synthesis of medicinal compound.</li> <li>• To understand application of drug molecules in human beings and animals.</li> <li>• To evaluate biological response of the drugs towards human bodies.</li> </ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	CO 1. Explain working principle and handling techniques of instruments.	PSO 1, PSO 3
	CO 2. Distinguish the qualitative and quantitative tests of the drug molecule.	PSO 2, PSO 4
	CO 3. Develop the synthesis method/route and characterization of the drug compounds.	PSO 5, PSO 6
	CO 4. Apply and validate the analytical method of drugs towards industrial or research	PSO 7, PSO 8

purpose.				
Content:		No of hours	Mapped to CO	Cognitive Level
<b>Module 1:</b>	<b>1) Qualitative and Quantitative tests of (Any 1)</b> 1. Paracetamol as per IP Monograph 2. Aspirin as per IP Monograph	<b>10</b>	CO1, CO2	K1, K2, K3
<b>Module 2:</b>	<b>2) Titrimetric Assay of the following bulk drugs: (4 x 2 = 8) (Any 2)</b> 1. Furosemide injection IP 2. Ketoprofen 3. Phenytoin	<b>08</b>	CO2, CO3	K2, K3, K4
<b>Module 3:</b>	<b>3) UV Spectrophotometric Assay of the following drugs (in different dosage forms): (4 x 2= 8) (Any 2)</b> 1. Mefenamic acid, 2. Furosemide, 3. Chloramphenicol	<b>08</b>	CO2, CO3	K2, K4, K5
<b>Module 4:</b>	<b>4) Synthesis of following bioactive or drug molecules (2x4 = 8 hours) (Any 2)</b> 1. Warfarin 2. 2-(p-Chlorophenyl)benzoxazole 3. Monastrol 4. Nitazoxanide	<b>08</b>	CO2, CO3	K3, K4
<b>Module 5:</b>	<b>5) Dissolution experiment:</b> Dissolution rate study of sustained release Diclofenac tablets IP	<b>06</b>	CO2, CO3	K3, K5
<b>Module 6:</b>	<b>6) Thin Layer Chromatographic experiments on pharmaceuticals (Any 1)</b> 1. To identify the given drug amongst the Paracetamol, Aspirin and Caffeine	<b>04</b>	CO3, CO4	K3, K5

	<p>citrate with the help of thin layer chromatography and calculate its Rf value.</p> <p>2. To identify the given sulpha drug among the sulphadiazine, Sulfamethoxazole and Trimethoprim with the help of thin layer chromatography and calculate its Rf value.</p>			
<b>Module 7:</b>	<p><b>7) High Performance liquid Chromatographic experiment:</b> To separate a mixture of Ibuprofen and Acetylsalicylic acid using reverse phase high performance liquid chromatography.</p>	<b>06</b>	CO3, CO4	K5, K6
<b>Module 8:</b>	<p><b>8) Separation of mixture</b> of o-Nitroaniline and p- Nitroaniline using column chromatography.</p>	<b>06</b>	CO1, CO2, CO3	K1, K2, K3
<b>Module 9:</b>	<p><b>9) Infrared spectroscopic analysis demonstration of instrumentation and interpretation of representative spectrum (Any 1)</b> a) To differentiate between analgesic NSAIDs: Aspirin, Ibuprofen, Paracetamol. b) To differentiate between Acetophenone, p-Nitroacetophenone, Benzamide.</p>	<b>04</b>	CO1, CO2, CO3	K1, K2, K3
<b>Pedagogy:</b>	<p>Pre-lab and Post-lab exercises. Demonstrations of experiments. Explanation of Procedures.</p>			
<b>Texts:</b>	<p>1. Vogel, A. I., Tatchell, A. R., &amp; Hannaford, B. S. F. (2011). Vogel's Textbook of Practical Organic Chemistry, 5<sup>th</sup> ed., Harlow, England: Prentice Hall.</p> <p>2. Connors, K. A. (1990). Textbook of Pharmaceutical Analysis, 3<sup>rd</sup> ed., New York, NY: Wiley-Interscience.</p> <p>3. Bassett, J., Mendham, J., &amp; Denny, R. C. (Revised by G. H. Jeffery). (2007). Vogel's Textbook of Quantitative Chemical Analysis, 6<sup>th</sup> ed., New Delhi, India: Pearson Education.</p>			
<b>References/ Readings:</b>	<p>Pharmacopoeias:</p> <p>1. Indian Pharmacopoeia, 9<sup>th</sup> ed., Ghaziabad: Indian Pharmacopoeia Commission.</p> <p>2. United States Pharmacopoeia (USP-NF, Issue 1, May 2024) Rockville, MD: United States Pharmacopoeial Convention.</p> <p>3. British Pharmacopoeia (BP 2025, Jan. 2025), London: Medicines and Healthcare Products Regulatory Agency</p>			

	<p>(MHRA).</p> <ol style="list-style-type: none"> <li>4. European Pharmacopoeia (Ph. Eur.), 11<sup>th</sup> ed., 2022, Strasbourg: European Directorate for the Quality of Medicines &amp; Health Care (EDQM), Council of Europe.</li> <li>5. Reynolds, J. E. F., (1993), Martindale: The Extra Pharmacopoeia, 30<sup>th</sup> ed., London, The Pharmaceutical Press.</li> <li>6. Moini, J. (2010). Pharmaceutical Laboratory Procedures, 1<sup>st</sup> ed., New Delhi: Cengage Learning India Pvt. Ltd.</li> </ol>
<b>Web Resources:</b>	<ol style="list-style-type: none"> <li>1. <a href="https://pharmaguideline.com/2020/01/assay-of-paracetamol-by-non-aqueous-titration.html">https://pharmaguideline.com/2020/01/assay-of-paracetamol-by-non-aqueous-titration.html</a></li> <li>2. <a href="https://www.ijpsr.com/bft-article/uv-spectrophotometric-determination-of-chloramphenicol-in-pharmaceutical-formulation/">https://www.ijpsr.com/bft-article/uv-spectrophotometric-determination-of-chloramphenicol-in-pharmaceutical-formulation/</a></li> <li>3. <a href="https://www.researchgate.net/publication/290861264_Synthesis_of_Warfarin">https://www.researchgate.net/publication/290861264_Synthesis_of_Warfarin</a></li> <li>4. <a href="https://www.omicsonline.org/open-access/hplc-method-for-determination-of-diazepam.pdf">https://www.omicsonline.org/open-access/hplc-method-for-determination-of-diazepam.pdf</a></li> <li>5. <a href="https://www.chemistrysteps.com/separation-of-o-and-p-nitroaniline-by-column-chromatography/">https://www.chemistrysteps.com/separation-of-o-and-p-nitroaniline-by-column-chromatography/</a></li> </ol>

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<b>Title of the Course</b>	Organic Chemistry Practical - I	
<b>Course Code</b>	CHO-5201	
<b>Number of Credits</b>	2	
<b>Theory/Practical</b>	Practical	
<b>Level</b>	400	
<b>Effective from AY</b>	2025-26	
<b>New Course</b>	Yes	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	NIL	
<b>Course Objectives:</b>	<ul style="list-style-type: none"> <li>• To understand essential laboratory equipment, safety protocols, and fundamental experimental purification techniques</li> <li>• To create practical skills in basic organic synthesis through key reactions, including electrophilic substitution and other important transformations.</li> <li>• To understand the methods of isolation and purification of naturally occurring organic compounds.</li> </ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	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	
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	<p><b>1.1 Introduction to laboratory equipment, apparatus and safety</b></p> <p>a. Use of common laboratory equipment like fume hood, vacuum pump, weighing balance.</p> <p>b. Introduction to various types of quick fit joints and apparatus.</p> <p>c. Safety Techniques:</p> <ol style="list-style-type: none"> <li>i. Disposal of chemicals</li> <li>ii. Personal Protective Equipment (PPE)</li> <li>iii. First aid</li> <li>iv. Fire extinguishers, types of fire</li> <li>v. Chemical hazards and risk assessment</li> </ol> <p><b>1.2 Laboratory Techniques-I</b></p> <p>a. Simple distillation (any one):</p> <ol style="list-style-type: none"> <li>i. Toluene-dichloromethane mixture using water condenser.</li> <li>ii. Nitrobenzene and aniline using air condenser.</li> </ol> <p>b. Steam distillation (any one):</p> <ol style="list-style-type: none"> <li>i. Separation of o- and p- nitrophenols.</li> <li>ii. Naphthalene from its suspension in water.</li> <li>iii. Clove oil from cloves.</li> </ol> <p>c. Crystallisation: Concept of induction of crystallization (any one)</p> <ol style="list-style-type: none"> <li>i. Crystallisation of phthalic acid from hot water using fluted filter paper and stemless funnel.</li> <li>ii. Acetanilide from boiling water</li> <li>iii. Naphthalene from ethanol.</li> </ol>	<b>16</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5

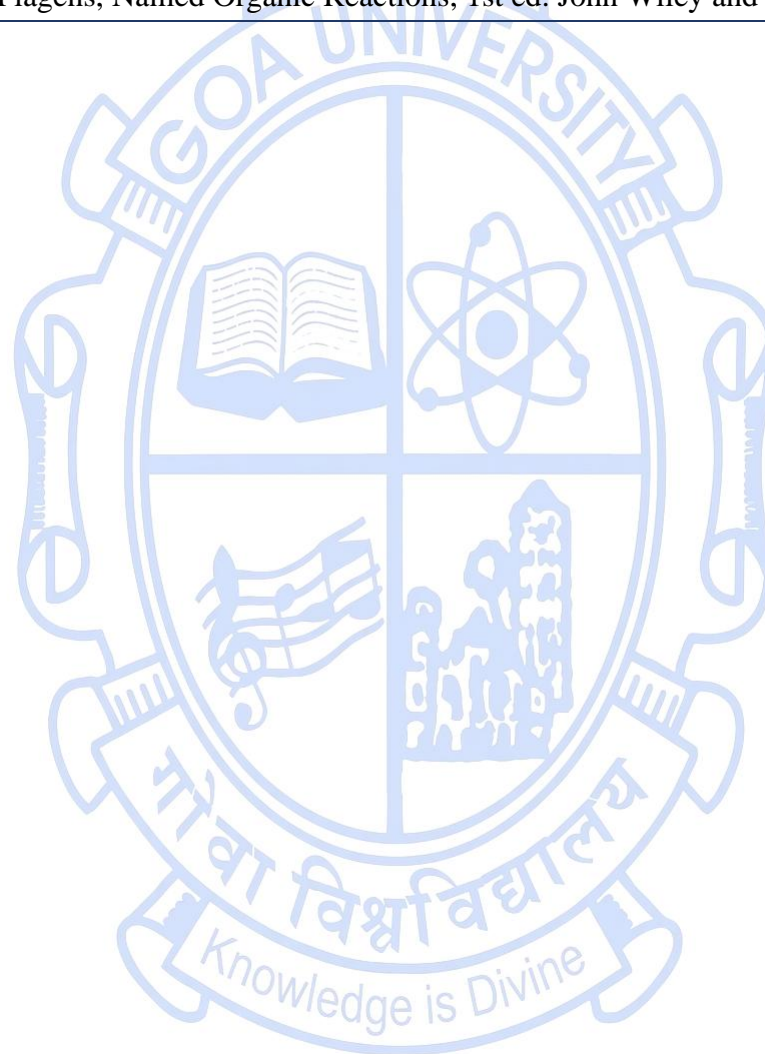
	iv. Decolorisation and crystallization of brown sugar (sucrose) with animal charcoal using gravity filtration.			
<b>Module 2:</b>	<p><b>2 Laboratory Techniques-II</b></p> <p>a. Sublimation: Simple or vacuum sublimation of camphor, naphthalene, anthracene or succinic acid (any one). Vacuum distillation (any one): o-dichlorobenzene, diphenyl ether. Explanation of use of nomograph.</p> <p>b. Thin layer Chromatography (any one):</p> <ol style="list-style-type: none"> <li>Separation of o and p-nitroanilines.</li> <li>Separation of analgesic drugs (ibuprofen/paracetamol)</li> <li>Separation of o and p-nitrophenols</li> </ol>	<b>12</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
<b>Module 3:</b>	<p><b>3. Organic synthesis (Any Four experiments)</b></p> <p>a. Aliphatic electrophilic substitution: Preparation of iodoform from ethanol &amp; acetone.</p> <p>b. Aromatic electrophilic substitution (any one):</p> <ol style="list-style-type: none"> <li>Preparation of p-bromoacetanilide.</li> <li>Bromination of acetophenone to phenacyl bromide</li> <li>Nitration of naphthalene to 1-nitronaphthalene</li> <li>Nitration of benzaldehyde to 3-nitrobenzaldehyde.</li> </ol> <p>c. Oxidation (any one)</p> <ol style="list-style-type: none"> <li>Benzoic acid from toluene.</li> <li>Cyclohexanone from cyclohexanol.</li> <li>Isoborneol to camphor using Jones reagent.</li> </ol> <p>d. Reduction (any one)</p> <ol style="list-style-type: none"> <li>Reduction of o-nitroaniline to o-phenylenediamine using Sn/HCl</li> <li>Reduction of p-nitro benzaldehyde to p-nitrobenzyl alcohol using NaBH<sub>4</sub>.</li> </ol> <p>e. Bromination of an alcohol using CBr<sub>4</sub>/ triphenylphosphine.</p> <p>f. Grignard reaction: Triphenylmethanol from benzoic acid ester or benzophenone.</p> <p>g. Aldol condensation: Dibenzalacetone from benzaldehyde</p> <p>h. Acetoacetic ester condensation: Preparation of ethyl n-butylacetoacetate</p>	<b>16</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5

	or ethyl acetoacetate.			
<b>Module 4:</b>	<p><b>Organic synthesis and synthetic reagents (Any two)</b></p> <p>a. Cannizzaro reaction using 4-chlorobenzaldehyde as substrate.</p> <p>b. Friedel Craft's reaction</p> <p>    i. using toluene and succinic anhydride</p> <p>    ii. Resorcinol to resacetophenone, benzene and maleic anhydride to benzoylacrylic acid.</p> <p>c. Solvent free preparation of coumarin by the Knoevenagel condensation under MW irradiation.</p> <p>d. Preparation of oxidizing agent (any one): Pyridinium chlorochromate-silica, pyridinium chlorochromate-alumina, MnO<sub>2</sub>.</p> <p>e. Preparation of cuprous chloride.</p> <p><b>Isolation from natural sources (Any two)</b></p> <p>    i. Caffeine from tea powder.</p> <p>    ii. Piperine from pepper.</p> <p>    iii. Cinnamaldehyde from cinnamon</p> <p>    iv. Lemongrass oil from lemongrass</p>	<b>16</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>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</li> <li>2. K. Tanaka, Solvent-Free Organic Synthesis, 2nd ed, Wiley-VCH, Weinheim, 2009.</li> <li>3. L. F. Fieser, K. L. Williamson, Organic Experiments, 7th ed. D. C. Heath, Lexington, 1992.</li> <li>4. K. L. Williamson, K. M. Masters, Macroscale and Microscale Organic Experiments, 6th ed. Cengage Learning, Boston, 2010</li> <li>5. R. K. Bansal, Laboratory Manual in Organic Chemistry, 5th ed. New Age International, New Delhi, 2016</li> <li>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</li> </ol>			

**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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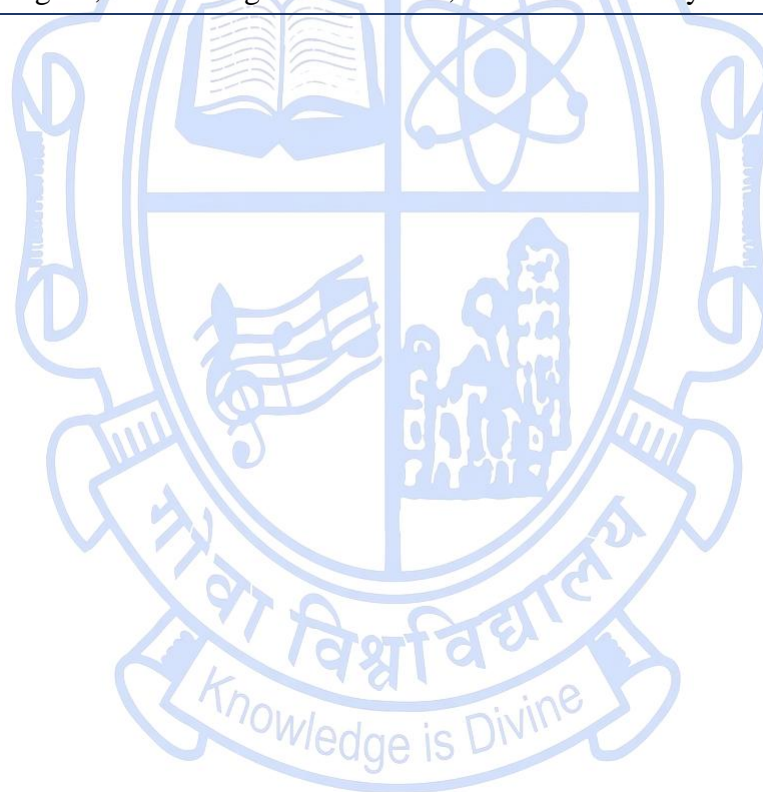
<b>Title of the Course</b>	Organic Chemistry Practical - II	
<b>Course Code</b>	CHO-5202	
<b>Number of Credits</b>	2	
<b>Theory/Practical</b>	Practical	
<b>Level</b>	400	
<b>Effective from AY</b>	2025-26	
<b>New Course</b>	Yes	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	NIL	
<b>Course Objectives:</b>	<ul style="list-style-type: none"> <li>To familiarize students with essential laboratory equipment, safety protocols, and fundamental experimental purification techniques</li> <li>To develop practical skills in basic organic synthesis through key reactions, including electrophilic substitution and other important transformations.</li> <li>To introduce the methods of isolation and purification of naturally occurring organic compounds.</li> </ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	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	
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	<p><b>1.1 Introduction to laboratory equipment, apparatus and safety</b></p> <p>a. Common Hazards in Chemical Laboratory, Risk assessment b. Accidents and Emergency procedures</p> <p><b>1.2 Laboratory Techniques (Any Three)</b></p> <p>a. Simple distillation: i. Simple distillation of thionyl chloride under anhydrous condition ii. Simple distillation under Nitrogen atmosphere of THF</p> <p>b. Fractional distillation: i. Chloroform-dichloromethane mixture using water condenser. ii. Toluene and cyclohexane using fractionating column.</p> <p>c. Vacuum distillation under inert atmosphere: Distillation of DMF, o-dichlorobenzene, POCl<sub>3</sub></p> <p>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.</p>	<b>16</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
<b>Module 2:</b>	<p><b>Organic Synthesis (Any Four)</b></p> <p>a. p-Iodonitrobenzene by Sandmeyer reaction b. Pinacol- Pinacolone rearrangement</p>	<b>16</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5

	<ul style="list-style-type: none"> <li>c. Hydrogenation of Maleic acid (Hydrogen balloon)</li> <li>d. Preparation of nitrostyrene from aldehyde</li> <li>e. Preparation of dibromocinnamic acid</li> <li>f. Reduction of nitro compounds</li> <li>g. Synthesis of Urea from ammonium cyanate</li> </ul>			
<b>Module 3:</b>	<p><b>3. Two-step Organic Synthesis (Any Two)</b></p> <ul style="list-style-type: none"> <li>a. Benzamide-Benzoic acid-Ethyl Benzoate</li> <li>b. Phthalic anhydride-Phthalimide-Anthranilic acid.</li> <li>c. Methyl benzoate- m-nitrobenzoate- m-nitrobenzoic acid</li> <li>d. Chlorobenzene-2, 4 -dinitrochlorobenzene-2,4 dinitrophenol</li> <li>e. Acetanilide-p-Bromoacetanilide-p-Bromoaniline</li> <li>f. Acetophenone-Oxime-Acetanilide</li> </ul>	<b>16</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
<b>Module 4:</b>	<p><b>4.1 Solvent Free Organic synthesis (Any One)</b></p> <ul style="list-style-type: none"> <li>a. Reduction using ball milling technique</li> <li>b. Oxidation of 2° alcohol using KMnO<sub>4</sub>/Alumina by grinding technique.</li> <li>c. Synthesis of 1,1'-Bi-2-naphthol (BINOL)</li> <li>d. Hunsdiecker reaction of cinnamic acid derivatives</li> <li>e. Beckmann rearrangement of oxime derivatives</li> </ul> <p><b>4.2 Separation, Isolation and Identification of Organic compounds (Any One)</b></p> <p>Separation, purification and identification of compounds of binary mixture (Solid-Solid, Solid-liquid and Liquid-liquid) using the TLC and column chromatography, chemical tests.</p> <p>IR spectra to be used for functional group identification.</p>	<b>12</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ul style="list-style-type: none"> <li>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</li> <li>2. K. Tanaka, Solvent-Free Organic Synthesis, 2nd ed, Wiley-VCH, Weinheim, 2009</li> </ul>			

	<ol style="list-style-type: none"><li>3. L. F. Fieser, K. L. Williamson, Organic Experiments, 7th ed. D. C. Heath, Lexington, 1992</li><li>4. K. L. Williamson, K. M. Masters, Macroscale and Microscale Organic Experiments, 6th ed. Cengage Learning, Boston, 2010</li><li>5. R. K. Bansal, Laboratory Manual in Organic Chemistry, 5th ed. New Age International, New Delhi 2016</li><li>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</li></ol>
<b>References/ Readings:</b>	<ol style="list-style-type: none"><li>1. S. Delvin, Green Chemistry, 1st ed. Sarup &amp; Sons, New Delhi, 2005.</li><li>2. J. Mohan, Organic Analytical Chemistry, 1st ed. Narosa Publishing House, New Delhi, 2014.</li><li>3. T. Laue, A. Plagens, Named Organic Reactions, 1st ed. John Wiley and Sons, Inc., Hoboken, 2005</li></ol>

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<b>Title of the Course</b>	Physical Chemistry Practical-I	
<b>Course Code</b>	CHP-5201	
<b>Number of Credits</b>	02	
<b>Theory/Practical</b>	Practical	
<b>Level</b>	400	
<b>Effective from AY</b>	2025-26	
<b>New Course</b>	Yes	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	NIL	
<b>Course Objectives:</b>	<ul style="list-style-type: none"> <li>To develop experimental skills on basic lab techniques in physical chemistry</li> <li>To understand fundamental laboratory concepts and acquire skills for data acquisition, analysis and interpretation</li> <li>To understand and follow safety protocols for handling chemicals, equipment and instruments.</li> <li>To apply the practical laboratory concepts for synthesis, problem solving and critical thinking</li> <li>To develop research skills through the principles of laboratory chemical research.</li> </ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	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
<b>Module 1:</b>	<p><b>1. Non- instrumental Experiments (Any 08)</b></p> <ol style="list-style-type: none"> <li>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.</li> <li>To determine the order of reaction between potassium persulphate and potassium iodide by graphical, fractional change and differential methods.</li> <li>To study the three-component system such as acetic acid, chloroform and water and obtain tie line.</li> <li>To determine the molecular weight of polyvinyl alcohol by viscosity measurement.</li> <li>To study the electro-kinetics of rapid reaction between <math>\text{SO}_4^{2-}</math> and <math>\text{I}^-</math> in an aqueous solution.</li> <li>To determine the buffer capacity of acidic buffer solution.</li> <li>To determine the partial molal volume of ethanol-water mixture at a given temperature.</li> <li>To measure energy content of various types of plastics using bomb calorimetry</li> <li>To determine number average molecular weight of a polymer sample with an indirect titration method.</li> <li>To investigate basic hydrolysis of ethyl acetate at four different temperatures and find out energy of activation</li> <li>To construct a phase diagram for a two-component system by plotting cooling curves for mixtures of different compositions.</li> <li>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.</li> </ol>	32	CO1, CO3, CO4 K2, K3, K4, K5
<b>Module 2:</b>	<p><b>2. Instrumental Experiments (Any 07)</b></p> <ol style="list-style-type: none"> <li>To determine the degree of hydrolysis of salt of weak base and strong acid using conductometer.</li> </ol>	28	CO2, CO3, CO4 K3, K4, K5

	<ol style="list-style-type: none"> <li>2. To determine the dissociation constants of a tribasic acid (Phosphoric acid obtain derivative plot to get equivalence point.</li> <li>3. To determine formal redox potential of <math>\text{Fe}^{2+}/\text{Fe}^{3+}</math> and <math>\text{Ce}^{3+}/\text{Ce}^{4+}</math> system obtain derivative plot to get equivalence point.</li> <li>4. To study spectrophotometric titration of ferrous ammonium sulphate with potassium permanganate (or dichromate vs permanganate)</li> <li>5. To determine Avogadro's number by improved electroplating.</li> <li>6. To determine the zeta potential of colloidal system and investigate the effect of different surfactants on stability of the colloids.</li> <li>7. To verify the Kohlrausch's law for weak electrolyte by conductometry.</li> <li>8. To determine the transport numbers of <math>\text{Cu}^{2+}</math> and <math>\text{SO}_4^{2-}</math> ions in <math>\text{CuSO}_4</math> solution by Hittorf's method.</li> </ol>			
<b>Pedagogy:</b>	<p>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.</p>			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. V. D. Athawale, P. Mathur, Experimental Physical Chemistry, New Age International Publishers, 1<sup>st</sup> ed., New Delhi, 2001.</li> <li>2. J.N. Gurtu, A. Gurtu, Advanced Physical Chemistry Experiments, Pragati Publications, 1<sup>st</sup> ed., Meerut, 2008.</li> <li>3. A. Findlay &amp; J. A. Kitchener, Practical Physical Chemistry, Longmans, Green and Co., 1<sup>st</sup> ed., London 1954.</li> <li>4. F. Daniels &amp; J. H. Mathews, Experimental Physical Chemistry, McGraw-Hill, 1<sup>st</sup> ed., New York, 1941.</li> </ol>			
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. A. M. James, Practical Physical Chemistry, Prentice Hall Press, 3<sup>rd</sup> ed., 1974.</li> <li>2. D.P. Shoemaker &amp; C. W. Garland, Experiments in Physical Chemistry, McGraw-Hill, 1<sup>st</sup> ed., New York, 1962.</li> <li>3. T. Kadow &amp; F. Mafune, Progress in experimental and theoretical studies of clusters, World Scientific publishers, 1<sup>st</sup> ed., New Jersey, 2002.</li> <li>4. C. Arora &amp; S. Bhattacharya, Advanced Physical Chemistry Practical Guide, Bentham Science Publishers, 1<sup>st</sup> ed., UAE, 2022.</li> <li>5. A. K. Hagi, L. Pogliani, A. C. F. Ribeiro, Practical applications of Physical Chemistry in food science and technology, 1<sup>st</sup> ed., Apple Academic Press, USA, 2021.</li> </ol>			

<b>Title of the Course</b>	Physical Chemistry Practical-II	
<b>Course Code</b>	CHP-5202	
<b>Number of Credits</b>	02	
<b>Theory/Practical</b>	Practical	
<b>Level</b>	400	
<b>Effective from AY</b>	2025-26	
<b>New Course</b>	Yes	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	NIL	
<b>Course Objectives:</b>	<ul style="list-style-type: none"> <li>To develop experimental skills on basic lab techniques in physical chemistry</li> <li>To understand fundamental laboratory concepts and acquire skills for data acquisition, analysis and interpretation</li> <li>To understand and follow safety protocols for handling chemicals, equipment and instruments.</li> <li>To apply the practical laboratory concepts for synthesis, problem solving and critical thinking</li> <li>To develop research skills through the principles of laboratory chemical research.</li> </ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	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
<b>Module 1:</b>	<p><b>1. Non- instrumental Experiments (Any 09)</b></p> <ol style="list-style-type: none"> <li>To determine the radius of a molecule by viscosity measurements.</li> <li>To determine <math>\Delta G</math>, <math>\Delta H</math> and <math>\Delta S</math> of silver benzoate by solubility product method.</li> <li>To investigate the adsorption of oxalic acid by activated charcoal and test the validity of Freundlich and Langmuir's isotherms.</li> <li>To determine the molecular weight of a given polymer by turbidimetry.</li> <li>To study the rate of reaction between ethyl bromoacetate and sodium thiosulphate kinetically.</li> <li>To determine the percentage composition of a given mixture of two liquids by stalagmometer method.</li> <li>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.</li> <li>To study the kinetics of the reaction between potassium persulphate (<math>K_2S_2O_8</math>), and potassium iodide (KI), and to determine a) Energy of activation b) Entropy of activation and c) Free energy change.</li> <li>To determine the order of reaction for hydrolysis of ethyl acetate by graphical, fractional change and differential methods.</li> <li>To determine the molecular weight of polystyrene by viscosity measurement.</li> </ol>	<b>36</b>	CO1, CO3, CO4	K1, K2, K3, K4, K5
<b>Module 2:</b>	<p><b>2. Instrumental Experiments</b></p> <ol style="list-style-type: none"> <li>To determine the relative strength of chloroacetic acid and acetic acid by conductometry.</li> <li>To determine the degree of hydrolysis of salt of weak base and strong acid using conductometry.</li> <li>To determine the composition of a mixture of acetic acid, dichloroacetic acid and hydrochloric acid by conductometric titration.</li> <li>To determine the dissociation constants of monobasic acid and dibasic acid and obtain derivative plot to get equivalence point.</li> </ol>	<b>24</b>	CO2, CO3, CO4	K2, K3, K4, K5

	<ol style="list-style-type: none"> <li>To determine the redox potential of <math>\text{Fe}^{2+}/\text{Fe}^{3+}</math> system by titrating it with standard <math>\text{K}_2\text{Cr}_2\text{O}_7</math> solution.</li> <li>To study the electrodeposition of metal.</li> </ol>			
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>V. D. Athawale, P. Mathur, Experimental Physical Chemistry, New Age International Publishers, 1st ed., New Delhi, 2001.</li> <li>J.N. Gurtu, A. Gurtu, Advanced Physical Chemistry Experiments, Pragati Publications, 1st ed., Meerut, 2008.</li> <li>A. Findlay &amp; J. A. Kitchener, Practical Physical Chemistry, Longmans, Green and Co., 1st ed., London 1954.</li> <li>F. Daniels &amp; J. H. Mathews, Experimental Physical Chemistry, McGraw-Hill, 1st ed., New York, 1941.</li> </ol>			
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>A. M. James, Practical Physical Chemistry, Prentice Hall Press, USA 3rd ed., 1974.</li> <li>D.P. Shoemaker &amp; C. W. Garland, Experiments in Physical Chemistry, McGraw-Hill, 1st ed., New York, 1962.</li> <li>T. Kadow &amp; F. Mafune, Progress in experimental and theoretical studies of clusters, World Scientific publishers, 1st ed., New Jersey, 2002.</li> <li>C. Arora &amp; S. Bhattacharya, Advanced Physical Chemistry Practical Guide, Bentham Science Publishers, 1st ed., UAE, 2022.</li> <li>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.</li> </ol>			

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<b>Title of the Course</b>	Analytical Chemistry Practical - I	
<b>Course Code</b>	CHA-5201	
<b>Number of Credits</b>	2	
<b>Theory/Practical</b>	Practical	
<b>Level</b>	400	
<b>Effective from AY</b>	2025-26	
<b>New Course</b>	Yes	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	Nil	
<b>Course Objectives:</b>	<ul style="list-style-type: none"> <li>• To perform various experimental techniques for analysis.</li> <li>• To learn data analysis, handling and interpretation of spectra.</li> <li>• To determine concentration of solutions.</li> <li>• To use techniques for qualitative and quantitative estimation.</li> </ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	CO 1. Explain data analysis, handling and interpretation of spectra.	PSO1, PSO3, PSO4
	CO 2. Apply different techniques for qualitative and quantitative estimation.	PSO1, PSO2, PSO6
	CO 3. Determine concentration of solutions.	PSO1, PSO6
	CO 4. Perform various experimental techniques for analysis.	PSO1, PSO2, PSO6

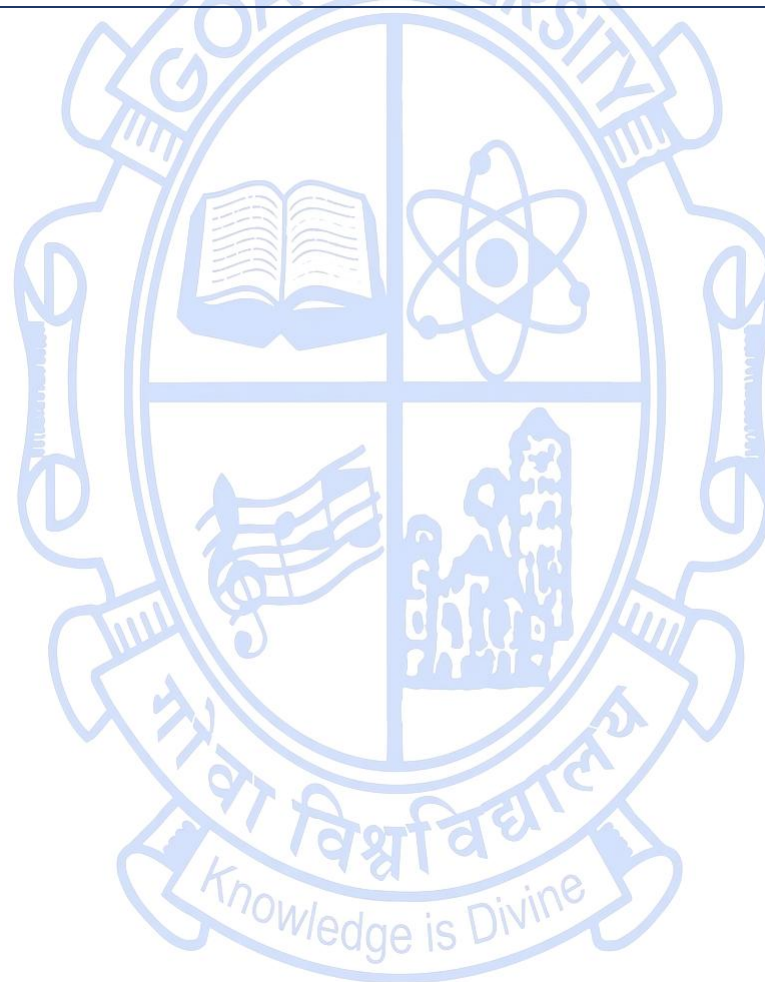
<b>Content:</b>	This course consists of 8 units of experiments in various areas of Analytical chemistry. Minimum 15 experiments which include at least 01 experiment from each unit to be performed.	<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	Statistics: <ol style="list-style-type: none"> <li>Calibration of selected Volumetric apparatus</li> <li>Calibration of selected Laboratory instruments</li> <li>Preparation of standard solutions and standardisation.</li> </ol>	<b>4</b>	CO3	K5
<b>Module 2:</b>	Colorimetry/ UV-Visible Spectrophotometry: <ol style="list-style-type: none"> <li>Estimation of Iron from Pharmaceutical sample (Tablet/capsule) by thiocyanate method</li> <li>Estimation of phosphoric acid in cola drinks by molybdenum blue method.</li> <li>Estimation of <math>\text{KNO}_3</math> by UV spectroscopy and <math>\text{K}_2\text{Cr}_2\text{O}_7</math> by Visible spectroscopy</li> <li>Simultaneous determination and Verification of law of additivity of absorbances (<math>\text{K}_2\text{Cr}_2\text{O}_7</math> and <math>\text{KMnO}_4</math>).</li> </ol>	<b>8</b>	CO4, CO2	K6, K3
<b>Module 3:</b>	Flame Spectrophotometry and AES/AAS/ICP Spectroscopy <ol style="list-style-type: none"> <li>Estimation of Na and K in food supplements or cosmetic products.</li> <li>Estimation of Pb in water sample by AES/AAS/ICP.</li> <li>Estimation of Fe and Al in Iron ore sample by AES/AAS/ICP.</li> </ol>	<b>8</b>	CO1, CO2	K2, K3
<b>Module 4:</b>	Ion Exchange Chromatography and High Performance Liquid Chromatography (HPLC): <ol style="list-style-type: none"> <li>Separation and Estimation of chloride and bromide using Ion exchange chromatography.</li> <li>Separation of anthracene and naphthalene using reverse phase chromatography</li> <li>Separation of benzaldehyde and benzyl alcohol using normal phase chromatography</li> </ol>	<b>8</b>	CO4, CO2	K6, K3
<b>Module 5:</b>	Volumetric Titrations: <ol style="list-style-type: none"> <li>Estimation of Ca in pharmaceutical tablet.</li> </ol>	<b>8</b>	CO4, CO3	K6, K5

	<ul style="list-style-type: none"> <li>ii. Estimation of Al and Mg in antacid tablet.</li> <li>iii. Estimation of CaO in cement.</li> </ul>			
<b>Module 6:</b>	<p>Solvent Extraction and spectrophotometry:</p> <ul style="list-style-type: none"> <li>i. Extraction of Cu as copper dithiocarbamate (DTC) using solvent extraction and estimation by spectrophotometry.</li> <li>ii. Determination of Ni as dimethylglyoxime complex by spectrophotometry.</li> <li>iii. Determination of silver as ion association complex with 1,10-phenanthroline and bromopyrogallol red.</li> </ul>	<b>8</b>	CO4, CO3	K6, K5
<b>Module 7:</b>	<p>Demonstration and Interpretation Exercises:</p> <ul style="list-style-type: none"> <li>i. Thermal studies: TG/DTA and Isothermal weight loss studies of various hydrated solids like <math>\text{CuSO}_4 \cdot 5\text{H}_2\text{O}</math>, <math>\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}</math>, <math>\text{FeC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}</math>.</li> <li>ii. X-ray powder diffractometry: Calculation of lattice parameters from X-ray powder pattern of cubic system such as <math>\text{NiMn}_2\text{O}_4</math>, <math>\text{CoFe}_2\text{O}_4</math>.</li> <li>iii. IR spectra of urea, benzoic acid, copper sulphate pentahydrate etc.</li> </ul>	<b>8</b>	CO1, CO2	K2, K3
<b>Module 8:</b>	<p>Demonstration:</p> <ul style="list-style-type: none"> <li>i. Turbidimeter.</li> <li>ii. KF instrument.</li> <li>iii. Polarimeter.</li> <li>iv. LCMS.</li> <li>v. NMR.</li> </ul>	<b>8</b>	CO1, CO2	K2, K3
<b>Pedagogy:</b>	<p>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.</p>			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>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.</li> <li>2. R. A. Day &amp; A.L. Underwood, Quantitative Analysis, 6<sup>th</sup> ed., Pearson Education India, 2015.</li> <li>3. J. Kenkel, Analytical Chemistry for Technicians, 3<sup>rd</sup> ed., Lewis publishers, USA, 2002.</li> <li>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</li> <li>5. A. J. Elias, Collection of interesting chemistry experiments, University press, Hyderabad, 2002.</li> </ol>			

**References/  
Readings:**

1. G. D. Christian, Analytical chemistry, 5<sup>th</sup> 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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<b>Title of the Course</b>	Analytical Chemistry Practical - II	
<b>Course Code</b>	CHA-5202	
<b>Number of Credits</b>	2	
<b>Theory/Practical</b>	Practical	
<b>Level</b>	400	
<b>Effective from AY</b>	2025-26	
<b>New Course</b>	Yes	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	Nil	
<b>Course Objectives:</b>	<ul style="list-style-type: none"> <li>• To perform various experimental techniques for analysis.</li> <li>• To learn data analysis, handling and interpretation of spectra.</li> <li>• To determine concentrations of solution.</li> <li>• To use techniques for qualitative and quantitative estimation.</li> </ul>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	CO 1. Explain data analysis, handling and interpretation of spectra.	PSO1, PSO3, PSO4
	CO 2. Apply different techniques for qualitative and quantitative estimation.	PSO1, PSO2, PSO6
	CO 3. Determine concentration of solutions.	PSO1, PSO6
	CO 4. Perform various experimental techniques for analysis.	PSO1, PSO2, PSO6

<b>Content:</b>	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.	<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	Statistics: i. Calibration of selected Volumetric apparatus ii. Calibration of selected Laboratory instruments iii. Preparation of standard solutions and standardisation.	<b>4</b>	CO3	K5
<b>Module 2:</b>	Titrimetric Analysis: i. Standardisation and estimation of Chloride using precipitation titration (Mohr's method) ii. Analysis of commercial caustic soda by neutralisation method. iii. Determination of sulphates by complexometric titration.	<b>8</b>	CO4, CO2	K6, K3
<b>Module 3:</b>	Flame Spectrophotometry and AES/AAS/ICP Spectroscopy i. Estimation of sodium and potassium in food supplements or cosmetic products using flame photometer. ii. Estimation of chromium in water sample by AES/AAS/ICP. iii. Estimation of nickel, molybdenum in Hastelloy C-22 using AES/AAS/ICP.	<b>8</b>	CO1, CO4	K2, K6
<b>Module 4:</b>	Natural product isolation and Ion Exchange Chromatography. i. Isolation of cinnamaldehyde from cinnamon. ii. Isolation of caffeine from tea powder. iii. Separation and estimation of cadmium and zinc.	<b>8</b>	CO4, CO2	K6, K3
<b>Module 5:</b>	UV-Visible Spectrophotometry and High Performance Liquid Chromatography (HPLC). i. Estimation of KNO <sub>3</sub> and K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> using UV- Visible spectroscopy. ii. Separation of benzaldehyde and benzoic acid using reverse phase HPLC. iii. Quantification of naphthalene in a sample using reverse phase HPLC.	<b>8</b>	CO4, CO3	K6, K5
<b>Module 6:</b>	Solvent Extraction and spectrophotometry i. Spectrophotometric determination of aspirin/phenacetin/caffeine in APC tablet	<b>8</b>	CO4, CO3	K6, K5

	<p>using solvent extraction.</p> <p>ii. Colorimetric determination of iron with salicylic acid.</p> <p>iii. Determination of copper in brass sample by colorimetry.</p>			
<b>Module 7:</b>	<p>Data Interpretation Exercises:</p> <p>i. NMR/Mass spectra</p> <p>ii. HPLC and GC chromatograph</p> <p>iii. XRD powder pattern of cubic systems</p> <p>iv. Thermogram of coordination compounds</p>	<b>8</b>	CO1, CO2	K2, K3
<b>Module 8:</b>	<p>Demonstration:</p> <p>i. Turbidimeter.</p> <p>ii. KF instrument.</p> <p>iii. Polarimeter.</p> <p>iv. LCMS.</p> <p>v. NMR.</p>	<b>8</b>	CO1, CO2	K2, K3
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>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.</li> <li>2. R. A. Day &amp; A.L. Underwood, Quantitative Analysis, 6<sup>th</sup> ed., Pearson Education India, New-Delhi, 2015.</li> <li>3. J. Kenkel, Analytical Chemistry for Technicians, 3<sup>rd</sup> ed., Lewis publishers, USA, 2002.</li> <li>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</li> <li>5. A. J. Elias, Collection of interesting chemistry experiments, University press, Hyderabad, 2002.</li> <li>6. A. Kar, Pharmaceutical Drug Analysis, New Age International, India, 2005</li> </ol>			
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. G. D. Christian, Analytical chemistry, 5<sup>th</sup> ed., John Willey and Sons, USA, 1994</li> <li>2. J. H. Kennedy, Analytical Chemistry: Principles, 2nd ed., Saunders College Publishing, Philadelphia, 1990.</li> <li>3. M. Asadi, Beet-Sugar Handbook, John Wiley &amp; Sons, USA, 2006</li> <li>4. R. E. Ardrey, Liquid Chromatography - Mass Spectrometry: An Introduction, John Wiley &amp; Sons, England, 2003</li> </ol>			

## SEMESTER III

### Research Specific Elective (RSE) Courses

<b>Title of the Course</b>	Pharmaceutical Chemistry Practical-III	
<b>Course Code</b>	CHH-6000	
<b>Number of Credits</b>	4	
<b>Theory/Practical</b>	Practical	
<b>Level</b>	500	
<b>Effective from AY</b>	2026-2027	
<b>New Course</b>	No	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	1. To translate certain theoretical concepts learnt earlier into experimental knowledge. 2. To learn synthesis of medicinal compound and application of drug molecules. 3. To get acquainted with chemical analysis and computational analysis of drugs. 4. To acquire hands on experience in laboratory techniques.	
<b>Course Outcomes:</b>	Students will be able to	<b>Mapped to PSO</b>
	CO1. explain the theoretical aspects of drug synthesis, analysis and computational studies.	PSO1, PSO3
	CO2. synthesize and recrystallize various chemical moieties in small scale.	PSO1, PSO2,

			PSO4
	CO3. analyse drugs using various quality control methods		PSO3, PSO4, PSO5, PSO6
	CO4. evaluate the percentage purity, binding affinity and physicochemical properties of pharmaceutical or chemical substances.		PSO4, PSO6, PSO7, PSO8
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>
<b>Module 1:</b>	<p><b>Syntheses of drugs and drug-like entities (<i>Minimum 4 experiments</i>)</b></p> <ol style="list-style-type: none"> <li>Propranolol from <math>\alpha</math>-Naphthol</li> <li>Eosin from Fluorescein</li> <li>Gramine from Indole</li> <li>3-Methyl-1-phenyl pyrazolone from phenyl hydrazine</li> <li>Ethyl Nalidixate from 2-amino-6 methylpyridine</li> <li>Methyl Salicylate from Salicylic acid</li> <li>Sulphanilamide from p-acetamido benzene sulphanilamide</li> <li>Chlorobutanol from acetone</li> </ol>	<b>24</b>	CO1, CO2, CO3, CO4 K1, K2, K3, K4
<b>Module 2:</b>	<p><b>Green Syntheses of drugs and drug-like entities (<i>Minimum 4 experiments</i>)</b></p> <ol style="list-style-type: none"> <li>Schiff base of Antipyrine with p-bromobenzaldehyde</li> <li>Phenothiazine from diphenylamine</li> <li>1,2,3,4-Tetrahydrocarbazole from cyclohexanone</li> <li>1,5-Benzodiazepine from acetophenone</li> <li>2-Phenyl Benzothiazole from 2-Amino thiophenol</li> <li>2-Methylbenzimidazole from o-phenylene diamine</li> <li>Monastrol from thiourea, ethylacetoacetate and 3-hydroxybenzaldehyde</li> <li>Substituted chalcone from 4-chlorobenzaldehyde (Claisen Schmidt condensation)</li> </ol>	<b>24</b>	CO1, CO2, CO3, CO4 K1, K2, K3, K4
<b>Module 3:</b>	<p><b>Selected experiments in organic synthesis (<i>Minimum 3 experiments</i>)</b></p> <ol style="list-style-type: none"> <li>p-Iodotoluene from p-toluidine (Diazotization)</li> </ol>	<b>12</b>	CO1, CO2, CO3, CO4 K1, K2, K3, K4

	<ul style="list-style-type: none"> <li>ii. Cinnamic acid from benzaldehyde (Perkin reaction)</li> <li>iii. Benzanilide from benzophenone (Beckmann Rearrangement)</li> <li>iv. Vanillin to Vanillyl alcohol (using NaBH<sub>4</sub>)</li> <li>v. Methyl orange from sulphanic acid (coupling diazotization process)</li> <li>vi. Benzhydrol from Benzaldehyde (Grignard reaction)</li> </ul>		CO4	
<b>Module 4:</b>	<ul style="list-style-type: none"> <li><b>i. Titrimetric assay of the following bulk drug/tablets. (<i>Minimum 2 experiments</i>)</b> Paracetamol, Isoniazid, Dapsone, Metronidazole, Calcium Gluconate</li> <li><b>ii. Spectrophotometric assay of the following tablets. (<i>Minimum 2 experiments</i>)</b> Allopurinol, Propranolol, p-Aminosalicylic acid, Dapsone</li> </ul>	<b>12</b>	CO3, CO4	K2, K3, K4,
<b>Module 5:</b>	<ul style="list-style-type: none"> <li><b>i. Dissolution of Experiments (<i>Minimum 2 experiments</i>)</b> To study the dissolution rate of the drug: Carbamazepine, Diclofenac, Ibuprofen, Isoniazid</li> <li><b>ii. Quality Control Evaluation of Tablets (<i>Minimum 1 tablet of all experiments</i>)</b> Hardness tests, friability testing and disintegration testing to be performed.</li> </ul>	<b>12</b>	CO1, CO2, CO3, CO4	K2, K3, K4,
<b>Module 6:</b>	<p><b>Techniques for drugs analyses</b></p> <p><b>a. Thin Layer Chromatography (<i>Minimum 1 experiments</i>)</b></p> <ul style="list-style-type: none"> <li>i. To identify the given drug amongst the Ibuprofen, Aspirin and caffeine citrate with the help of thin layer Chromatography and R<sub>f</sub> value.</li> <li>ii. To identify the given Sulpha drug amongst the Sulphacetamide, sulphanilamide and trimethoprim with the help of thin layer chromatography and R<sub>f</sub> value.</li> </ul> <p><b>b. Column Chromatography (<i>Minimum 1 experiments</i>)</b></p> <p>Mixture separation using normal column Silica gel:</p> <ul style="list-style-type: none"> <li>i. Salicylic acid and Acetylsalicylic acid</li> <li>ii. p-Aminobenzoic acid and Benzocaine</li> <li>iii. Benzil and Dilantin</li> <li>iv. Salicylaldehyde and 3-Acetyl coumarin</li> </ul>	<b>24</b>	CO2, CO3, CO4	K1, K2, K3, K4,

	<p><b>c. HPLC analysis (qualitative) of the following drugs and combination of drugs using reverse phase column: (Minimum 2 experiments)</b></p> <ol style="list-style-type: none"> <li>Paracetamol</li> <li>Ibuprofen</li> <li>Celecoxib</li> <li>Sulphanilamide</li> <li>Diclofenac sodium and Paracetamol in combined dosage form.</li> </ol> <p><b>d) Identification of following drugs by IR spectroscopy (Any 2 drugs)</b> Celecoxib, Antipyrine, Chloramphenicol, Sulphanilamide</p>			
<b>Module 7:</b>	<p><b>Drug Design Experiments (Any 3)</b></p> <ol style="list-style-type: none"> <li>Use of Chemdraw/ISISDraw for drawing structures, chemical reactions, equations.</li> <li>Energy minimization of molecules using Avogadro software.</li> <li>Molecular docking software such as Hex software or autodocking. COX-inhibitor, thymidilate synthase, glycogen synthase, E.Coli protein</li> <li>Finding the docking score (Evaluate).</li> <li>Intermolecular interactions of small molecule with macromolecule using Discovery studio (<a href="https://discover.3ds.com/discovery-studio-visualizer-download">https://discover.3ds.com/discovery-studio-visualizer-download</a>)</li> <li>Determination of log P, MR, hydrogen bond donors and acceptors of selected drugs using DruLiTo software or SwissADME web server.</li> </ol>	<b>12</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>A. A. Siddiqui and S. Siddiqui. Natural Products Chemistry Practical Manual: For Science and Pharmacy Courses. CBS Publishers, NewDelhi, 2008.</li> <li>A. I. Vogel, A. R. Tatchell, and B. S. F. Hannaford. Vogel's Textbook of Practical Organic Chemistry. 5th ed., Prentice Hall, Harlow, England, 2011.</li> <li>F. D. King. Medicinal Chemistry: Principles and Practice. Royal Society of Chemistry, Cambridge, 1994.</li> <li>J. Bassett, J. Mendham, and R. C. Denny. Revised by G. H. Jeffery. Vogel's Textbook of Quantitative Chemical</li> </ol>			

	<p>Analysis. 6th ed., Pearson Education, New Delhi, 2007.</p> <ol style="list-style-type: none"> <li>5. J. E. F. Reynolds. Martindale: The Extra Pharmacopoeia. 30th ed., The Pharmaceutical Press, London, 1993.</li> <li>6. J. Mohan. Organic Analytical Chemistry. Narosa Publishing House, New Delhi, 2014.</li> <li>7. J. Moini. Pharmaceutical Laboratory Procedures. 1st ed., Cengage Learning India Pvt. Ltd., New Delhi, 2010.</li> <li>8. K. A. Connors. Textbook of Pharmaceutical Analysis. 3rd ed., Wiley-Interscience, New York, 1990.</li> <li>9. L. F. Fieser and K. L. Williamson. Organic Experiments. 7th ed., D. C. Heath, 1992.</li> <li>10. N. K. Vishnoi. Advanced Practical Organic Chemistry. 3rd ed., Vikas Publishing House, UP 2009.</li> <li>11. N. S. Gnanpragasam and G. Ramamurthy. Organic Chemistry: Lab Manual. Viswanathan S. Printers &amp; Publishers Pvt. Ltd., Chennai, 2009.</li> <li>12. R. K. Bansal. Laboratory Manual in Organic Chemistry. 5th ed., New Age International, Delhi 2016.</li> <li>13. S. Delvin. Green Chemistry. Sarup &amp; Sons, NewDelhi, 2005.</li> </ol>
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. Indian Pharmacopoeia, 9<sup>th</sup> Ed., Ghaziabad: Indian Pharmacopoeia Commission.</li> <li>2. British Pharmacopoeia (BP 2025, Jan. 2025), London: Medicines and Healthcare Products Regulatory Agency (MHRA).</li> <li>3. European Pharmacopoeia (Ph. Eur.), 11<sup>th</sup> Ed., 2022, Strasbourg: European Directorate for the Quality of Medicines &amp; HealthCare (EDQM), Council of Europe.</li> <li>4. United States Pharmacopoeia (USP-NF, Issue 1, May 2024) Rockville, MD: United States Pharmacopoeial Convention.</li> </ol>
<b>Web Resources:</b>	<ol style="list-style-type: none"> <li>1. Indian Pharmacopoeia (IP) – 2010 Vol.2 (PDF)  <a href="https://qps.nhsrindia.org/sites/default/files/202201/INDIAN%20PHARMACOPOIA%202010%20Volume%202.pdf">https://qps.nhsrindia.org/sites/default/files/202201/INDIAN%20PHARMACOPOIA%202010%20Volume%202.pdf</a>.</li> </ol>

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<b>Title of the Course</b>	Pharmaceutical Chemistry Practical-IV	
<b>Course Code</b>	CHH-6001	
<b>Number of Credits</b>	4	
<b>Theory/Practical</b>	Practical	
<b>Level</b>	500	
<b>Effective from AY</b>	2026-2027	
<b>New Course: Yes/No</b>	No	
<b>Bridge Course/ Value added Course: Yes/No</b>	No	
<b>Course for advanced learners: Yes/No</b>	No	
<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To translate certain theoretical concepts learnt earlier into experimental knowledge.</li> <li>2. To learn synthesis of medicinal compound and application of drug molecules.</li> <li>3. To get acquainted with chemical analysis and computational analysis of drugs.</li> <li>4. To acquire hands on experience in laboratory techniques.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to	<b>Mapped to PSO</b>
	CO1. explain the theoretical aspects of drug synthesis, analysis and computational studies.	PSO1, PSO3
	CO2. synthesize and recrystallize various chemical moieties in small scale.	PSO1, PSO2, PSO4
	CO3. analyse drugs using various quality control methods	PO3, PO4, PSO5,

			PSO6	
	CO4. evaluate the percentage purity, binding affinity and physicochemical properties of pharmaceutical or chemical substances.		PSO4, PSO6, PSO7, PSO8	
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	<b>Syntheses of drugs and drug-like entities; (Minimum 4 experiments )</b> <ol style="list-style-type: none"> <li>i. 6-Bromo-2-chloro-3-formylquinoline from acetanilide</li> <li>ii. Sodium benzoate from Salicylic acid</li> <li>iii. Sorbic acid from crotonaldehyde</li> <li>iv. Barbiturate from diethyl-n-butylmalonate</li> <li>v. Tolbutamide from p-toluene sulphonamide</li> <li>vi. Azo-stilbene compounds</li> <li>vii. Substituted of 2'-hydroxychalcone (Claisen Schmidt condensation) from 2 hydroxyacetophenone</li> <li>viii. Synthesis of chalcone 2,4-dinitrophenylhydrazones from chalcone</li> </ol>	<b>24</b>	CO1, CO2	K1, K2, K3, K4
<b>Module 2:</b>	<b>Green Syntheses of drugs and drug-like entities (Minimum 4 experiments)</b> <ol style="list-style-type: none"> <li>i. 2-Phenylbenzimidazole from o-phenylene diammine and benzoic acid</li> <li>ii. 1,4-dihydropyridine from ethylacetoacetate</li> <li>iii. 2-MethylBenzothiazole from 2-Amino thiophenol</li> <li>iv. Schiff base of Antipyrine with p-Chlorobenzaldehyde</li> <li>v. Monastrol analogue synthesis urea, ethylacetoacetate and 3-hydroxybenzaldehyde</li> <li>vi. Synthesis of acetanilide from p-aminophenol</li> <li>vii. 2-p-chlorophenylbenzimidazole from o-phenylene diamine</li> <li>viii. Synthesis of warfarin from 4-hydroxycoumarin.</li> </ol>	<b>24</b>	CO1, CO2	K1, K2, K3, K4
<b>Module 3:</b>	<b>Selected experiments in organic synthesis (Minimum 3 experiments)</b>	<b>12</b>	CO1,	K1, K2,

	<ul style="list-style-type: none"> <li>i. Benzhydrol from benzophenone (Reduction)</li> <li>ii. p-Iodobenzoic acid from p-aminobenzoic acid (Diazotization)</li> <li>iii. 3-Acetylindole from Indole (Friedal Crafts reaction)</li> <li>iv. p-methylacetophenone oxime to p-methylacetanilide (Beckmann Rearrangement)</li> <li>v. Enzymatic reduction of ethylacetoacetate using Baker's yeast.</li> <li>vi. Trans - Stilbene by Wittig reaction</li> <li>vii. Terephthalic acid from p-xylene (Oxidation process)</li> </ul>		CO2	K3, K4
<b>Module 4:</b>	<p><b>a) Assay of the following bulk drug/tablets. (Minimum 2 experiments)</b>            Ferrous sulphate, Chlorpheniramine Maleate, Benzyl Penicillin, Phenobarbitone</p> <p><b>b) Spectrophotometric assay of the following tablets. (Minimum 2 experiments)</b>            Chloroquine phosphate (CHP), Zolmitriptan. Promethazine HCl, Indomethacin</p>	<b>12</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4
<b>Module 5:</b>	<p><b>i. Dissolution Experiments (Any 2) (Minimum 2 experiments)</b>            To study the dissolution rate of the drug:            Saccharin, Celecoxib, Chlorpheniramine maleate, Chloramphenicol</p> <p><b>ii. Quality Control Evaluation of Tablets (Minimum 1 tablet of all experiments)</b>            Hardness tests, friability testing and disintegration testing to be performed</p>	<b>12</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4
<b>Module 6:</b>	<p><b>Chromatographic techniques</b></p> <p><b>a) Thin Layer Chromatography ((Minimum 1experiments of 3h each)</b></p> <ul style="list-style-type: none"> <li>i. To identify the given drug amongst the paracetamol, acetanilide, and caffeine citrate with the help of thin layer chromatography and Rf value.</li> <li>ii. To identify the given sulpha drugs amongst the Dapsone, sulphaacetamide and trimethoprim with the help of thin layer chromatography and Rf value.</li> </ul> <p><b>b) Column Chromatography (Any 1) (Minimum 1 experiment of 6h each) Mixture separation using normal column silica gel</b></p> <ul style="list-style-type: none"> <li>i. Benzil and Benzilic acid</li> </ul>	<b>24</b>	CO1, CO2, CO3, CO4	K2, K3, K4

	<ul style="list-style-type: none"> <li>ii. Glycine and Hippuric acid</li> <li>iii. o-phenylene diamine and 2,3-diphenylquinoxaline</li> <li>iv. Salicylaldehyde and coumarin</li> </ul> <p><b>c) HPLC analysis of the following drugs: (Minimum 2 experiment of 6h each)</b></p> <ul style="list-style-type: none"> <li>i. Methyl Dopa</li> <li>ii. Sulphaacetamide</li> <li>iii. Paclitaxel</li> <li>iv. Celecoxib</li> </ul> <p><b>d) Identification of following drugs by IR spectroscopy (Any 1 drug total 3h)</b> Benzocaine, Caffeine, Phenytoin, Suphaacetamide</p>			
<b>Module 7:</b>	<p><b>Drug Design Experiments (Any 4)</b></p> <ul style="list-style-type: none"> <li>i. Use of Chemdraw/ISISDraw for drawing structures, chemical reactions, equations.</li> <li>ii. Energy minimization of molecules using Avogadro software.</li> <li>iii. molecular docking software such as Hex software or autodocking. COX-inhibitor, thymidilate synthase, glycogen synthase, E.Coli protein</li> <li>iv. finding the docking score (Evaluate).</li> <li>v. Intermolecular interactions of small molecule with macromolecule using Discovery studio software. (<a href="https://discover.3ds.com/discovery-studio-visualizer-download">https://discover.3ds.com/discovery-studio-visualizer-download</a>)</li> <li>vi. Determination of log P, MR, hydrogen bond donors and acceptors of selected drugs using DruLiTo software or SwissADME web server.</li> </ul>	<b>12</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4
<b>Pedagogy:</b>	Students should be given suitable hands-on learning, pre- and post-lab assignments and explanations revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. A. A. Siddiqui and S. Siddiqui. Natural Products Chemistry Practical Manual: For Science and Pharmacy Courses. CBS Publishers, NewDelhi, 2008.</li> <li>2. A. I. Vogel, A. R. Tatchell, and B. S. F. Hannaford. Vogel's Textbook of Practical Organic Chemistry. 5th ed., Prentice Hall, Harlow, England, 2011.</li> <li>3. F. D. King. Medicinal Chemistry: Principles and Practice. Royal Society of Chemistry, Cambridge, 1994.</li> </ol>			

	<ol style="list-style-type: none"> <li>4. J. Bassett, J. Mendham, and R. C. Denny. Revised by G. H. Jeffery. Vogel's Textbook of Quantitative Chemical Analysis. 6th ed., Pearson Education, New Delhi, 2007.</li> <li>5. J. E. F. Reynolds. Martindale: The Extra Pharmacopoeia. 30th ed., The Pharmaceutical Press, London, 1993.</li> <li>6. J. Mohan. Organic Analytical Chemistry. Narosa Publishing House, New Delhi, 2014.</li> <li>7. J. Moini. Pharmaceutical Laboratory Procedures. 1st ed., Cengage Learning India Pvt. Ltd., New Delhi, 2010.</li> <li>8. K. A. Connors. Textbook of Pharmaceutical Analysis. 3rd ed., Wiley-Interscience, New York, 1990.</li> <li>9. L. F. Fieser and K. L. Williamson. Organic Experiments. 7th ed., D. C. Heath, 1992.</li> <li>10. N. K. Vishnoi. Advanced Practical Organic Chemistry. 3rd ed., Vikas Publishing House, UP 2009.</li> <li>11. N. S. Gnanpragasam and G. Ramamurthy. Organic Chemistry: Lab Manual. Viswanathan S. Printers &amp; Publishers Pvt. Ltd., Chennai, 2009.</li> <li>12. R. K. Bansal. Laboratory Manual in Organic Chemistry. 5th ed., New Age International, Delhi 2016.</li> <li>13. S. Delvin. Green Chemistry. Sarup &amp; Sons, NewDelhi, 2005.</li> </ol>
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. British Pharmacopoeia (BP 2025, Jan. 2025). London: Medicines and Healthcare Products Regulatory Agency (MHRA).</li> <li>2. King, F. D. Medicinal Chemistry: Principles and Practice. Royal Society of Chemistry, Cambridge, 1994.</li> <li>3. Leach, A. Molecular Modelling: Principles and Applications. Longman, 1998.</li> <li>4. United States Pharmacopoeia (USP-NF, Issue 1, May 2024). Rockville, MD: United States Pharmacopoeial Convention.</li> </ol>
<b>Web Resources:</b>	<ol style="list-style-type: none"> <li>1. Indian Pharmacopoeia (IP) – 2010 Vol.2 (PDF) <a href="https://qps.nhsrindia.org/sites/default/files/202201/INDIAN%20PHARMACOPOIA%202010%20Volume%202.pdf">https://qps.nhsrindia.org/sites/default/files/202201/INDIAN%20PHARMACOPOIA%202010%20Volume%202.pdf</a>.</li> </ol>

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<b>Title of the Course</b>	Polymers in Pharmaceuticals and Novel Drug Delivery Systems
<b>Course Code</b>	CHH-6002
<b>Number of Credits</b>	4
<b>Theory/Practical</b>	Theory
<b>Level</b>	500
<b>Effective from AY</b>	2026-2027
<b>New Course</b>	No
<b>Bridge Course/ Value added Course</b>	No
<b>Course for advanced learners</b>	No

<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To learn classification synthesis and properties of polymers.</li> <li>2. To understand the role of polymers in drug delivery systems.</li> <li>3. To comprehend various types of Novel Drug Delivery System.</li> <li>4. To study innovative techniques in drug delivery systems.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to	<b>Mapped to PSO</b>
	CO1. explain the various biodegradable polymers used in the pharmaceuticals.	PSO1, PSO2
	CO2. classify various polymers and Novel Drug Delivery System based on different parameters.	PSO2, PSO3
	CO3. analyse the natural and synthetic polymers and novel formulation using different analytical techniques.	PSO4, PSO5

	CO4. develop an innovative drug delivery system using polymers from natural sources.		PSO6, PSO7, PSO8	
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	<b>Natural and Synthetic Polymers</b> Classification & nomenclature of polymers, functionality concept- linear, -branched and -cross linked polymers. Introduction to biodegradable polymers: General methods of synthesis, properties, mechanism of biodegradation in the body. Analytical methods for monitoring biodegradation processes of environmentally degradable polymers. Characterization and evaluation of biodegradable polymers.	<b>08</b>	CO1, CO2,	K1, K2, K3, K4
<b>Module 2:</b>	<b>Novel drug delivery systems</b> Foundations of drug delivery in a conceptual and mathematical context. Drug delivery carriers, routes of administration. Recent developments in responsive polymers, polymer therapeutics and advanced systems designed for molecular recognition or engineered for intracellular delivery of novel therapeutics. Polymeric devices for drug delivery systems: Diffusion-controlled (monolithic devices), solvent-activated (swelling- or osmotically-controlled devices), chemically controlled (biodegradable), or externally-triggered systems (e.g., pH, temperature).	<b>10</b>	CO2, CO3, CO4	K2, K3, K4,
<b>Module 3:</b>	<b>Types of polymers for novel drug delivery systems</b> Poly lactic-co-glycolic acid (PLGA), PGA(poly glycolic acid), Polyglutamic acid (PGA), Polylactic acid, PNIPAAm [Poly(N- isopropylacrylamide)], pHEMA[Poly 2-hydroxyethyl methacrylate], PPy [Polypyrrole], PAMAM [Poly (amidoamine)], DEXTRAN.	<b>08</b>	CO1, CO2, CO3	K2, K3, K4, K5
<b>Module 4:</b>	<b>Types of drug delivery systems</b> Theory of controlled release drug delivery systems. Microencapsulation: methods of encapsulation. Transdermal drug delivery systems: theory, formulation, production and evaluation. Targeted drug delivery systems: concept of drug targeting, importance in therapeutics.	<b>08</b>	CO2, CO3, CO4	K2, K3, K4

<b>Module 5:</b>	<p><b>Advanced biopolymeric systems for drug delivery</b></p> <p>Critical points in biopolymeric-controlled release matrix systems, biopolymeric gels in drug delivery, in situ polymeric gels for topical drug delivery, smart polysaccharide hydrogels in drug delivery and release. Polysaccharide-based nanoparticles: nanocarriers for sustained delivery of drugs, polysaccharide-based nanocarriers for oral delivery of insulin in diabetes liposomes and dendrimers for advanced drug delivery, marine polysaccharides systems for drug delivery applications.</p>	<b>14</b>	CO1, CO2, CO3, CO4	K3, K4, K5
<b>Module 6:</b>	<p><b>Recent innovations in polymeric drug delivery systems and its applications</b></p> <p>Recent innovations in conventional dosage form like tablets, capsules, sterile dosage forms, pellets, mucoadhesive system, grdds, peptide drug delivery, supercritical fluid technique, pegylation, nanoparticulate drug delivery. Sustained in vitro and in vivo delivery of metformin from plant pollen-derived composite microcapsules, polymeric hydrogels for controlled drug delivery to treat arthritis. Advancements in rectal drug delivery systems: clinical trials, and patents perspective. future opportunities and challenges.</p>	<b>12</b>	CO2, CO3, CO4	K2, K3, K4
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. A. K. Nayak and Md. S. Hasnain. Advanced Biopolymeric Systems for Drug Delivery. 1st ed., Springer, Singapore, 2020.</li> <li>2. A. Lendlein and A. Sisson. Handbook of Biodegradable Polymers: Isolation, Synthesis, Characterization and Applications. 1st ed., Wiley Publishers, Weinheim, 2011.</li> <li>3. L. Lliun and S. S. Davis. Polymer in Controlled Drugs Delivery. Wright, Bristol, 1987.</li> <li>4. P. J. Sinko. Martin's Physical Pharmacy and Pharmaceutical Science. 6th ed., Lippincott Williams &amp; Wilkins, Philadelphia, 2006.</li> <li>5. R. P. Brown. Handbook of Plastic Test Methods. 2nd ed., George Godwin Ltd., London, 1981.</li> <li>6. S. J. Carter. Cooper and Gunn's Tutorial Pharmacy. 6th ed., CBS Publishers Ltd., New Delhi, 2008.</li> <li>7. V. A. Guerrera. Innovative Polymers for Controlled Drug Delivery. 1st ed., Vol. 14, Multidisciplinary Digital Publishing Institute, Basel, 2022.</li> <li>8. V. V. Ranade and J. B. Cannon. Drug Delivery Systems. 3rd ed., CRC Press, Boca Raton, 2011.</li> </ol>			

<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. A. H. Beckett and J. B. Stenlake. Practical Pharmaceutical Chemistry. Vols. I–II, CBS Publishers, New Delhi, 2005.</li> <li>2. A. Ravve. Principles of Polymer Chemistry. Springer, New York, 2012.</li> <li>3. G. S. Bankar. Modern Pharmaceutics. Marcel Dekker Inc., New York, 2002.</li> <li>4. H. R. Kircheldorf. Handbook of Polymer Synthesis. Parts A and B, Marcel Dekker Inc., New York, 1992.</li> <li>5. J. David. Polymers. Oxford University Press, Oxford, 2015.</li> <li>6. J. R. Crompton. Analysis of Polymer: An Introduction. Pergamon Press, Oxford, 1989.</li> <li>7. J. R. Fried. Polymer Science and Technology. PHI Pvt. Ltd., New Delhi, 2000.</li> <li>8. J. R. Juliano. Drug Delivery Systems. Oxford University Press, Oxford, 1980.</li> <li>9. J. R. Robinson and V. H. L. Lee. Controlled Drug Delivery. Drugs and Pharmaceutical Sciences Series, Vol. 29, Marcel Dekker Inc., New York, 1987.</li> <li>10. K. Y. Saunders. Organic Polymer Chemistry. Chapman and Hall, London, 1976.</li> <li>11. L. Lliun and S. S. Davis. Polymer in Controlled Drugs Delivery. Wright, Bristol, 1987.</li> <li>12. M. Charin. Biodegradable Polymers as Drug Delivery Systems. Informa Healthcare, New York, 1990.</li> <li>13. M. I. Gutcho. Microcapsules and Microencapsulation Techniques. Noyes Data Corporation, Park Ridge, New Jersey, 1976.</li> <li>14. M. P. Steven. Polymer Chemistry: An Introduction. Oxford University Press, New York, 1990.</li> <li>15. N. K. Jain. Advances in Controlled and Novel Drug Delivery. CBS Publishers &amp; Distributors, New Delhi, 2001.</li> <li>16. R. Sinha. Outlines of Polymer Technology: Manufacture of Polymers. PHI Pvt. Ltd., New Delhi, 2000.</li> <li>17. U. S. Beans, A. K. Beckett, and J. E. Caralem. Advances in Pharmaceutical Sciences. Vols. 1–4, Elsevier, Amsterdam, 2009.</li> <li>18. V. R. Gowarikar, N. V. Vishwanathan, and J. Sreedhar. Polymer Science. New Age International, New Delhi, 2015.</li> <li>19. Y. W. Chien. Novel Drug Delivery Systems. CRC Press, Boca Raton, 1992.</li> </ol>
<b>Web Resources:</b>	<ol style="list-style-type: none"> <li>1. <a href="https://pmc.ncbi.nlm.nih.gov/articles/PMC3438887/">https://pmc.ncbi.nlm.nih.gov/articles/PMC3438887/</a></li> <li>2. <a href="https://www.asiapharmaceutics.info/index.php/ajp/article/view/51">https://www.asiapharmaceutics.info/index.php/ajp/article/view/51</a>.</li> </ol>

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<b>Title of the Course</b>	Bioorganic and Medicinal Chemistry
<b>Course Code</b>	CHH-6003
<b>Number of Credits</b>	4
<b>Theory/Practical</b>	Theory
<b>Level</b>	500
<b>Effective from AY</b>	2026-2027
<b>New Course</b>	No
<b>Bridge Course/ Value added Course</b>	No
<b>Course for advanced learners</b>	No

<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To understand the concepts of bioorganic &amp; medicinal chemistry and brief about carbohydrates, nucleic acids and enzyme chemistry.</li> <li>2. To learn the concepts of the biomimetics and its application.</li> <li>3. To acquire knowledge on biosynthesis of natural products and the concept of drugs as enzyme inhibitors.</li> <li>4. To synthesize selected drugs and understand its mechanism.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to	<b>Mapped to PSO</b>
	CO1. explain various concepts involved in bioorganic and medicinal chemistry.	PSO1, PSO2
	CO2. classify bioorganic molecules and drugs based on their structure, mechanism and significance.	PSO1, PSO2, PSO3
	CO3. illustrate the synthetic routes of biomolecules, natural products and drugs.	PSO1, PSO2, PSO3, PSO5

	CO4. design the various chemical molecules effective against enzymes.		PSO1, PSO3, PSO7, PSO8
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b> <b>Cognitive Level</b>
<b>Module 1:</b>	<b>Bioorganic chemistry</b> Basic concepts, definition, proximity effects in organic chemistry and overlapping subject biochemistry and organic chemistry, molecular adaptation, molecular recognition.	<b>04</b>	CO1, CO2, CO3 K1, K2, K3, K4
<b>Module 2:</b>	<b>Carbohydrates, Nucleic acids and Protein Chemistry</b> Chemical structure and properties of nucleosides, nucleotides, nucleic acids. The biological and biochemical mechanisms of DNA replication and transcription. The structure of amino acids and the primary, secondary and tertiary structure of peptides and proteins. Determination of configuration of glucose (Fisher's proof). Cyclic structure of glucose. Mutarotation Haworth projections, Lobry de Bruyn-van Ekenstein rearrangement; stepping up (Kiliani- Fischer method) and stepping-down (Ruff's & Wohl's methods) of aldoses, end-group interchange of aldoses. Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose).	<b>06</b>	CO1, CO2, CO3 K1, K2, K3, K4
<b>Module 3:</b>	<b>Enzyme Chemistry</b> Introduction, nomenclature, classification and extraction of enzymes. Introduction to catalysis and enzymes; multifunctional catalysis, intramolecular catalysis, mechanism of enzyme action, factors responsible for enzyme specificity, enzyme activity and kinetics (Michaelis Menten and Lineweaver Burk plots). Enzyme inhibitions (Reversible and irreversible), structure, mechanism -Chymotrypsin, Ribonuclease, lysozyme and Carbopeptidase-A. Enzymes in synthetic organic chemistry. [Reactions to be covered- additions, eliminations, substitutions, condensations, oxidations, reductions and rearrangement]	<b>08</b>	CO1, CO2, CO3 K1, K2, K4
<b>Module 4:</b>	<b>Biomimetics and Biosynthesis of Natural products</b>	<b>10</b>	CO1, K1, K2,

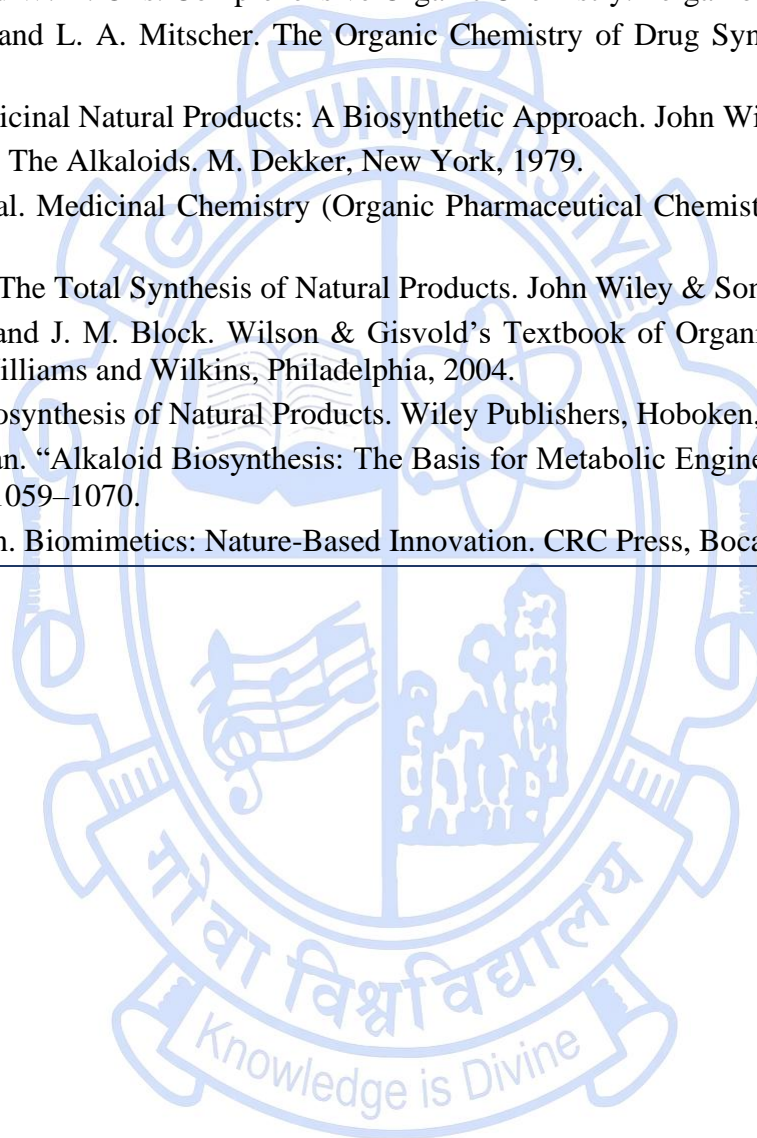
	<p><b>Biomimetics:</b> definition, biological mechanisms, natural mechanisms, biomimetic structures, biomimicry at the cell-material interface, tissue structure and biomimetic applications. biomimetic chemistry for NADH model.</p> <p><b>biosynthesis of natural products:</b></p> <p>Biosynthesis of alkaloids: types of metabolites of plants (primary and secondary), Types of metabolic pathways: shikimic and mevalonic. biosynthesis of morphine from tyrosine and nicotine from ornithine.</p> <p>Biosynthesis of steroids: testosterone and cholesterol. Biosynthesis of 6-methylsalicylic acid, tetracyclines.</p> <p>Modular polyketide synthase, erythromycin biosynthesis, engineering novel polyketide antibiotics.</p>		CO2, CO3, CO4	K4
<b>Module 5:</b>	<p><b>Co-Enzyme Chemistry</b></p> <p>Chemical structures of co-enzymes and cofactors, oxidoreduction (NAD<sup>+</sup>, NADP<sup>+</sup>), pyridoxal phosphate (PLP) in transamination, Thiamine pyrophosphate (TPP), biotin (CO<sub>2</sub> carrier), haemoglobin (O<sub>2</sub>- carrier), flavin (FMN, FAD, FADH<sub>2</sub>), oxene Reactions, lipoic acid, mechanisms of reactions catalyzed by co-factors.</p> <p>Oxidation by cytochrome-450. Hansester as NADH model (give an example). enzyme inhibitors as drugs. antagonist behaviour of caffeine, role of enoyl acp reductase, cyclooxygenase inhibitors, <math>\alpha</math>-glucosidase, dihydrofolate reductase, ACE-2 in the biological processes.</p>	<b>10</b>	CO1, CO3, CO4	K1, K2, K4
<b>Module 6:</b>	<p><b>Medicinal Chemistry and Pharmacology</b></p> <p>Role of medicinal chemistry, properties of drug and receptor, pharmacophore, toxicophore and metabiophore. Pharmacodynamics and pharmacokinetics. drug design based on target based and phenotype approach.</p> <p>Enzyme inhibitors as drugs. antagonist behaviour of caffeine, role of enoyl acp reductase, cyclooxygenase inhibitors, kinase, <math>\alpha</math>-glucosidase, dihydrofolate reductase, ACE-2 in the biological processes.</p> <p>Designing the drug and mechanism of action of isoniazid, ibuprofen, erlotinib, acarbose, captopril. concept of molecular docking in computer aided drug designing.</p>	<b>12</b>	CO3, CO4	K1, K2, K4

	Structure activity relationships of drug molecules, binding role of OH group, -NH <sub>2</sub> group, double bond and aromatic ring to receptor. SAR of following drugs (Chloramphenicol, Procaine, Isoniazid, Chloroquine, Methyl Dopa).			
<b>Module 7:</b>	<p><b>Synthesis of drugs with mechanism:</b></p> <p>Anti-inflammatory Drugs: naproxen, celecoxib. Anti-hypertensive Drugs: captopril, atenolol. Drugs acting on CNS: (a) CNS Stimulant: dextro-amphetamine, (b) Respiratory stimulant: doxapram, (c) CNS anti-depressant: (i) chlorpromazine (antipsychotic) (ii) diazepam (anxiolytic) (iii) phenobarbital (antiepileptic) (d) anaesthetic drugs: (i) general: ketamine (ii) local: lidocaine. antibiotics: amoxycillin. antimycobacterial: ethambutol. antiviral: acyclovir. antimicrobial: sulfamethoxazole. antidiabetics: tolbutamide (k). antineoplastic drugs: (a) antagonist: fluorouracil (b) alkylating agents: i) chlorambucil (ii) cis-platin. antimalarial: hydroxychloroquine.</p>	<b>10</b>	CO3, CO4	K1, K2, K3, K4, K5, K6
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. D. A. Williams and T. L. Lemke. Foye's Principles of Medicinal Chemistry. 5th ed., Lippincott Williams &amp; Wilkins, Philadelphia, 2006.</li> <li>2. D. J. Abraham and D. P. Rotella. Burger's Medicinal Chemistry: Drug Discovery and Development. 7th ed., John Wiley &amp; Sons, Hoboken, New Jersey, 2010.</li> <li>3. D. Shriram and P. Yogeshwari. Medicinal Chemistry. Pearson Education, Delhi, 2007.</li> <li>4. G. L. Patrick. Introduction to Medicinal Chemistry. 6th ed., Oxford University Press, Oxford, 2017.</li> <li>5. H. Singh and V. K. Kapoor. Medicinal and Pharmaceutical Chemistry. Vallabh Prakashan, Delhi, 2010.</li> <li>6. I. L. Finar. Organic Chemistry: Stereochemistry and the Chemistry of Natural Products. Pearson Education India, Delhi, 2002.</li> <li>7. J. M. Beale, Jr., and J. Block. Wilson and Gisvold's Textbook of Organic and Medicinal Chemistry. 12th ed., Wolters Kluwer India Pvt. Ltd., New Delhi, 2010.</li> <li>8. K. Nakanishi. Natural Product Chemistry. Academic Press, Boston, 2013.</li> <li>9. N. K. Tripathi and R. C. Verma. Bioorganic and Medicinal Chemistry: Theory and Practicals. Thakur Publications Pvt. Ltd., Delhi, 2021.</li> </ol>			

**References/  
Readings:**

1. D. Barton and W. D. Ollis. Comprehensive Organic Chemistry. Pergamon, Oxford, 1979.
2. D. Lednicher and L. A. Mitscher. The Organic Chemistry of Drug Synthesis. Vol. III, John Wiley & Sons, New York, 2005.
3. D. Paul. Medicinal Natural Products: A Biosynthetic Approach. John Wiley & Sons, New York, 2002.
4. D. R. Dalton. The Alkaloids. M. Dekker, New York, 1979.
5. G. R. Chatwal. Medicinal Chemistry (Organic Pharmaceutical Chemistry). Himalaya Publishing House, Mumbai, 2002.
6. J. ApSimon. The Total Synthesis of Natural Products. John Wiley & Sons, New York, 1992.
7. J. M. Beale and J. M. Block. Wilson & Gisvold's Textbook of Organic Medicinal & Pharmaceutical Chemistry. Lippincott Williams and Wilkins, Philadelphia, 2004.
8. M. Paolo. Biosynthesis of Natural Products. Wiley Publishers, Hoboken, New Jersey, 2010.
9. T. M. Kutchan. "Alkaloid Biosynthesis: The Basis for Metabolic Engineering of Medicinal Plants." Plant Cell, vol. 7, 1995, pp. 1059–1070.
10. Y. Bar-Cohen. Biomimetics: Nature-Based Innovation. CRC Press, Boca Raton, 2012.

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<b>Title of the Course</b>	Drug Quality and Regulatory Affairs
<b>Course Code</b>	CHH-6004
<b>Number of Credits</b>	4
<b>Theory/Practical</b>	Theory
<b>Level</b>	500
<b>Effective from AY</b>	2026-2027
<b>New Course: Yes/No</b>	No
<b>Bridge Course/ Value added Course: Yes/No</b>	No
<b>Course for advanced learners: Yes/No</b>	No

<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To introduce the ICH guidelines for drug product efficacy and safety through governing bodies across globe &amp; IPR.</li> <li>2. To learn the process of drug discovery, development and quality management concepts in pharmaceutical industries.</li> <li>3. To know the regulatory authorities and agencies governing the manufacture and sale of pharmaceuticals.</li> <li>4. To understand the roles of quality control and quality assurance in pharmaceutical industries.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to	<b>Mapped to PSO</b>
	CO1. impart the fundamental knowledge on the regulatory requirements for approval of new drugs, and drug products in regulated markets of India & other countries.	PSO1, PSO2
	CO2. explain the detail on the regulatory requirements, documentation requirements, and registration procedures for marketing the drug products.	PSO2, PSO3
	CO3. analyze stability aspects of safety and efficacy of pharmaceutical products.	PSO4, PSO5

	CO4. evaluate various governing regulatory bodies throughout the globe and insights of IPR.		PSO 6, PSO7, PSO8
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b> <b>Cognitive Level</b>
<b>Module 1:</b>	<p><b>New drug discovery and development</b>  Stages of drug discovery, drug development process, pre-clinical studies, non-clinical activities, clinical studies, Innovator and generics. Concept of generics, generic drug product development. Regulatory approval process and timelines involved in Investigational New Drug (IND), New Drug Application (NDA), Abbreviated New Drug Application (ANDA). Changes to an approved NDA / ANDA.</p> <p>Registration of Indian drug product in overseas market procedure for export of pharmaceutical products, technical documentation, Drug Master Files (DMF), Common Technical Document (CTD), electronic Common Technical 163 Document (eCTD), ASEAN Common Technical Document (ACTD) research.</p> <p>Regulatory concepts basic terminology, guidance, guidelines, regulations, laws and acts, orange book, federal register, code of federal regulatory, purple book.</p>	<b>12</b>	CO1, CO2, CO3   K1, K2, K3, K4, K5
<b>Module 2:</b>	<p><b>Quality Management I</b>  <b>Pharmaceutical quality Management:</b> Basics of quality management, total quality management (TQM), principles of six sigma, ISO 9001:2008, 9001:2015, ISO 14001:2004, pharmaceutical quality management – ICH Q10, knowledge management, quality metrics, operational excellence and quality management review. OSHAS guidelines, NABL certification and accreditation, CFR-21 part 11, WHO-GMP requirements.</p> <p><b>Quality systems:</b> Change management/ change control. Deviations, out of specifications (OOS), out of trend (OOT), complaints - evaluation and handling, Investigation and determination of root cause, corrective &amp; preventive actions (CAPA), returns and recalls, vendor qualification, annual product reviews, batch review and batch release. Concept of IPQC, area clearance/ line clearance.</p>	<b>12</b>	CO1, CO2, CO3,   K1, K2, K3, K4

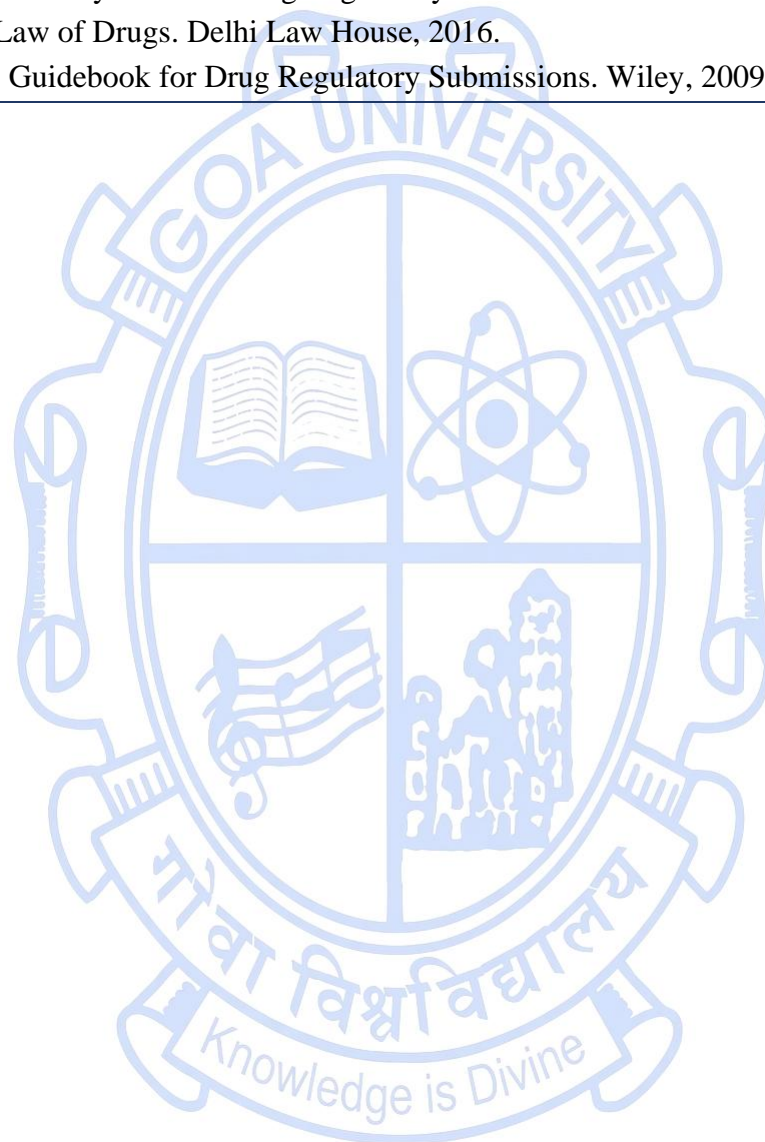
<p><b>Module 3:</b></p>	<p><b>Quality Management II</b>  In process quality controls on various dosage forms sterile &amp; non sterile standard operating procedures for various operations like cleaning, filling, drying compression, coating polishing, sterilization Quality control laboratories responsibilities good laboratory practices. Data generation and storage.  Quality control documentation, retention of sample records, audits of quality control facilities. Finished products release, quality reviews, batch release documents. Ware housing, good ware housing practices, materials &amp; management. Distribution &amp; selection of records, handling of returned good, recovered materials &amp; reprocessing, waste disposal, scrap disposal procedures &amp; records.  Audits: introduction, definition, Summary, types of audits, audit policy, internal and external Audits, second party audits, external third-party audits, auditing strategies, preparation and conducting audit, auditing strategies, audit analysis, audit report, audit follow up.</p>	<p>12</p>	<p>CO1, CO2, CO3</p>	<p>K1, K2, K3, K4</p>
<p><b>Module 4:</b></p>	<p><b>Fundamentals of regulatory affairs International Conference on Harmonisation:</b>  <b>Technical requirements for registration of pharmaceuticals for human Use:</b> introduction, structure and process for harmonisation. ICH guidelines on quality: stability testing of new drug substances and products stability testing, photostability testing of new drug substances and products, stability testing for new dosage forms, bracketing and matrixing designs for stability testing of new drug substances and products. Evaluation of stability data, impurities in new drug substances, impurities in new drug products, impurities guideline for residual solvents.  <b>Product efficacy and safety ICH guidelines on efficacy:</b> ICH guidelines on clinical trial and good clinical practice. ICH guidelines on safety: carcinogenicity studies- need for carcinogenicity studies of pharmaceuticals and testing for carcinogenicity of pharmaceuticals. Genotoxicity: a standard battery for genotoxicity testing of pharmaceuticals. Detection of toxicity to reproduction for medicinal products &amp; toxicity to male fertility. Preclinical safety evaluation of biotechnology-derived pharmaceuticals.</p>	<p>12</p>	<p>CO1, CO2, CO3, CO4</p>	<p>K1, K2, K3, K4</p>
<p><b>Module 5:</b></p>	<p><b>Governing regulatory bodies and IPR: country authority submission</b></p>	<p>12</p>	<p>CO3, CO4</p>	<p>K1, K2, K3, K4,</p>

	<p>U.S food &amp; drug administration USDMF  Canada therapeutic product directorate DMF  Europe :</p> <ol style="list-style-type: none"> <li>1) European medicines agency (EMA/ National Authorities) EDMF</li> <li>2) European directorate for quality of medicines CEP/COS &amp; health care products.</li> <li>3) MHRA – Medicines and health care products regulatory agency</li> </ol> <p>Product filing  Responding regulatory deficiencies  Final approval procedure preparation, review and submission of drug master files to regulatory authorities as per their specific requirements.</p> <p><b>Intellectual property rights (IPR)</b>  Salient features of Indian patents (Amendments) Act 1999, 2002 and 2005. US and European patent system.  Background, salient features and impact of international treaties / conventions such as paris convention, berne convention, World trade organization (WTO), World intellectual property organization (WIPO), trade related aspects of intellectual property rights (TRIPS), patent co-operation treaty (PCT), madrid protocol.</p>			K5
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. G. R. Chatwal. Medicinal Chemistry (Organic Pharmaceutical Chemistry). Himalaya Publishing House, Mumbai, 2002.</li> <li>2. G. S. Banker, and C. T. Rhodes. Modern Pharmaceutics. 4th ed., Marcel Dekker Inc., 2005.</li> <li>3. H. A. Lieberman, L. Lachman, and J. B. Schwartz. Pharmaceutical Dosage Forms: Tablets. Vols. I–III, 2nd ed., CBS Publishers &amp; Distributors, New Delhi, 2005.</li> <li>4. I. R. Berry, and R. P. Martin, editors. The Pharmaceutical Regulatory Process. 2nd ed., Drugs and the Pharmaceutical Sciences, vol. 185, Informa Healthcare Publishers.</li> <li>5. J. Ali, and Baboota. Regulatory Affairs in the Pharmaceutical Industry. 2nd ed., Academic Press, 2021.</li> </ol>			

	<ol style="list-style-type: none"> <li>6. J. M. Beale, and J. M. Block. Wilson &amp; Gisvold's Textbook of Organic Medicinal &amp; Pharmaceutical Chemistry. Lippincott Williams and Wilkins, Philadelphia, 2004.</li> <li>7. L. Lachman, H. A. Lieberman, and J. L. Kanig. The Theory and Practice of Industrial Pharmacy. 3rd ed., Varghese Publishers, Mumbai, 1991.</li> <li>8. P. J. Sinko. Martin's Physical Pharmacy and Pharmaceutical Sciences. 5th ed., B. I. Publications Pvt. Ltd., Noida, 2006.</li> <li>9. R. A. Guarino. New Drug Approval Process: Accelerating Global Registrations. 5th ed., Drugs and the Pharmaceutical Sciences, vol. 190.</li> <li>10. S. H. Willing, M. M. Tuckerman, and W. Hitchings IV. Good Manufacturing of Pharmaceuticals: A Plan for Total Quality Control. 3rd ed., Bhalani Publishing House, Mumbai, 1991.</li> </ol>
<p><b>References/ Readings:</b></p>	<ol style="list-style-type: none"> <li>1. A. F. Hirsch. Good Laboratory Practices Regulations in Drugs and The Pharmaceutical Sciences. Vol. 38, Marcel Dekker. NY 2003</li> <li>2. A. Teasdale, D. Elder, and R. W. Nims, editors. ICH Quality Guidelines: An Implementation Guide. John Wiley &amp; Sons, NY 2017.</li> <li>3. British Pharmacopoeia. British Pharmacopoeia Commission Office, London, 2008.</li> <li>4. C. V. S. Subrahmanyam, and J. Thimmasetty. Pharmaceutical Regulatory Affairs: Selected Topics. Vallabh Prakashan, Delhi, 2013.</li> <li>5. D. J. Pisano, and D. Mantus, editors. FDA Regulatory Affairs: A Guide for Prescription Drugs, Medical Devices, and Biologics.</li> <li>6. D. J. Pisano, and D. S. Cox Gad, editors. FDA Regulatory Affairs: A Guide for Prescription Drugs, Medical Devices, and Biologics. Pharmaceutical Manufacturing Handbook. John Wiley and Sons, New Jersey, 2008.</li> <li>7. Draft Manual of Patent Practice and Procedure. The Patent Office, India, 2008.</li> <li>8. F. A. Rozovsky, and R. K. Adams. Clinical Trials and Human Research: A Practical Guide to Regulatory Compliance.</li> <li>9. Indian Pharmacopoeia. Controller of Publication, Delhi, 1996.</li> <li>10. Manual of Patent Office Practice and Procedure. 2010.</li> <li>11. Original Laws. Published by Government of India.</li> <li>12. P. Das, and G. Das. Protection of Industrial Property Rights.</li> </ol>

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| 13. S. Itkar, and N. S. Vyawahare. Drug Regulatory Affairs. Nirali Prakashan, Pune, 2019 |
| 14. S. N. Katju. Law of Drugs. Delhi Law House, 2016.                                    |
| 15. S. Weinberg. Guidebook for Drug Regulatory Submissions. Wiley, 2009                  |

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<b>Title of the Course</b>	API Process, Manufacture and Green Chemistry
<b>Course Code</b>	CHH-6005
<b>Number of Credits</b>	4
<b>Theory/Practical</b>	Theory
<b>Level</b>	500
<b>Effective from AY</b>	2026-2027
<b>New Course</b>	No
<b>Bridge Course/ Value added Course</b>	No
<b>Course for advanced learners</b>	No

<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To learn about the selected drugs and the role of process chemistry.</li> <li>2. To understand the process research and development and the drug optimization and drug discovery.</li> <li>3. To impact knowledge of various concepts involved in green synthesis and green technologies used in chemistry.</li> <li>4. To study the application of green chemistry approaches to pharmaceutical industry.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to	<b>Mapped to PSO</b>
	CO1. explain about top marketed drugs, the role of process chemistry, process research and development.	PSO1, PSO2
	CO2. understand the drug optimization and drug discovery and how chemistry can be done using greener alternatives.	PSO2, PSO3
	CO3. apply the knowledge of modern green techniques for providing sustainable solutions to drug synthesis.	PSO4, PSO5

	CO4. analyse and evaluate the concepts of green chemistry to create and develop scalable processes in industry.		PSO6, PSO8	PSO7,
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	<p><b>Process Chemistry in Pharmaceutical Industry</b></p> <p>Background and role of process chemistry. strategy of process research &amp; development in pharma industry. case studies: a practical synthesis of ifetroban sodium. synthesis of 5-lipoxygenase inhibitors. chemistry of vitamin d: a challenging field for process research. dilevalol hydrochloride: development of a commercial process.</p> <p>the process research and development of dupont merck's cyclic urea diols, a new class of hiv protease inhibitors. process research and development of penicillin-g (antibacterial); fosinopril (antihypertensive).</p> <p>combinatorial chemistry: introduction, drug optimization drug discovery solid phase technique parallel synthesis mixed combinatorial synthesis.</p>	<b>12</b>	CO1, CO2, CO3	K1, K2, K3, K4
<b>Module 2:</b>	<p><b>Biocatalysis, phase transfer catalysis, asymmetric synthesis and polymorphism:</b></p> <p>a. Biocatalysis and engineering: an interdisciplinary approach to the manufacture of the benzodiazepine drug.</p> <p>b. Application of phase transfer catalysis in pharmaceutical industry for drug synthesis.</p> <p>c. Asymmetric synthesis and enantioselectivity: enantioselective synthesis of chiral 2-hydroxycarboxylic acids and esters asymmetric catalysis. eg. asymmetric hydrogenation L-Dopa process; Sharpless asymmetric epoxidations eg. synthesis of fluoxetine enantiomers.</p> <p>Chiral (Salen)Mn(III) complexes in asymmetric epoxidations: Practical synthesis of cis-aminoindanol and its application to enantiopure drug synthesis. Practical enantio- and diastereo selective Processes for azetidiones.</p> <p>d. Polymorphism solid state crystallization recrystallization of drug molecules. eg. isolation techniques and characterization of polymorphs of venlafaxine hydrochloride, clopidogrel bisulphate and lorazepam (<b>any two</b>).</p>	<b>12</b>	CO1, CO2, CO3	K1, K2, K3, K4, K5

<p><b>Module 3:</b></p>	<p><b>Safety norms in chemical process: concept of green chemistry, its 12 principles and green chemistry metrics</b></p> <p>Introduction, industrial disasters of the world, green chemistry, twelve green principles, need for green chemistry in pharmaceuticals, green chemistry for better sustainability. green chemistry metrics for measuring greenness (e-factor, atom economy, mass intensity, process mass intensity, process mass efficiency, chemical yield). waste prevention, management and hierarchy. atom economy: calculation and predicting greenness of a reaction.</p> <p>comparison of Diels alder reaction and Wittig reaction. addition v/s elimination v/s substitution. less hazardous chemical synthesis: avoiding use of hazardous substances for any synthesis (thiamine hydrochloride to be preferred over KCN for benzoin condensation). role of chirality in the need for designing safer chemicals with illustration of thalidomide.</p>	<p><b>08</b></p>	<p>CO1, CO2, CO3</p>	<p>K1, K2, K3, K4</p>
<p><b>Module 4:</b></p>	<p><b>Safer solvents in chemistry</b></p> <p>Knoevenagel condensation by grinding method. Advantages and disadvantages of solvent-free reaction. Water as green solvent in organic synthesis (Diels Alder Reaction). In water and on water mechanisms. Ionic liquids as designer solvents with one application. Supercritical solvents and their application in extractions. deep eutectic solvent (DES) with example and one application. fluorinated solvents and biphasic extraction.</p>	<p><b>08</b></p>	<p>CO1, CO2, CO3</p>	<p>K1, K2, K3, K4, K5</p>
<p><b>Module 5:</b></p>	<p><b>Emerging greener technologies for energy efficiency and catalysis</b></p> <p>Organic synthesis at ambient temperature and pressure, photochemical reactions as green process (advantages). Microwave assisted organic synthesis: Principle and applications. Sonochemistry as a sustainable alternative for organic synthesis, giving examples. Electrifying organic synthesis in designing new target molecules.</p> <p>Continuous flow synthesis as a sustainable technology for pharmaceutical industry. Impact of continuous flow chemistry in the synthesis of natural products and active pharmaceutical ingredients. Recent examples of green chemistry articles of interest to the pharmaceutical industry: C-H- activation, green fluorination, continuous processing</p>	<p><b>10</b></p>	<p>CO1, CO2, CO3, CO4</p>	<p>K1, K2, K3, K4</p>

	and process intensification.			
<b>Module 6:</b>	<b>Green synthesis of representative drugs</b> Multicomponent synthesis: ugi, biginelli, passerni, mannich, strecker. one-pot synthesis of (s)-baclofen. synthesis of ibuprofen, boots (conventional) and green synthesis. comparison and atom economy. green synthesis of paracetamol, aspirin, celecoxib, sildenafil citrate, sertraline, artemisinin, paroxetine, pregabalin, imatinib, simvastatin, quinapril hcl.	<b>10</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. H. G. Brittain, Polymorphism in Pharmaceutical solids, 2<sup>nd</sup> Ed., CRC Press, 1998.</li> <li>2. K. G. Gadamasetti, Process chemistry in the pharmaceutical industry, 1<sup>st</sup> Ed., Taylor and Francis, 1999.</li> <li>3. K. G. Gadamasetti, Process chemistry in the pharmaceutical industry: Challenges in an everchanging climate, 2<sup>nd</sup> Ed., Taylor and Francis, 2019.</li> <li>4. K. Tanaka, Solvent Free Organic Synthesis, 2<sup>nd</sup> Ed., Wiley – VCH GmbH and Co. KgaA, Weinheim, 2003.</li> <li>5. P. G. Jessop and W. Leitner, Chemical Synthesis using Supercritical fluids, Wiley – VCH, Verlag, (Eds., Weinheim, 1999.</li> <li>6. V. K. Ahluwalia and M. Kidwai, New Trends in Green Chemistry, 1<sup>st</sup> Ed., Anamaya Publishers, New Delhi, 2004.</li> </ol>			
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. A. Kumar &amp; A. Anjali, Adoption of green methodology in industry for the synthesis of sildenafil citrate and Celecoxib: case study. Volume 60, Part 2, 2022, Pages 1021-1025.</li> <li>2. A. Loupy, Microwaves in Organic Synthesis, Wiley – VCH Verlag, Weinheim, (Ed.), 2002.</li> <li>3. A. S. Matlack, Introduction to Green Chemistry, Marcel Dekker, Inc., New York, 2001.</li> <li>4. C - Jun Li and T – Hang Chan, Organic Reactions in Aqueous Media, John Wiley and Sons INC., N. York, 2001.</li> <li>5. C. Starks, C. Liotta, M. Halpern, “Phase-Transfer Catalysis: Fundamentals, Applications and Industrial Perspectives,” Chapter 16, Chapman &amp; Hall, New York, 1994.</li> <li>6. E. Yu, H. P. R. Mangunuru, N.I S. Telang, C. J. Kong, J. Verghese, S. E. Gilliland, S. Ahmad, R. N. Dominey &amp; B. F. Gupton, Beilstein, High-yielding continuous-flow synthesis of antimalarial drug hydroxychloroquine, J. Org. Chem. 2018, 14, 583– 592.</li> </ol>			

7. F. Fanelli, G. Parisi, L. Degennaro & R. Luisi, Contribution of microreactor technology and flow chemistry to the development of green and sustainable synthesis, *Beilstein J. Org. Chem.* 2017, 13, 520–542.
8. F. Z. Dorwald, *Organic Synthesis on Solid Phase*, Wiley – VCH Verlag, Weinheim, 2002.
9. J. M. DeSouza, R. Galaverna, A. A. N. De Souza, T. J. Brocksom, J. C. Pastre, R.M.A. De Souza & K. T. De Oliveira. Impact of continuous flow chemistry in the synthesis of natural products and active pharmaceutical ingredients, *Anais da Academia Brasileira de Ciências*, 2018, 90(1 Suppl. 2): 1131-1174.
10. M. Lancaster, *Green Chemistry*, The Royal Society of Chemistry, Cambridge, UK, 2002.
11. P. J. Harrington, *Pharmaceutical Process Chemistry for Synthesis: Rethinking the Routes to Scale-Up*, Wiley Publishers, 2011.
12. P. T. Anastas and J. C. Warner, *Green Chemistry, Theory and Practice*, Oxford University Press, N. York, 1998.
13. P. T. Anastas and T. C. Williamson, *Green Chemistry: Frontiers in benign chemical synthesis and processes*, Oxford University Press, Oxford, Eds. 1998.
14. P. Wasserscheid and T. Welton, *Ionic Liquids in Synthesis*, Wiley – VCH Verlag, Ed., Weinheim, 2003.
15. R. Hilfiker, *Polymorphism in Pharmaceutical industry*, Wiley-VCH, 2006.
16. R. Porta, M. Benaglia, & A. Puglisi. *Flow Chemistry: Recent Developments in the Synthesis of Pharmaceutical Products*. *Org. Process Res. Dev.* 2016, 20, 2–25.
17. R. Sanghi and M. M. Srivastava, *Green Chemistry: Environment Friendly Alternatives*, Narosa Publishing House, Eds. New Delhi, 2007.
18. R. V. Eldik and F. G. Klärner, *High Pressure Chemistry*, Wiley – VCH Verlag, (Eds.), Weinheim, 2002.
19. Samuel Delvin, *Green Chemistry*, IVY Publishing House, Delhi, 2006.
20. V. K. Ahluwalia, *Green Chemistry: Environmentally Benign Reactions*, Ane Books India, New Delhi, 2006.

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<b>Title of the Course</b>	Research Methodology in Pharmaceutical Chemistry and Instrumental Techniques
<b>Course Code</b>	CHH-6006
<b>Number of Credits</b>	4
<b>Theory/Practical</b>	Theory
<b>Level</b>	500
<b>Effective from AY</b>	2026-2027
<b>New Course</b>	No
<b>Bridge Course/ Value added Course</b>	No
<b>Course for advanced learners</b>	No

<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To understand the literature review process, safe laboratory practices and ethics in research.</li> <li>2. To explain preparation and purification of organic compounds</li> <li>3. To study the common software and databases in chemistry, and experimental techniques used in organic reaction.</li> <li>4. To acquire the knowledge of modern methodologies in chemical analysis.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to	<b>Mapped to PSO</b>
	CO1. describe the various aspects of research methodology, animal cell culture, lab safety and analytical technique.	PSO1, PSO2, PSO3, PSO4
	CO2. classify academic writing, scientific conduct, data analysis and cell culture techniques.	PSO1, PSO2, PSO3, PSO4
	CO3. analyse the structure and purity of the samples using various instrumental methods.	PSO2, PSO3,

			PS04, PSO5	
	CO4. apply the knowledge of software and research methodologies in writing the research/review article.		PSO5, PSO7	PSO6,
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	<p><b>Introduction to Research Methodology</b></p> <p><b>Research methodology</b>  Research- meaning, objectives, motivation, types and methodology.  Process- formulating the research problem; literature survey; developing the hypothesis and the research design; sample design and collection of the data; execution of the project; analysis of data; testing of hypothesis; generalizations and interpretation, and preparation of the report or presentation of the results &amp; conclusions.</p> <p><b>Scientific conduct and ethics</b>  Ethics: definition, nature of moral judgements and reactions, Ethics with respect to science and research.  Intellectual honesty and research integrity.  Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP).  Redundant publications: duplicate and overlapping publications.  Selective reporting and misrepresentation of data.</p> <p><b>Academic writing</b>  Publication ethics: definition, introduction and importance  Conflicts of interest  Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa.  Violation of publication ethics, authorship and contributorship.  Identification of publication misconduct, complaints and appeals.</p>	<b>15</b>	CO1, CO2,	K1, K2, K3, K4

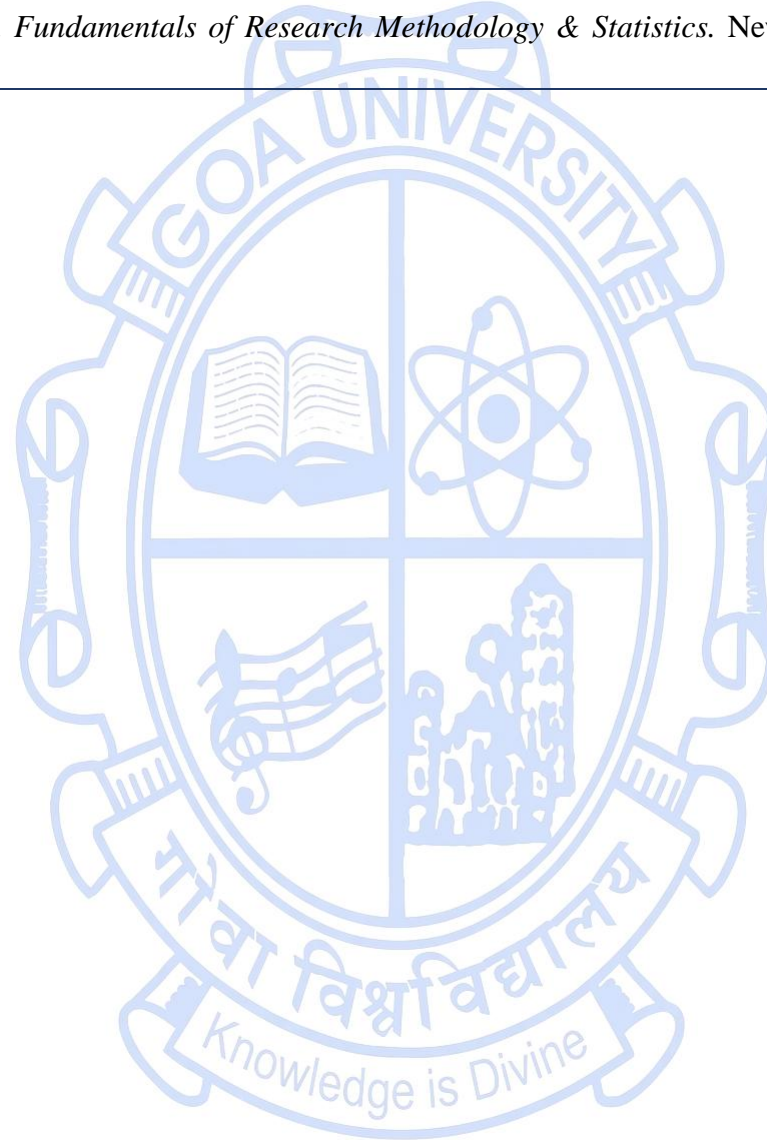
	Predatory publishers and journals.			
<b>Module 2:</b>	<p><b>Databases and Research metrics</b></p> <p><b>Databases:</b></p> <p>a. Indexing databases</p> <p>b. Citation databases: web of science, scopus, etc.</p> <p><b>Research metrics:</b></p> <p>a. Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score</p> <p>b. Metrics: h-index, g index, i10 index etc.</p> <p><b>Safety in chemistry</b></p> <p>Good laboratory practices.</p> <p>Handling of various chemicals, solvents &amp; glassware.</p> <p>Fires and fighting with fires.</p> <p>Hazardous substances, classification and handling</p> <p>Safety data sheet</p>	<b>10</b>	CO1, CO2, CO4	K2, K3, K4, K5
<b>Module 3:</b>	<p><b>Softwares in chemistry</b></p> <p>Data plotting</p> <p>Structure drawing</p> <p>Molecular docking softwares</p> <p>Bioinformatics tools (FASTA, BLAST, BLAT, RASMOL)</p> <p>Databases (GENBANK, Pubmed, PDB)</p>	<b>07</b>	CO2, CO3, CO4	K3, K4, K5, K6
<b>Module 4:</b>	<p><b>Instrumental methods of analysis:</b></p> <p>Demonstration and/ or data analysis in following techniques.</p> <p>a) Elemental analysis: CHNS analysis.</p> <p>b) AES</p> <p>c) FE-SEM</p> <p>d) AFM</p>	<b>08</b>	CO1, CO2, CO3	K2, K3, K4, K5, K6

	e) Raman spectroscopy f) Combined spectral analysis of compounds using IR, NMR and Mass spectroscopy			
<b>Module 5:</b>	<b>Computational Methods for Data Analysis:</b> Application of mean, mode, median; coefficient of correlation, standard deviation; least squares fitting methods (both linear and non-linear regression analyses). Usage of software packages for data analysis including excel, ORIGIN, etc. statistical tests of significance, type of significance tests, parametric tests (students “t” test, ANOVA, Correlation coefficient, regression), non-parametric tests (wilcoxon rank tests, analysis of variance, correlation, chi square test), null hypothesis, P values, degree of freedom, interpretation of P values. Laboratory information management system (LIMS) and text information management system (TIMS).	<b>10</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
<b>Module 6:</b>	<b>Animal Tissue Culture for pharmacological screening</b> Basic concepts Laboratory safety and biohazards Role of media components Handling and storage of cell lines Cell culture technique Types of cell culture. Application of cell cultures in pharmaceutical industry and research.	<b>10</b>	CO1, CO2	K1, K2, K3, K4,
<b>Pedagogy:</b>	Lectures/ tutorials/ project work/ industry visits/viva/seminars/ term papers/assignments/ presentations/ self-study/Case Studies/ writing the research/review article etc. or a combination of some of these. Session shall be interactive in nature to enable peer group learning.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. B. S. Furniss, A. J. Hannaford, V. Rogers, P. W. G. Smith, and A. R. Tatchell. <i>Vogel's Textbook of Practical Organic Chemistry</i>. 5th ed., ELBS, London, 2007.</li> <li>2. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch. <i>Fundamentals of Analytical Chemistry</i>. 9th ed., Cengage Learning, Boston, MA, 2013.</li> <li>3. D. A. Skoog, F. J. Holler, and S. R. Crouch. <i>Principles of Instrumental Analysis</i>. 7th ed., Cengage Learning, Boston, MA, 2017.</li> </ol>			

	<ol style="list-style-type: none"> <li>4. D. Pavia, G. Lampman, G. Kriz, and J. Vyvyan. <i>Introduction to Organic Spectroscopy</i>. 5th ed., Cengage Learning, Stamford, CT, 2015.</li> <li>5. E. J. Celis. <i>Cell Biology: A Laboratory Handbook</i>. Vols. I–IV, 2nd ed., Academic Press, New York, 1998.</li> <li>6. G. D. Christian. <i>Analytical Chemistry</i>. 6th ed., Wiley, Hoboken, NJ, 2004.</li> <li>7. J. Mendham, R. C. Denny, J. D. Barnes, and M. Thomas. <i>Vogel's Textbook of Quantitative Chemical Analysis</i>. 6th ed., Pearson Education Asia, Delhi, 2002.</li> <li>8. R. M. Silverstein, G. C. Bassler, and T. C. Morrill. <i>Spectrometric Identification of Organic Compounds</i>. 5th ed., John Wiley, New York, 1991.</li> <li>9. R. T. Freshney. <i>Culture of Animal Cells</i>. 5th ed., John Wiley &amp; Sons, New York, 2006.</li> </ol>
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. A. Bird. <i>Philosophy of Science</i>. Routledge, London, 2006.</li> <li>2. A. Leach. <i>Molecular Modelling: Principles and Applications</i>. Longman, London, 1998.</li> <li>3. A. M. Coghill, and L. R. Garson. <i>The ACS Style Guide: Effective Communication of Scientific Information</i>. Oxford University Press, New York, 2006.</li> <li>4. A. Szabo, and N. S. Ostlund. <i>Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory</i>. Dover Publications, Mineola, NY, 1989.</li> <li>5. C. R. Kothari. <i>Research Methodology: Methods &amp; Techniques</i>. New Age International Pvt. Ltd., New Delhi, 2004.</li> <li>6. E. A. V. Ebsworth, D. W. H. Rankin, and S. Craddock. <i>Structural Methods in Inorganic Chemistry</i>. ELBS, London, 1987.</li> <li>7. E. J. Gareth. <i>Human Cell Culture Protocols</i>. Humana Press, Totowa, NJ, 1996.</li> <li>8. F. D. King. <i>Medicinal Chemistry: Principles and Practice</i>. Royal Society of Chemistry, Cambridge, 1994.</li> <li>9. H. V. Keer. <i>Principles of the Solid-State</i>. New Age International, New Delhi, 1994.</li> <li>10. K. V. Raman. <i>Computers in Chemistry</i>. Tata McGraw-Hill, New Delhi, 1993.</li> <li>11. <i>Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards</i>. The National Academies Press, Washington, D.C., 2011.</li> <li>12. R. R. Spier, and J. B. Griffiths. <i>Animal Cell Biotechnology</i>. Academic Press, London, 1990.</li> <li>13. R. S. Drago. <i>Physical Methods in Chemistry</i>. W. B. Saunders Company, Philadelphia, 2016.</li> <li>14. S. K. Pundir, and A. Bansal. <i>Computers for Chemists</i>. Pragati Prakashan, Meerut, 2010.</li> </ol>

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| <p>15. V. Rajaraman. <i>Computer Programming in Fortran 90 and 95</i>. PHI Learning Pvt. Ltd., New Delhi, 2013.</p> <p>16. Y. K. Singh. <i>Fundamentals of Research Methodology &amp; Statistics</i>. New Age International Pvt. Ltd., New Delhi, 2006.</p> |
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### Discipline Specific Vocational Elective (DSVE) Courses

<b>Title of the Course</b>	Pharmaceutical and Spectral Analysis	
<b>Course Code</b>	CHH-6401	
<b>Number of Credits</b>	4 (2T+2P)	
<b>Theory/Practical</b>	Theory & Practical	
<b>Level</b>	500	
<b>Effective from AY</b>	2026-2027	
<b>New Course</b>	No	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To learn the principles, scope, and applications of modern analytical techniques used in pharmaceutical analysis.</li> <li>2. To understanding of spectral and chromatographic methods for the identification and quantification of drugs and impurities.</li> <li>3. To get acquainted with chemical analysis of drugs.</li> <li>4. To acquire hands on experience in laboratory techniques.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	CO 1. explain the scope and range of modern pharmaceutical technology.	PSO1
	CO 2. apply knowledge of ICH and Q9 guidelines to manage quality risk in analytical laboratories.	PSO2, PSO3

	CO 3. analyse drugs using various quality control methods		PSO4, PO 5	
	CO 4. evaluate the percentage purity, and physicochemical properties of pharmaceutical or chemical substances.		PSO6, PSO7, PSO8	
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	<p><b>Pharmaceutical Analysis and Techniques:</b>  Scope and range of modern pharmaceutical analysis. Listing of various pharmaceutical analytical techniques, with broad discussion on their instrumentation, working and pharmaceutical applications: HPLC, GC, HPTLC, DSC-DTA, XRD. Material and product specifications: Definition of specifications, study of ICH Q6 guidelines and understanding of specifications through study of pharmacopeial monographs on drug substances and products.</p> <p>Documentation of analytical data-STPs, certificate of analysis, laboratory books: Typical documents used in a GLP laboratory including standard test protocols, COA and laboratory notebooks.</p>	<b>08</b>	CO1, CO2	K1, K2, K3, K4
<b>Module 2:</b>	<p><b>Quality and risk management in analytical laboratory:</b>  Definition of quality risk management in ICH Q9 guideline. Its importance and application to analytical laboratory with examples. Quality of analysis by design. Impurity profiling: Types of impurities in drug substances and products. Method development for impurity analysis, techniques, identification and quantization. Management of analytical laboratory: Organization of laboratories based on their types, staffing, skill development and training, budgeting and financing, purchase of costly equipment, qualities of laboratory manager and management styles. Laboratory inspections and audit: Internal inspection, external audit, concepts, preparing for inspections and audits.</p>	<b>07</b>	CO1, CO2	K1, K2, K3, K4,
<b>Module 3:</b>	<p><b>Spectral Analysis-I:</b>  <b>Ultra Violet (UV)-visible spectroscopy and its pharmaceutical applications:</b>  Electronic excitations, principle, Woodward-Fieser and Fieser-Kuhn with problems,</p>	<b>06</b>	CO1, CO2	K1, K2, K3, K4,

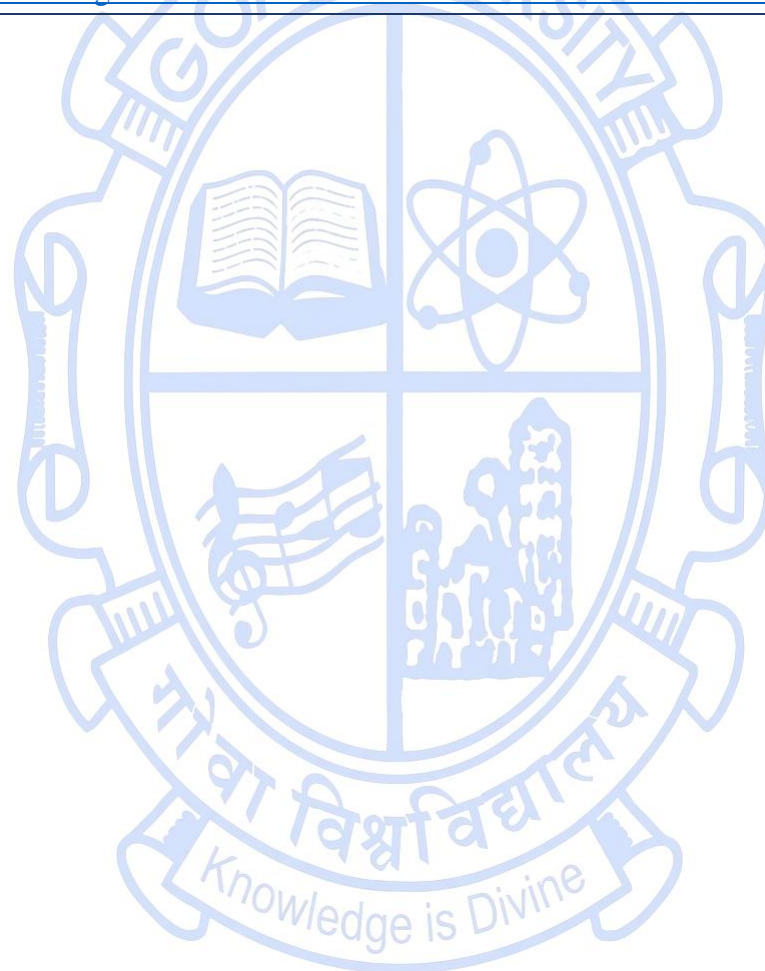
	<p>Factors affecting UV spectra. Types of UV spectroscopic analytical techniques with illustrative examples: Simultaneous equation method, Difference spectrophotometric method and Derivative spectrophotometric method.</p> <p><b>Infrared (IR)spectroscopy:</b> Principle of Infra-Red spectroscopy, types of vibrations, Correlation of structure with IR spectra: Influence of substituents, ring size, hydrogen bonding, vibrational coupling and field effect on frequency. Characteristic frequencies of drugs.</p>			
<b>Module 4:</b>	<p><b>Spectral Analysis-II:</b> <b>Nuclear Magnetic Resonance (NMR) spectroscopy:</b> 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. Introduction to 2D NMR techniques and interpretation of spectra of simple organic compounds using following 2D-NMR techniques: COSY, NOESY, TOCSY and INADEQUATE. Principles and applications; heteronuclear coupling of carbon to <sup>19</sup>F and <sup>31</sup>P. <b>Mass Spectroscopy:</b> Molecular ion and metastable peak, fragmentation patterns, nitrogen and ring rules, McLafferty rearrangement, electron and chemical ionization modes, applications.</p>	<b>09</b>	CO2, CO3	K1, K2, K3, K4
<b>Practical (2 Credit)</b>				
<b>Module 5:</b>	<p><b>DSC-DTA/XRD analysis (1 experiments of 4h)</b> i. Analysis of cocrystals (Any one) a. Salicylic acid and Isoniazid b. Urea and Ibuprofen c. Nicotinamide and Ibuprofen d. Benzoic acid and Carbamazepine ii. Detection of polymorphism and pseudomorphism in Triamcinolone A and B or Phenobarbitone by DSC or DTA</p>	<b>4</b>	CO3, CO4	K1, K2, K3, K4

<p><b>Module 6:</b></p>	<p><b>Chromatographic techniques</b>  <b>Determination of purity of the following classes of drugs/formulation using HPLC(3 experiments of 6h)</b>  i) Antibacterials- Sulphacetamide, sulphadiazine  ii) Antinflammatory- celecoxib, indomethacin  iii) Anticonvulsant-carbamazepine  iv) Anticoagulant-warfarin  v) Antifungal-clotrimazole cream  vi) Antihistamine-chlorphenamine syrup  vii) Diuretic-theophylline tablet  <b>Analysis of drugs/formulation using HPTLC (Any 1 experiment of 6h)</b>  i) To separate a mixture of sulphonamides.  ii) Simultaneous determination of alprazolam and fluoxetine hydrochloride in tablet formulations by highperformance thin-layer chromatography.  <b>Thin layer chromatography of impurities in pharmacopoeial products (Any 1 experiment of 2h)</b>  (+)-2-aminobutanol (1%) in Ethambutol HCl tablets, impurities in Nitrazepam tablets, 4-chlorophenol in Dichlorophen.</p>	<p><b>26</b></p>	<p>CO3, CO4</p>	<p>K1, K2, K3, K4</p>
<p><b>Module 7:</b></p>	<p><b>Spectroscopic techniques</b>  Analysis of pharmacopoeial compounds or their formulations by UV Vis spectrophotometer. (Any 4 experiments of 4h)  Mebendazole, clotrimazole, naproxen, ciprofloxacin, telmisartin, chlorpromazine hydrochloride  Simultaneous estimation of multicomponent containing formulations by UV spectrophotometry. (Any 1 experiments of 6h)  i) Simultaneous estimation of atorvastatin and ezetimibe by UV spectroscopy  ii) Simultaneous estimation of sodium benzoate and caffeine by UV spectroscopy.  iii) Simultaneous estimation of isoniazid and rifampicin by UV spectroscopy.  Identification of drugs by UV-Vis, FT-IR, NMR, Mass (Any 4 experiment of 2h)  albendazole, mefloquine, celecoxib, propranolol, tinidazole. Ibuprofen, aspirin,</p>	<p><b>30</b></p>	<p>CO3, CO4</p>	<p>K1, K2, K3, K4</p>

	chloramphenicol, Lidocaine, naproxen, chloroquine, citral, caffeine			
<b>Pedagogy:</b>	<p>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.</p> <p>Students should be given suitable hands-on learning, pre- and post-lab assignments and explanations revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.</p>			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. D. A. Skoog, F. J. Holler, and T. A. Nineman. Principles of Instrumental Analysis. 7th ed., Cengage Learning, Boston, 2018.</li> <li>2. D. H. Williams and I. Fleming. Spectroscopic Methods in Organic Chemistry. 5th ed., McGraw-Hill, New York, 1995.</li> <li>3. D. L. Pavia, G. M. Lampman, G. S. Kriz, and J. A. Vyvyan. Spectroscopy. 3rd ed., Thomson Learning, Belmont, California, 2001.</li> <li>4. D. T. Rossi and M. Sinz. Mass Spectrometry in Drug Discovery. 1st ed., Taylor and Francis, Boca Raton, 2001.</li> <li>5. F. Rouessac and A. Rouessac. Chemical Analysis: Modern Instrumentation Methods and Techniques. 2nd ed., Wiley Publishers, Hoboken, New Jersey, 2013.</li> <li>6. M. E. Swartz and I. S. Krull. Analytical Method Development and Validation. 1st ed., CRC Press, Boca Raton, 1997.</li> <li>7. M. Valcarcer. Principles of Analytical Chemistry. 2000th ed., Springer, Berlin, 2012.</li> <li>8. R. M. Silverstein, F. X. Webster, and D. J. Kiemle. Spectrometric Identification of Organic Compounds. 7th ed., Wiley &amp; Sons, Hoboken, New Jersey, 2005.</li> <li>9. S. Ahuja and S. Scypinski. Handbook of Modern Pharmaceutical Analysis. 2nd ed., Elsevier Publishers, Amsterdam, 2010.</li> <li>10. W. Kemp. Organic Spectroscopy. 3rd ed., Palgrave Macmillan, London, 2019.</li> </ol>			
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. H. W. Dibbem. UV and IR Spectra of Some Important Drugs. Annals of Pharmacotherapy, Cantor Aulendorf Publishers, 1978.</li> <li>2. I. Sunshine and M. Caplis. CRC Handbook of Mass Spectra of Drugs. CRC Press, Boca Raton, 1981.</li> <li>3. J. P. Seiler. Good Laboratory Practices. Springer, Berlin, 2001.</li> <li>4. J. R. Dyer. Applications of Absorption Spectroscopy of Organic Compounds. Prentice Hall of India Pvt. Ltd., New Delhi, 1978.</li> </ol>			

	<ol style="list-style-type: none"><li>5. M. Pellecchia, D. Sem, and K. Wüthrich. “NMR in Drug Discovery.” Nature Reviews Drug Discovery, vol. 1, 2002, pp. 211–219.</li><li>6. R. F. Venn. Principles and Practice of Bioanalysis. CRC Press, Boca Raton, 2008.</li></ol>
<b>Web Resources:</b>	<ol style="list-style-type: none"><li>1. Indian Pharmacopoeia (IP) – 2010 Vol.2 (PDF) <a href="https://qps.nhsrindia.org/sites/default/files/202201/INDIAN%20PHARMACOPOIA%202010%20Volume%202.pdf">https://qps.nhsrindia.org/sites/default/files/202201/INDIAN%20PHARMACOPOIA%202010%20Volume%202.pdf</a>.</li></ol>

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<b>Title of the Course</b>	Pharmaceutical Calibration and Validation	
<b>Course Code</b>	CHH-6402	
<b>Number of Credits</b>	4 (2T+2P)	
<b>Theory/Practical</b>	Theory & Practical	
<b>Level</b>	500	
<b>Effective from AY</b>	2026-2027	
<b>New Course</b>	No	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To learn principles of calibration and validation of analytical instruments.</li> <li>2. To acquire the knowledge on analytical instruments.</li> <li>3. To get acquainted with calibration and validation procedures.</li> <li>4. To gain hand-on practice in designing and documenting the calibration and validation assets.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	explain the principles of validation in ensuring product quality, regulatory compliance, and patient safety.	PSO1
	understand calibration techniques and validation methodologies and calibration techniques.	PSO2, PSO3
	analyze regulatory requirements and guidelines for validation, including FDA, EMA, and WHO.	PSO4, PSO5

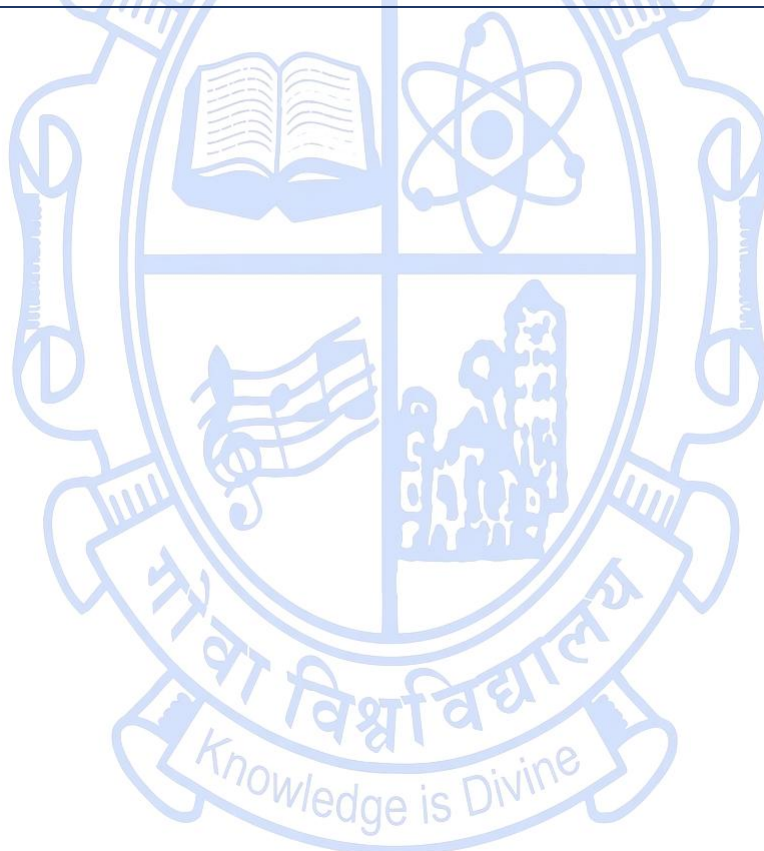
	design and develop Calibration and method validation protocol.		PSO6, PSO7, PSO8	
<b>Content:</b>	<b>Theory (2 Credit)</b>	<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	<p><b>Calibration</b> Significance of calibration in analytical chemistry. Standardizing methods; standards used, certified reference material. Blanks and controls; types and significance Statistical evaluation of analytical results; relative error, standard deviation, knowledge of q test, test of significance, linear Least Squares estimation and coefficient of regression.</p> <p>Errors in calibration, Modes and protocols of calibration; External standard method, Standard addition method, Spiking, Internal standard method and standard bracket method.</p>	<b>08</b>	CO1, CO2,	K1, K2, K3, K4,
<b>Module 2:</b>	<p><b>Validation</b> Introduction to validation, Validation and calibration of various instruments used for drug analysis such as UV-Visible Spectrophotometer, IR Spectrophotometer, Spectrofluorometer, HPLC, HPTLC and GC. Validation and qualification, Overview of qualification of some instruments. Overview of installation, operation, and performance qualification (IQ, OQ, PQ) of analytical equipment. Regulatory requirements for analytical method validation international conference on harmonization (ICH) guideline Q2A Introduction to QA / QC, Safety Practices in a Chemical Laboratory</p>	<b>14</b>	CO1, CO2	K1, K2, K3, K4,
<b>Module 3:</b>	<p><b>Validation of analytical procedures</b> Linearity and range criteria and their role in instrumental method validation Detailed discussion on accuracy and precision role in the method validation Role of quantification limit and specificity -Limit of Detection (LOD) and Limit of Quantification (LOQ) Robustness &amp; method validation.</p> <p>Ruggedness of chromatographic method Ruggedness of sample preparation procedure Complete method validation package, analytical data, protocol, plan, revisions, and change controls.</p>	<b>08</b>	CO1, CO2	K1, K2, K3, K4,
<b>Practical (2 credit)</b>				

<b>Module 4:</b>	<p><b>Calibration And Validation Experiments : (Any 3 experiments of 4h)</b></p> <p>i. Introduction to common apparatus used in laboratory and their calibration; volumetric glassware, analytical Balances, Excel-charts for calibration plot.</p> <p>ii. Validation, qualification, Calibration of dissolution Test Apparatus.</p> <p>iii. Calibration of Colorimetry, pH meter, Potentiometer, Conductivity meter and to check the performance of the instrument.</p> <p>iv. To determine Water content in the given sample by Karl Fischer reagent along with moisture content in the given sample using infrared moisture balance.</p>	<b>12</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4,
	<p>v. Calibration and Validation the following drugs using UV-Visible spectrophotometry. (Any 2 experiments of 3h)</p> <p>vi. Levodopa, Paracetamol, Ciprofloxacin, Ibuprofen, Captopril.</p> <p>vii. Calibration &amp; Validation of HPLC instruments and to check the performance of the instrument. (Any 1 experiments of 6h)</p>	<b>12</b>	CO3, CO4	K1, K2, K3, K4,
	<p>viii. Validation of UV-Spectrophotometric Simultaneous Analysis in Marketed Tablets. (Any 3 experiments of 6h)</p> <p>Paracetamol and Aceclofenac Ciprofloxacin and Ornidazole Levofloxacin and Ornidazole Metformin and Glimepiride Atorvastatin and Amlodipine</p> <p>ix. Method Validation of following drugs using Colorimetry (Any 3 experiments of 6h)</p> <p>Ciprofloxacin, Metformin, Ascorbic acid, Chlorpromazine, Rifampicin, Sulfamethoxazole, Methyldopa, Diclofenac, Metformin, Ranitidine, Ciprofloxacin, Atenolol.</p>	<b>36</b>	CO3, CO4	K1, K2, K3, K4,
<b>Pedagogy:</b>	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			

	<p>learning.</p> <p>Students should be given suitable hands-on learning, pre- and post-lab assignments and explanations revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.</p>
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. B. T. Loftus, R. A. Nash. <i>Pharmaceutical Process Validation</i>. 3rd ed., Marcel Dekker Inc., New York, 1997.</li> <li>2. D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch. <i>Fundamentals of Analytical Chemistry</i>. 9th ed., Cengage Learning, USA, 2014.</li> <li>3. F. Carleton, James Agalloco. <i>Validation of Aseptic Pharmaceutical Processes</i>. 2nd ed., CRC Press, 2003.</li> <li>4. F. J. Holler, D. A. Skoog, S. R. Crouch. <i>Principles of Instrumental Analysis</i>. 6th ed., Thomson Books, London, 2007.</li> <li>5. G. W. Ewing. <i>Instrumental Methods of Chemical Analysis</i>. 5th ed., McGraw-Hill International, New York, 1985.</li> <li>6. H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle. <i>Instrumental Methods of Analysis</i>. 7th ed., CBS Publishers, India, 2004.</li> <li>7. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, B. Sivasankar. <i>Vogel's Textbook of Quantitative Chemical Analysis</i>. 6th ed., Pearson, New Delhi, 2009.</li> <li>8. L. D. Field, S. Sternhell, J. R. Kalman. <i>Organic Structures from Spectra</i>. 4th ed., Wiley, Singapore, 2007.</li> <li>9. L. Lachman, Herbert A. Lieberman, Joseph L. Kanig. <i>The Theory and Practice of Industrial Pharmacy</i>. 3rd ed., Varghese Publishing House, Bombay, 1987.</li> <li>10. M. Levin. <i>Pharmaceutical Process Scale-Up</i>. 2nd ed., Marcel Dekker Inc., New York, 2002.</li> <li>11. R. M. Silverstein, F. X. Webster. <i>Spectrometric Identification of Organic Compounds</i>. 6th ed., Wiley, USA, 1998.</li> <li>12. W. Kemp. <i>Organic Spectroscopy</i>. 3rd ed., Palgrave, New York, 1991.</li> </ol>
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. B. K. Sharma. <i>Instrumental Methods of Chemical Analysis</i>. Goel Publishing House, Meerut, 2004.</li> <li>2. C. Chan, Churg, Heiman Lam, Y. C. Lee, and Yue Zhang. <i>Analytical Method Validation and Instrument Performance Verification</i>. Wiley Interscience, 2004.</li> <li>3. D. A. LeBlanc. <i>Validated Cleaning Technologies for Pharmaceutical Manufacturing</i>. Interpharm Press, 2000.</li> <li>4. F. J. Carlton, James Agalloco, eds. <i>Validation of Pharmaceutical Processes: Sterile Products</i>. Marcel Dekker, 2003.</li> <li>5. G. Wingate. <i>Validating Corporate Computer Systems: Good IT Practice for Pharmaceutical Manufacturers</i>. Interpharm Press, 1997.</li> <li>6. H. Gunzler, A. Williams. <i>Handbook of Analytical Techniques</i>. 1st ed., Wiley, Germany, 2001.</li> <li>7. J. H. Kennedy. <i>Analytical Chemistry: Principles</i>. 2nd ed., Saunders College Publishing, Philadelphia, 1990.</li> </ol>

	<p>8. L. Huber. Validation and Qualification in Analytical Laboratories. Informa Healthcare, 2007.</p> <p>9. P. A. Cloud. Pharmaceutical Equipment Validation: The Ultimate Qualification Handbook. Interpharm Press, 1998.</p> <p>10. R. A. Day, A. L. Underwood. Quantitative Analysis. 6th ed., Prentice Hall, USA, 2001.</p> <p>11. S. I. Haider. Validation Standard Operating Procedures: A Step-by-Step Guide for Achieving Compliance in the Pharmaceutical, Medical Device, and Biotech Industries. CRC Press, 2004.</p> <p>12. Terveeks (or Deeks). Validation Master Plan. Davis Harwood International Publishing, 1995.</p>
<b>Web Resources:</b>	<p>1. Indian Pharmacopoeia (IP) – 2010 Vol.2 (PDF)  <a href="https://qps.nhsrindia.org/sites/default/files/202201/INDIAN%20PHARMACOPOIA%202010%20Volume%202.pdf">https://qps.nhsrindia.org/sites/default/files/202201/INDIAN%20PHARMACOPOIA%202010%20Volume%202.pdf</a>.</p>

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<b>Title of the Course</b>	Herbal Drug Technology and Cosmetology
<b>Course Code</b>	CHH-6403
<b>Number of Credits</b>	4 (2T + 2P)
<b>Theory/Practical</b>	Theory & Practical
<b>Level</b>	500
<b>Effective from AY</b>	2026-2027
<b>New Course</b>	No
<b>Bridge Course/ Value added Course</b>	No
<b>Course for advanced learners</b>	No

<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To learn classification of cosmetics and cosmeceuticals in India.</li> <li>2. To study the formulation and building blocks of cosmetology.</li> <li>3. To introduce GMP, quality control, and applicable to herbal and cosmetic industries.</li> <li>4. To gain hand-on practice in formulate of various cosmetics and herbal dosage forms.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	CO 1. explain the regulatory requirements for manufacture, labeling, and import of cosmetics in India.	PSO1
	CO 2. describe skin and hair biology and their relation to common cosmetic problems.	PSO2, PSO3
	CO 3. formulate various cosmetic and herbal preparations scientifically.	PSO4, PSO5
	CO 4. evaluate the raw herb or herbal dosage form using standard procedure.	PSO6, PSO7, PSO8

Content:		No of hours	Mapped to CO	Cognitive Level
<b>Module 1:</b>	<p><b>Herbal Drug Industry</b> Present scope and future prospects. A brief account of plant-based industries and institutions involved in work on medicinal and aromatic plants in India. Components of GMP (Schedule – T) and its objectives, Infrastructural requirements, working space, storage area, machinery and equipments, standard operating procedures, health and hygiene, documentation and records. WHO and Indian regulatory requirements of Clinical trials for herbal formulations.</p> <p>Herbal formulations: Conventional herbal formulations like syrups, mixtures and tablets and Novel dosage forms like phytosomes.</p> <p>Herbal Excipients – Significance of substances of natural origin as excipients – colorants, sweeteners, binders, diluents, viscosity builders, disintegrants, flavors &amp; perfumes.</p>	07	CO1, CO2	K1, K2, K3, K4
<b>Module 2:</b>	<p><b>Herbal preparations and their biological evaluation techniques</b> Development of Ayurvedic and Herbal formulations and their evaluation by physical methods, chemical methods and microscopical techniques. Application of various chromatographic methods in separation and identification of marker compounds in the formulations. Fingerprinting techniques and its importance.</p> <p>Development of analytical techniques for the estimation of markers present in the Herbal and classical formulations. Evaluation of Herbal drugs and formulations by biological methods. General animal models for screening of Herbal drugs and formulations. Toxicological evaluations of herbal drugs and formulations.</p>	07	CO1, CO2	K1, K2, K3, K4
<b>Module 3:</b>	<p><b>Cosmetics</b> Cosmetic products as per Indian regulation. Indian regulatory requirements for labelling of cosmetics Regulatory provisions relating to import of cosmetics., Misbranded and spurious cosmetics. Regulatory provisions relating to manufacture of cosmetics – Conditions for obtaining license, prohibition of manufacture and sale of certain cosmetics, loan license, offences and penalties.</p>	08	CO1, CO2	K1, K2, K3, K4

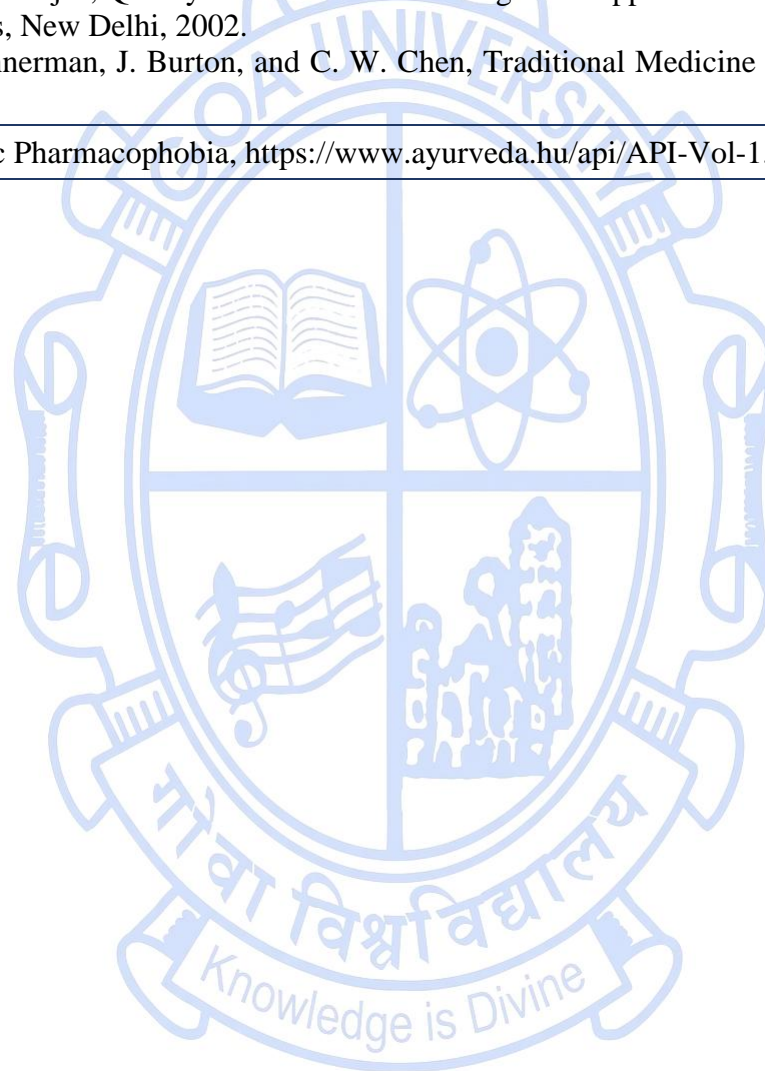
	Cosmetics - Biological aspects: Structure of skin relating to problems like dry skin, acne, pigmentation, prickly heat, wrinkles and body odour. Structure of hair and hair growth cycle. Common problems associated with oral cavity. Cleansing and care needs for face, neck, body and under-arm.			
<b>Module 4:</b>	<p><b>Formulation Building blocks</b></p> <p>Building blocks for different product formulations of cosmetics/cosmeceuticals. surfactants –classification and application. emollients, rheological additives: classification and application.</p> <p>antimicrobial used as preservatives, their merits and demerits. factors affecting microbial preservative efficacy. building blocks for formulation of a moisturizing cream, vanishing cream, cold cream, shampoo and toothpaste. soaps and syndet bars.</p> <p>controversial ingredients: parabens, formaldehyde liberators, dioxane. design of cosmeceutical products: sun protection, sunscreens classification and regulatory aspects.</p> <p>addressing dry skin, acne, sun protection, pigmentation, prickly heat, wrinkles, body odor., dandruff, dental cavities, bleeding gums, mouth odor and sensitive teeth through cosmeceutical formulations.</p>	<b>08</b>	CO1, CO2	K1, K2, K3, K4,
<b>Practical (2 Credit)</b>				
<b>Module 5:</b>	<p><b>Cosmetics and Herbal Experiments: (Any 4 experiments of 3h)</b></p> <p><b>Cosmetics and herbal product preparation and its Evaluation</b></p> <ol style="list-style-type: none"> <li>i. leather shaving cream</li> <li>ii. mouth wash</li> <li>iii. sunscreen lotion</li> <li>iv. syrup</li> <li>v. turmeric face pack</li> <li>vi. rouges</li> <li>vii. foundation cream</li> <li>viii. tooth powder</li> </ol>	<b>12</b>	CO3, CO4	K1, K2, K3, K4

<b>Module 6:</b>	<b>Formulation and labelling of pharmaceutical dosage as per cGMP Guidelines</b> ( <i>Any 3 experiments of 4h</i> ) <ul style="list-style-type: none"> <li>i. Aqueous iodine solution I.P</li> <li>ii. Elixir and pain balm</li> <li>iii. Paraffin liniment (BPC)</li> <li>iv. Non-Staining iodine ointment BPC</li> <li>v. Non staining iodine ointment with methyl salicylate (BPC)</li> <li>vi. Paediatric B.P.C.</li> <li>vii. Sulphur ointment</li> </ul>	<b>12</b>	CO3, CO4	K1, K2, K3, K4
<b>Module 7:</b>	<b>Monograph of the Herbal drugs and herbal formulations</b> ( <i>Any 3 experiments of 6h</i> ) <ul style="list-style-type: none"> <li>i. Ginkgo tablets (<i>Ginkgo biloba</i> Linn. Tablets),</li> <li>ii. Belladonna dry extract tablets (<i>Atropa bella-donna</i> Linn. dry extract tablets),</li> <li>iii. Guggulipid tablets (<i>Commiphora wightii</i> Arnott tablets),</li> <li>iv. Sarpagandha powder (<i>Rauvolfia serpentina</i> Kurz powder),</li> <li>v. Sarpagandha tablets (<i>Rauvolfia serpentina</i> Kurz tablets),</li> <li>vi. Senna tablets (<i>Cassia angustifolia</i> Vahl. tablets)</li> </ul>	<b>18</b>	CO3, CO4	K1, K2, K3, K4
<b>Module 7:</b>	<b>Monograph of the Herbal oils</b> ( <i>Any 3 experiments of 6h</i> ) <ul style="list-style-type: none"> <li>i. Rosemary oil (<i>Rosmarinus officinalis</i> Linn. oil),</li> <li>ii. Peppermint oil (<i>Mentha piperita</i> Linn. oil),</li> <li>iii. Nutmeg oil (<i>Myristica fragrans</i> Houttuyn oil),</li> <li>iv. Lemon grass oil (<i>Cymbopogon flexuosus</i> Stapf oil),</li> <li>v. Eucalyptus oil (<i>Eucalyptus globulus</i> oil),</li> <li>vi. Dill Seed oil (<i>Anethum sowa</i> oil),</li> <li>vii. Cinnamon bark oil (<i>Cinnamomum zeylanicum</i> Nees. Bark oil),</li> <li>viii. Clove bud oil (<i>Syzygium aromaticum</i> Linn. Bud oil),</li> <li>ix. Coconut oil (<i>Cocos nucifera</i> Linn. oil)</li> </ul>	<b>18</b>	CO3, CO4	K1, K2, K3, K4
<b>Pedagogy:</b>	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			

	<p>group learning.</p> <p>Students should be given suitable hands-on learning, pre- and post-lab assignments and explanations revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.</p>
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. A. I. Vogel, A Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education Limited, Harlow, England, 2000.</li> <li>2. A. I. Vogel, A Textbook of Quantitative Inorganic Analysis, Including Elementary Instrumental Analysis, 4th Ed., ELBS and Longman Publications, London, 1978.</li> <li>3. A. I. Vogel, A. R. Tatchell, B. S. Furniss, and A. J. Hannaford, Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Prentice Hall, London, 2011.</li> <li>4. A. O. Barel, M. Paye, and H. I. Maibach, Handbook of Cosmetic Science and Technology, 3rd and 4th Eds., CRC Press, Boca Raton, FL, 2009.</li> <li>5. B. Carli, Cosmetic Formulations: A Beginner's Guide, 7th Ed., 2020.</li> <li>6. F. G. Mann and B. C. Saunders, Practical Organic Chemistry, 4th Ed., ELBS and Longman Publications, London, 1960.</li> <li>7. K. H. C. Baser and G. Buchbauer, Handbook of Essential Oils: Science, Technology, and Applications, 2nd Ed., CRC Press, Boca Raton, FL, 2015.</li> <li>8. M. Vimaladevi, Textbook of Herbal Cosmetics, 1st Ed., CBS Publishers, New Delhi, 2015.</li> <li>9. S. S. Agarwal, Herbal Drug Technology, 1st Ed., University Press, Hyderabad, 2007.</li> </ol>
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. C. P. Hare, Indian Herbal Remedies: Rational Western Therapy, Ayurvedic and Other Usage, Botany, Springer, 2004.</li> <li>2. E. Sagarin, Cosmetic Science and Technology, Vols. I–III, Wiley-Interscience, 1957.</li> <li>3. H. Panda, The Complete Technology Book on Herbal Beauty Products with Formulations and Processes, Asia Pacific Business Press Inc., 2005.</li> <li>4. Indian Herbal Pharmacopoeia, 2nd Ed., Indian Drug Manufacturers' Association (IDMA) in association with Regional Research Laboratory (RRL), Jammu, Mumbai, 2002.</li> <li>5. Indian Pharmacopoeia, 9th Ed., Indian Pharmacopoeia Commission, Ghaziabad, 2022.</li> <li>6. K. Duerbeck, Natural Ingredients for Cosmetics, Cosmetic Science Publications, 2005.</li> <li>7. M. Daniel, Herbal Technology: Concepts and Advances, Satish Serial Publishing House, 2008.</li> <li>8. P. Bare, Cosmetics Analysis: Selective Methods with Techniques, Cosmetic Press, 1998.</li> </ol>

	<ol style="list-style-type: none"><li>9. P. Pushpangadan, Ethnobiology in India: A Status Report, All India Coordinated Research Project on Ethnobiology, Ministry of Environment and Forests, Government of India, New Delhi, 1995.</li><li>10. P. W. Mukherjee, Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals, Business Horizons Publishers, New Delhi, 2002.</li><li>11. R. H. Bannerman, J. Burton, and C. W. Chen, Traditional Medicine and Health Care Coverage, WHO, Geneva, 1983.</li></ol>
<b>Web Resources:</b>	<ol style="list-style-type: none"><li>1. Ayurvedic Pharmacophobia, <a href="https://www.ayurveda.hu/api/API-Vol-1.pdf">https://www.ayurveda.hu/api/API-Vol-1.pdf</a></li></ol>

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<b>Title of the Course</b>	Pharmaceutical Manufacturing Technology
<b>Course Code</b>	CHH-6404
<b>Number of Credits</b>	4 (2T+2P)
<b>Theory/Practical</b>	Theory & Practical
<b>Level</b>	500
<b>Effective from AY</b>	2026-2027
<b>New Course</b>	Yes
<b>Bridge Course/ Value added Course</b>	No
<b>Course for advanced learners</b>	No

<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>To learn the principles, design, and control of aseptic and non-sterile pharmaceutical manufacturing processes.</li> <li>To gain knowledge of advanced sterile manufacturing technologies, including automation, CIP/SIP, lyophilization, and form-fill-seal systems.</li> <li>To acquire a detailed understanding of pharmaceutical packaging materials, containers, and closures and their quality control evaluation.</li> <li>To gain the skills to formulate, prepare, and evaluate various pharmaceutical dosage forms using both natural and synthetic excipients.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	CO 1. explain the principles and equipment used in aseptic product manufacture	PSO1
	CO 2. apply process automation, environmental control, and sterilization technologies in production.	PSO2, PSO3

	CO 3. evaluate an automated process and appropriate packaging system.		PSO4, PSO5	
	CO 4. formulate and evaluate various pharmaceutical formulations.		PSO6, PSO7, PSO8	
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	<p><b>Aseptic process, Advanced sterile product and Process Automation in Pharmaceutical Industry</b></p> <p><b>Aseptic process technology</b> Manufacturing, manufacturing flowcharts, in process-quality control tests for following sterile dosage forms: ointment, suspension and emulsion, dry powder, solution (small volume &amp; large volume).</p> <p><b>Advanced sterile product manufacturing technology</b> Area planning &amp; environmental control, wall and floor treatment, fixtures and machineries, change rooms, personnel flow, utilities &amp; utilities equipment location, engineering and maintenance.</p> <p><b>Process Automation in Pharmaceutical Industry</b> with specific reference to manufacturing of sterile semisolids, small volume parenterals &amp; large volume parenterals (SVP &amp; LVP), monitoring of parenteral manufacturing facility, cleaning in place (CIP) sterilization in place (SIP), prefilled syringe, powdered jet, needle free injections, and form fill seal technology (FFS). Lyophilization technology: Principles, process, equipment</p>	<b>12</b>	CO1, CO2, CO3,	K1, K2, K3, K4,
<b>Module 2:</b>	<p><b>Non sterile manufacturing process, advance non-sterile solid product and coating technology</b></p> <p><b>Non sterile manufacturing process technology</b> Manufacturing, manufacturing flowcharts dosage forms.</p> <p><b>Advance non-sterile solid product manufacturing technology</b> Process Automation in Pharmaceutical Industry with specific reference to manufacturing of tablets and coated products, Improved Tablet Production: Tablet production process, granulation and pelletization equipments, continuous and batch</p>	<b>12</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6

	<p>mixing, rapid mixing granulators, rota granulators, spheronizers and marumerisers, and another specialized granulation and drying equipments. Problems encountered.</p> <p><b>Coating technology</b></p> <p>Process, equipments, particle coating, fluidized bed coating, application techniques. Problems encountered.</p>			
<b>Module 3:</b>	<p><b>Containers and closures for pharmaceuticals</b></p> <p>Types, performance, assuring quality of glass; types of plastics used, Drug plastic interactions, biological tests, modification of plastics by drugs; different types of closures and closure liners; film wrapper; blister packs; bubble packs; shrink packaging; foil / plastic pouches, bottle seals, tape seals, breakable seals and sealed tubes</p>	<b>06</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
<b>Practical (2 Credit)</b>				
<b>Module 4:</b>	<p><b>Practical Experiments based on formulation-I</b></p> <p><i>(Any 6 experiments of 8h)</i></p> <ol style="list-style-type: none"> <li>i. Formulation and evaluation of dry syrup with combination of drugs cetirizine hydrochloride and chloramphenicol.</li> <li>ii. Formulation development and evaluation of medicated jelly.</li> <li>iii. Formulation and evaluation of pharmaceutical suspension using natural excipients.</li> <li>iv. Formulation and evaluation of trans dermal patches.</li> <li>v. Formulation and evaluation of meloxicam floating capsules.</li> <li>vi. Formulation and evaluation of ginger officinale emulgel.</li> <li>vii. Formulation and evaluation of eprosartan mesylate nanosuspension.</li> <li>viii. Formulation and estimation of ephedrine hydrochloride in cough syrup.</li> <li>ix. Formulation and evaluation of microencapsulation of oils.</li> <li>x. Formulation and evaluation of nanorobots</li> <li>xi. Formulation and evaluation of nasal gel.</li> <li>xii. Formulation development and evaluation of taste masked Cefuroxime axetil dry</li> </ol>	<b>48</b>	CO3, CO4	K1, K2, K3, K4, K5

	suspension			
<b>Module 5:</b>	<p><b>Practical Experiments based on formulation-II</b> (Any 2 experiments of 6h)</p> <ol style="list-style-type: none"> <li>Prepare and evaluate granules by wet granulation method.</li> <li>Formulation and evaluation of mucoadhesive in situ gel for intranasal delivery of Almotriptan malate</li> <li>Preparation and evaluation of cross-linked alginate-based microspheres.</li> <li>Formulate and evaluate chewable antacid tablet.</li> <li>Formulate and evaluate diclofenac microcapsule using solvent evaporation technique</li> </ol>	<b>12</b>	CO3, CO4	K1, K2, K3, K4, K5
<b>Pedagogy:</b>	<p>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.</p> <p>Students should be given suitable hands-on learning, pre- and post-lab assignments and explanations revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.</p>			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>E. J. Bauer, Pharmaceutical Packaging Handbook, Informa Healthcare USA, New York, 2009.</li> <li>K. E. Avis, A. J. Shukla, and H. A. Lieberman, Pharmaceutical Dosage Forms: Parenteral Medications, Vols. 1–3, CRC Press, Boca Raton, FL, 2010.</li> <li>N. K. Jain and S. N. Sharma, Pharmaceutics: Practical Manual for B. Pharm Students, Vallabh Prakashan, New Delhi, 2014.</li> <li>N. K. Jain, Pharmaceutical Production Management, CBS Publishers &amp; Distributors, New Delhi, 2007.</li> <li>P. K. Gupta, Practical Pharmaceutics: A Student Companion, CBS Publishers &amp; Distributors, New Delhi, 2015.</li> <li>R. K. Khar, S. P. Vyas, and F. J. Ahmed, Textbook of Industrial Pharmacy, CBS Publishers &amp; Distributors, New Delhi, 2018.</li> <li>S. C. Gad, Pharmaceutical Manufacturing Handbook: Production, CRC Press, Boca Raton, FL, 2008.</li> </ol>			
<b>References/</b>	<ol style="list-style-type: none"> <li>A. N. Martin, P. J. Sinko, and M. J. C. Martin, Martin's Physical Pharmacy and Pharmaceutical Sciences, 6th Ed.,</li> </ol>			

**Readings:**

- Wolters Kluwer, Philadelphia, 2011.
2. A. R. Gennaro, Remington: The Science and Practice of Pharmacy, 22nd Ed., Lippincott Williams & Wilkins, Philadelphia, 2013.
3. C. V. S. Subrahmanyam, Textbook of Physical Pharmaceutics and Industrial Pharmacy, Vallabh Prakashan, New Delhi, 2019.
4. D. A. Dean, E. R. Evans, and I. H. Hall, Pharmaceutical Packaging Technology, 1st Ed., Taylor & Francis, London, 2000.
5. E. A. Rawlins, Bentley's Textbook of Pharmaceutics, 8th Ed., Baillière Tindall, London, 2007.
6. G. Bunn, Good Manufacturing Practices for Pharmaceuticals, 7th Ed., CRC Press, Boca Raton, FL, 2019.
7. G. S. Banker and C. T. Rhodes, Modern Pharmaceutics, 5th Ed., CRC Press, Boca Raton, FL, 2012.
8. L. Lachman, H. A. Lieberman, and J. L. Kanig, The Theory and Practice of Industrial Pharmacy, 4th Ed., CBS Publishers and Distributors, New Delhi, 2013.
9. L. V. Allen Jr., The Art, Science, and Technology of Pharmaceutical Compounding, 6th Ed., American Pharmacists Association, Washington, D.C., 2020.
10. M. E. Aulton and K. Taylor, Aulton's Pharmaceutics: The Design and Manufacture of Medicines, 6th Ed., Churchill Livingstone, Elsevier, London, 2021.
11. P. J. Sinko, Martin's Physical Pharmacy and Pharmaceutical Sciences, 5th Ed., B. I. Publications Pvt. Ltd., Noida, 2006.
12. S. H. Willing, M. M. Tuckerman, and W. Hitchings IV, Good Manufacturing of Pharmaceuticals: A Plan for Total Quality Control, 3rd Ed., Bhalani Publishing House, Mumbai, 1991.
13. S. J. Carter, Cooper and Gunn's Tutorial Pharmacy, 6th Ed., CBS Publishers and Distributors, New Delhi, 2010.

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## SEMESTER IV

### Generic Elective (GE) Courses

<b>Title of the Course</b>	Pharmacological and Toxicological Screening Techniques	
<b>Course Code</b>	CHH-6201	
<b>Number of Credits</b>	4	
<b>Theory/Practical</b>	Theory	
<b>Level</b>	500	
<b>Effective from AY</b>	2026-2027	
<b>New Course: Yes/No</b>	No	
<b>Bridge Course/ Value added Course: Yes/No</b>	No	
<b>Course for advanced learners: Yes/No</b>	No	
<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"><li>1. To learn the principles and methods of biological standardization.</li><li>2. To study the concept of screening methods of biological assay.</li><li>3. To learn the various principles and types of toxicity.</li><li>4. To understand core functions and classification systems in pharmacovigilance.</li></ol>	
<b>Course Outcomes:</b>	Students will be able to	<b>Mapped to PSO</b>
	CO1. explain the various biological and toxicological screening methods.	PSO1, PSO2
	CO2. classify and interpret various bioassay, types of toxicology.	PSO2, PSO3

	CO3. analyse the types, mechanism and effects of bioassay and toxicity.		PSO2, PSO3, PSO6
	CO4. evaluate the bioassay, modern methods of analysis of toxins and applications of pharmacovigilance.		PSO6, PSO7, PSO8
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b> <b>Cognitive Level</b>
<b>Module 1:</b>	<p><b>Animal ethics and principles of biological standardization and screening methods</b> Introduction to pharmacological research. Animal ethics, regulations for conducting animal experimentation. Anesthesia and euthanasia of experimental animals.</p> <p><b>Bioassay</b>-Introduction, methods of biological assay, principles of biological assays-methods used in bioassay of vitamins, hormones, vaccines, cardiac drugs and other pharmacopeial preparations. Zebrafish model to screen pharmaceutical molecules.</p> <p><b>Organization of Screening for the pharmacological activity of new substances.</b> Anti-inflammatory agents-carrageenan induced paw oedema, cotton pellet method. Anticonvulsants: Convulsions induced by chemicals, induced by electroshock, combined procedures. Sympathomimetic agents: Mydriasis, the uterus and ascending colon of the rat.</p>	<b>15</b>	CO1, CO2, CO3  K1, K2, K3, K4
<b>Module 2:</b>	<p><b>Toxicology:</b> Definition and types of toxicology, basic principles of toxicology, carcinogenicity, mutagenicity, teratogenicity, acute, sub-acute and chronic toxicity. Detailed toxicity (mild/moderate/severe toxicology wherever applicable) and treatment of drugs such as salicylates/ paracetamol, opium, quinine, ethyl alcohol, etc.</p> <p>Toxic chemicals in the environment, impact of toxic chemicals on enzymes. Biochemical effects of arsenic, lead mercury, cadmium, carbon monoxide, pesticides and carcinogens.</p>	<b>12</b>	CO1, CO2, CO3  K2, K3, K4
<b>Module 3:</b>	<p><b>Essentials of Analytical Toxicology</b> Physicochemical, biochemical &amp; genetic basis of toxicity; principle of toxicokinetic, mutagenesis and carcinogenesis. Behavioral, inhalation toxicity, hypersensitivity and immune response, range finding tests Acute, subacute and chronic toxicity studies. Classification of Toxins: Acute toxicity tests, determination of LD50 value. Subacute</p>	<b>10</b>	CO1, CO2, CO3  K2, K3, K4

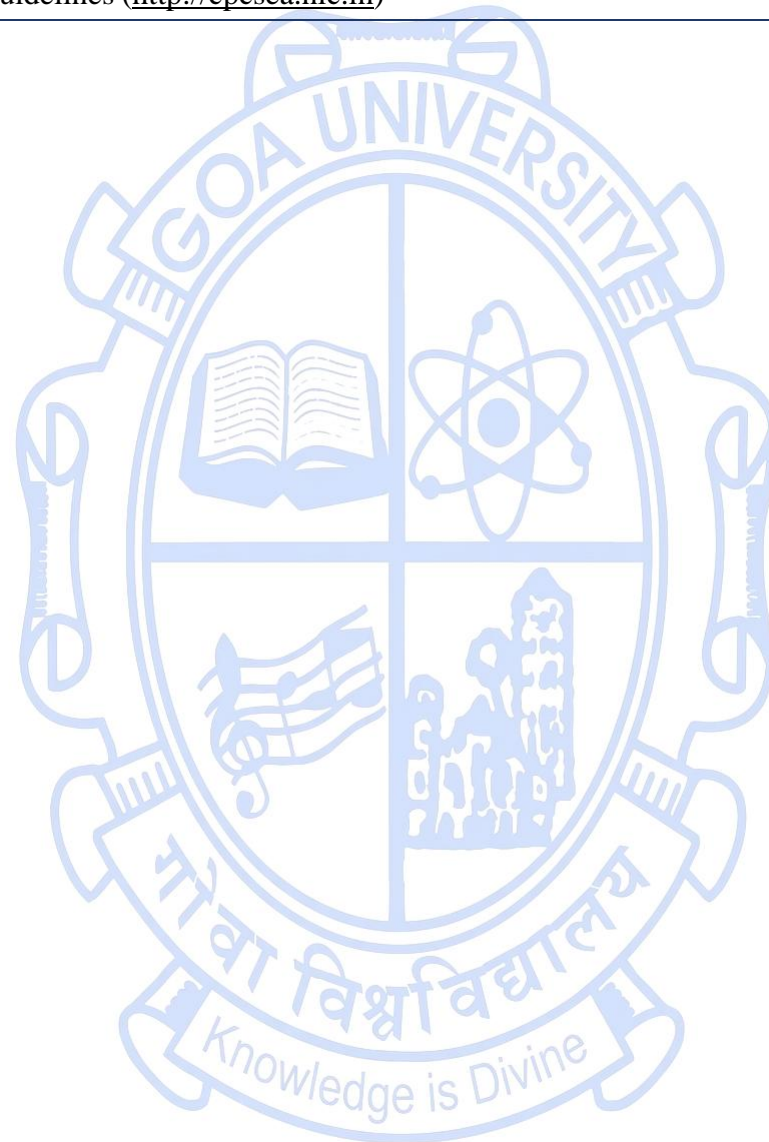
	tests - Histopathological and biochemical estimations on toxicity induced in animal models. Modern methods of analysis for toxins-barbiturate poisoning, amphetamine poisoning.			
<b>Module 4:</b>	<b>Applications of toxicology</b> Clinical toxicology, environmental toxicology/ ecotoxicology forensic toxicology/ post-mortem, toxicology industrial/occupational toxicology. Food toxicology, behavioral toxicology, preventive toxicology, descriptive toxicology, mechanistic toxicology, regulatory toxicology, genetic toxicology, systemic toxicology.	<b>08</b>	CO1, CO2, CO3	K2, K3, K4
<b>Module 5:</b>	<b>Pharmacovigilance</b> Introduction to pharmacovigilance, history and development of pharmacovigilance, importance of safety monitoring of medicine, WHO international drug monitoring programme, Pharmacovigilance Program of India (PvPI), Introduction to adverse drug reactions, Definitions and classification of ADRs, detection and reporting, methods in causality assessment, severity and seriousness assessment, predictability and preventability assessment, management of adverse drug reactions, basic terminologies used in pharmacovigilance, terminologies of adverse medication related events, regulatory terminologies, <b>Drug and disease classification</b> Anatomical, therapeutic and chemical classification of drugs, international classification of diseases, daily defined doses, International Non-proprietary, Names for drugs Drug dictionaries and coding in pharmacovigilance, WHO adverse reaction terminologies, MedDRA and Standardized MedDRA queries, WHO drug dictionary, EudraVigilance medicinal product dictionary Information resources in pharmacovigilance	<b>15</b>	CO4	K2, K3, K4
<b>Pedagogy:</b>	Mainly lectures, videos 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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. A. K. De, Environment Chemistry, Wiley Eastern Ltd., New Delhi, 2003.</li> <li>2. B. K. Sharma, Industrial Chemistry, 1st Ed., Narosa Publishing House, New Delhi, 1998.</li> <li>3. B. L. Strom, S. E. Kimmel, and S. Hennessy, Textbook of Pharmacoepidemiology, John Wiley &amp; Sons Ltd., Hoboken, 2021.</li> </ol>			

	<ol style="list-style-type: none"> <li>4. G. P. Mohanta and P. K. Manna, Textbook of Pharmacovigilance: Concept and Practice, 2nd Ed., Pharma Med Press, Hyderabad, 2020.</li> <li>5. G. Parthasarathi, K. Nyfort-Hansen, and M. C. Nahata, A Textbook of Clinical Pharmacy Practice – Essential Concepts and Skills, 1st Ed., Universities Press, Hyderabad, 2007.</li> <li>6. H. P. Rang and M. A. Dale, Pharmacology, Elsevier Health Sciences Division, London, 2011.</li> <li>7. J. Talbot and P. Waller, Stephens' Detection of New Adverse Drug Reactions, Wiley Publishers, Chichester, 2003.</li> <li>8. L. S. Goodman and A. Gillman, The Pharmacological Basis of Therapeutics, McGraw-Hill Professional Publishing, New York, 2010.</li> <li>9. M. V. Krishnan, Safety Management in Industries, Jaico Publishers, Mumbai, 2002.</li> <li>10. R. K. Trivedi and P. K. Goel, Chemical and Biological Methods for Water Pollution Studies, Environment Publications, Karad (India), 1984.</li> <li>11. R. S. Satoskar and S. D. Bhandarkar, Pharmacology and Pharmacotherapeutics, Popular Prakashan Ltd., Mumbai, 2006.</li> <li>12. S. K. Gupta, Textbook of Pharmacovigilance, 2nd Ed., Jaypee Brothers Medical Publishers, New Delhi, 2019.</li> <li>13. S. K. Gupta, U. Singh, and T. Velpandian, Analytical Toxicology for Poisoning Management and Toxicovigilance, Varosa Publishing House, New Delhi, 2002.</li> <li>14. S. K. Kulkarni, Handbook of Experimental Pharmacology, Vallabh Prakashan, Delhi, 1993.</li> <li>15. Y. Munjal, API Textbook of Medicine, Jaypee Brothers Medical Publishers Pvt., New Delhi, 2015.</li> </ol>
<p><b>References/ Readings:</b></p>	<ol style="list-style-type: none"> <li>1. B. Cobert and P. Biron, Practical Drug Safety from A to Z, Jones &amp; Bartlett Publishers, Burlington, 2017.</li> <li>2. B. Cobert, Cobert's Manual of Drug Safety and Pharmacovigilance, 3rd Ed., Jones &amp; Bartlett Publishers, Burlington, 2019.</li> <li>3. E. G. C. Clarke, Isolation and Identification of Drugs, Body Fluids and Post-Mortem Material, The Pharmaceutical Press, London, 1986.</li> <li>4. P. Waller, An Introduction to Pharmacovigilance, Wiley Publishers, Chichester, 2017.</li> <li>5. R. S. Satoskar and S. D. Bhandarkar, Pharmacology and Pharmacotherapeutics, Popular Prakashan Ltd., Mumbai, 2006.</li> <li>6. W. Andrew, Pharmaceutical Manufacturing Encyclopaedia, Vols. I &amp; II, 3rd Ed., William Andrew Publishing, Norwich, 2007.</li> </ol>

**Web Resources:**

1. CPCSEA guidelines (<http://cpcsea.nic.in>)

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<b>Title of the Course</b>	GMP, GLP & Pharmaceutical Technology	
<b>Course Code</b>	CHH-6202	
<b>Number of Credits</b>	4	
<b>Theory/Practical</b>	Theory	
<b>Level</b>	500	
<b>Effective from AY</b>	2026-2027	
<b>New Course</b>	No	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To learn cGMP &amp; GLPs concepts in pharmaceutical industries.</li> <li>2. To understand the roles of quality control and quality assurance in pharmaceutical industries.</li> <li>3. To prepare documentation in pharmaceutical industry.</li> <li>4. To describe the pharmaceutical unit operations and processes involved in industrial drug manufacturing.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to	<b>Mapped to PSO</b>
	CO1. explain the principles, elements, and expectations of GMP, GLP, and GCP.	PSO1, PSO2
	CO2. analyse the organizational structure, personnel roles, documentation systems, and quality control procedures.	PSO2, PSO3
	CO3. apply unit operations and unit processes in drug production.	PSO2, PSO3, PSO6

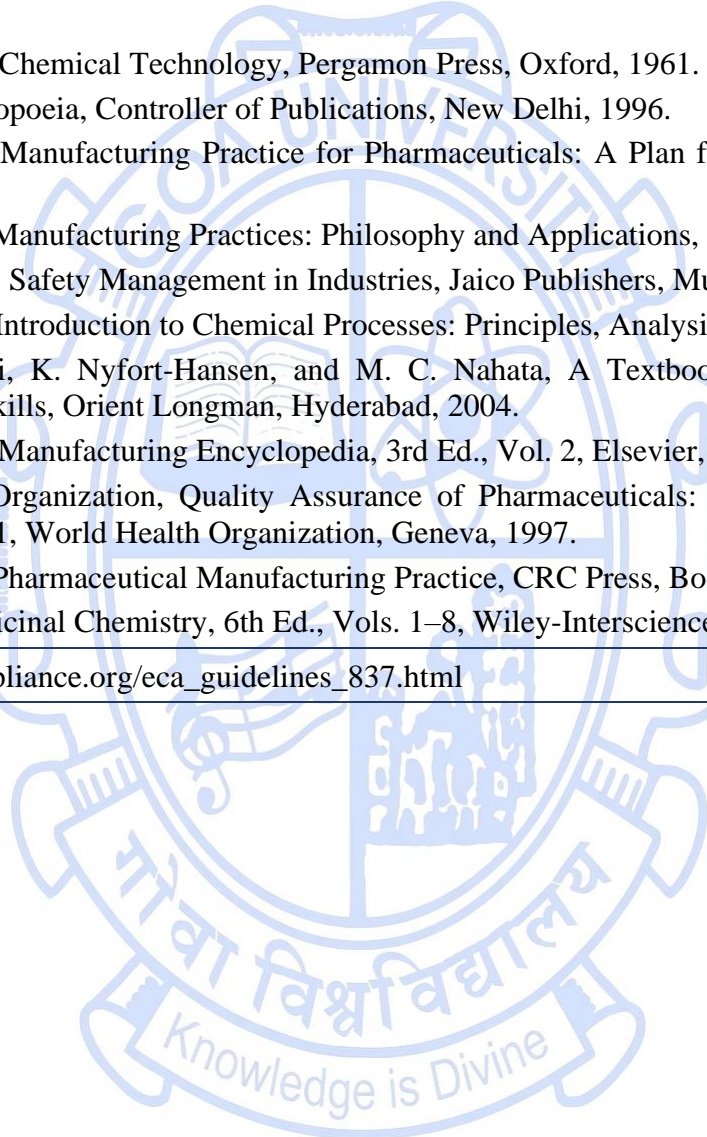
	CO4. evaluate the role of quality assurance, regulatory documentation, and Good Documentation Practices in the manufacturing and approval of pharmaceutical products.		PSO6, PSO8	PSO7,
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	<p><b>Good Manufacturing Practices</b> Introduction of GMP, drug laws and regulations, essential elements of GMP regulations, GMP expectations, characteristics of GMP products, legal consequences of GMP non-compliance. Philosophy of c-GMP &amp; GLPs. Organization and personnel, responsibilities, training, hygiene, personal records.</p> <p>Premises: location, Design, Plant layout, construction, maintenance, sanitation, environmental control, utilities &amp; services like gas, water, electricity. Maintains of sterile areas, control of contamination. Equipment; selection, purchase specifications. Raw material; purchase specifications, stores, selection of vendors, controls on raw materials. Five "Ps" of GMP; "Product", "Premise", "People", "Procedure", and "Process", Role of quality assurance in the pharmaceutical industry.</p>	<b>12</b>	CO1, CO2	K1, K2, K3, K4
<b>Module 2:</b>	<p><b>Good laboratory Practices</b> Good quality control Laboratory Practices (GLP): introduction and the reasoning behind the GLPs, Essential and required good laboratory practices (GLPs), GLP and GMP.</p> <p>Regulations for an analytical laboratory-21 CFR Part 11. Critical operational elements of analytical laboratories. Review GLPs and GMPs and their regulations for analytical labs. Roles and responsibilities of personnel, appropriate design and placement of laboratory equipment. Requirements for maintenance and calibration. ICH guidelines involved. Introduction to GCP and principles governing GCP.</p>	<b>12</b>	CO1, CO2	K1, K2, K3, K4
<b>Module 3:</b>	<p><b>Documentation in Pharmaceutical Industry</b> Importance of documentation - a regulatory requirement. Three tier documentation, Policy, procedures and work instructions, and records (Formats). Basic principles- how to maintain, retention and retrieval etc. Role, objective, and importance of standard operating procedures (SOPs) and its use in the pharmaceutical industry. Standard operating procedures (How to</p>	<b>12</b>	CO1, CO2, CO3	K2, K3, K4

	<p>write), Master batch record, batch manufacturing record, quality audit plan and reports. Specification and test procedures, protocols and reports. Distribution records. Electronic data handling.</p> <p>Concepts of controlled and uncontrolled documents. Submission documents for regulators DMFs, as common technical document and electronic common technical documentation (CTD, eCTD). Concept of regulated and non-regulated markets. Role, objective, and importance of certificate of analysis (CofA), certificate of manufacturing (CofM), and certificate of packaging (CofP). Objective and importance of incident reports, Stability process Investigation reports.</p>			
<b>Module 4:</b>	<p><b>Unit Operations</b></p> <p><b>Extraction:</b> Liquid equilibria, extraction with reflux, extraction with agitation, counter current extraction.</p> <p><b>Filtration:</b> Theory of filtration, pressure and vacuum filtration, centrifugal filtration,</p> <p><b>Distillation:</b> azeotropic and steam distillation</p> <p><b>Evaporation:</b> Types of evaporators, factors affecting evaporation.</p>	<b>08</b>	CO1, CO2, CO4	K2, K3, K4
<b>Module 5:</b>	<p><b>Unit Processes</b></p> <p><b>Nitration:</b> Nitrating agents, Aromatic nitration, kinetics and mechanism of aromatic nitration, process equipment for technical nitration, mixed acid for nitration,</p> <p><b>Halogenation:</b> Kinetics of halogenations, types of halogenations, catalytic halogenations. Case study on industrial halogenation process.</p> <p><b>Oxidation:</b> Introduction, types of oxidative reactions, Liquid phase oxidation with oxidizing agents. Non-metallic Oxidizing agents such as H<sub>2</sub>O<sub>2</sub>, sodium hypochlorite, Oxygen gas, ozonolysis.</p> <p><b>Reduction:</b> Catalytic hydrogenation, Heterogeneous and homogeneous catalyst; Hydrogen transfer reactions, Metal hydrides. Case study on industrial reduction process.</p> <p><b>Fermentation:</b> Aerobic and anaerobic fermentation. Production of Antibiotics; Penicillin and Streptomycin, Vitamins: B2 and B12 Statins: Lovastatin, Simvastatin.</p> <p><b>Reaction progress kinetic analysis.</b> Streamlining reaction steps, route selection, Characteristics of expedient routes, characteristics of cost-effective routes, reagent</p>	<b>16</b>	CO1, CO2, CO4	K2, K3, K4

	selection, families of reagents useful for scale-up.			
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. G. S. Banker and C. T. Rhodes, Modern Pharmaceutics, Marcel Dekker Inc., New York, 2005.</li> <li>2. H. A. Lieberman, L. Lachman, and J. B. Schwartz, Pharmaceutical Dosage Forms: Tablets, 2nd Ed., Vols. I–III, CBS Publishers and Distributors, New Delhi, 2005.</li> <li>3. K. G. Gadamasetti, Process Chemistry in Pharmaceutical Industries, Taylor &amp; Francis Group, London, 1999.</li> <li>4. K. R. Gadamasetti, Process Chemistry in the Pharmaceutical Industry: Challenges in an Ever-Changing Climate – An Overview, CRC Press, Boca Raton, 1999.</li> <li>5. L. Lachman, H. A. Lieberman, and J. L. Kanig, The Theory and Practice of Industrial Pharmacy, 3rd Ed., Varghese Publishers, Mumbai, 1991.</li> <li>6. M. D. Hynes III (Ed.), Pharmaceutical Pre-Approval Inspections: Guide to Regulatory Success, 2nd Ed., Informa Healthcare, New York, 2008.</li> <li>7. P. J. Sinko, Martin’s Physical Pharmacy and Pharmaceutical Sciences, 5th Ed., B. I. Publications Pvt. Ltd., Noida, 2006.</li> <li>8. R. N. Shreve, Chemical Process Industries, 5th Ed., McGraw-Hill Book Company, New York, 2000.</li> <li>9. S. B. Chandalia, Hand Book of Process Development, Multitech Publishing Company, Mumbai, 1998.</li> <li>10. S. Weinberg, Good Laboratory Practice Regulations, 3rd Ed., Marcel Dekker, New York, 2002.</li> <li>11. S. Willig and J. Stoker, Good Manufacturing Practices for Pharmaceuticals: A Plan for Quality Control, 4th Ed., Revised and Expanded, Marcel Dekker, New York, 1991.</li> <li>12. Y. Anjanayuli and R. Marayya, Quality Assurance and Quality Management in Pharma Industry, Pharma Book Syndicate, Hyderabad, 2005.</li> </ol>			
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. H. G. Brittain (Ed.), Polymorphism in Pharmaceutical Solids, Vol. 95, Marcel Dekker, New York, 1999.</li> <li>2. Government of India, Drug and Cosmetics Act, 1940 and Rules, 1945, Ministry of Health and Family Welfare, New Delhi.</li> <li>3. S. C. Gad, Pharmaceutical Manufacturing Handbook, John Wiley and Sons, New Jersey, 2008.</li> <li>4. P. H. Groggins, Unit Processes in Organic Synthesis, McGraw-Hill, New York, 1958.</li> </ol>			

	<ol style="list-style-type: none"> <li>5. P. J. Harrington, Pharmaceutical Process Chemistry for Synthesis: Rethinking the Routes to Scale-Up, Wiley, Hoboken, 2011.</li> <li>6. F. A. Henglein, Chemical Technology, Pergamon Press, Oxford, 1961.</li> <li>7. Indian Pharmacopoeia, Controller of Publications, New Delhi, 1996.</li> <li>8. J. Sharp, Good Manufacturing Practice for Pharmaceuticals: A Plan for Quality Control, CRC Press, Boca Raton, 2004.</li> <li>9. J. Sharp, Good Manufacturing Practices: Philosophy and Applications, Interpharma Press, Illinois, USA, 2004.</li> <li>10. M. V. Krishnan, Safety Management in Industries, Jaico Publishers, Mumbai, 2002.</li> <li>11. R. M. Murphy, Introduction to Chemical Processes: Principles, Analysis, Synthesis, McGraw-Hill, New York, 2011.</li> <li>12. G. Parthasarathi, K. Nyfort-Hansen, and M. C. Nahata, A Textbook of Clinical Pharmacy Practice: Essential Concepts and Skills, Orient Longman, Hyderabad, 2004.</li> <li>13. Pharmaceutical Manufacturing Encyclopedia, 3rd Ed., Vol. 2, Elsevier, Amsterdam, 2007.</li> <li>14. World Health Organization, Quality Assurance of Pharmaceuticals: A Compendium of Guidelines and Related Materials, Vol. 1, World Health Organization, Geneva, 1997.</li> <li>15. J. Sharp, Good Pharmaceutical Manufacturing Practice, CRC Press, Boca Raton, 2004.</li> <li>16. A. Burger, Medicinal Chemistry, 6th Ed., Vols. 1–8, Wiley-Interscience, New York, 2003.</li> </ol>
<b>Web Resources:</b>	<ol style="list-style-type: none"> <li>1. <a href="http://www.gmp.compliance.org/eca_guidelines_837.html">www.gmp.compliance.org/eca_guidelines_837.html</a></li> </ol>

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<b>Title of the Course</b>	Pharmaceutical Biotechnology and Forensic Science
<b>Course Code</b>	CHH-6203
<b>Number of Credits</b>	4
<b>Theory/Practical</b>	Theory
<b>Level</b>	500
<b>Effective from AY</b>	2026-2027
<b>New Course</b>	Yes
<b>Bridge Course/ Value added Course</b>	No
<b>Course for advanced learners</b>	No

<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>To introduce the fundamental concepts of biotechnology and forensic science.</li> <li>To provide knowledge of enzymes, biosensors, fermentation technology, and forensic analysis.</li> <li>To acquire knowledge of genetic engineering, immune system, fermentation technology and analytical techniques in forensic science.</li> <li>To equip learners with applied knowledge to integrate biotechnology and forensic science for pharmaceutical, clinical, and investigative purposes.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to	<b>Mapped to PSO</b>
	CO1. explain the principles and applications of biotechnology, genetic engineering, recombinant DNA technology and forensic science in medicine.	PSO1, PSO2
	CO2. classify types of immunity, vaccines, blood products, and poisons; and analyse their applications in healthcare and forensic science.	PSO2, PSO3

	CO3. apply the knowledge of biotechnology and forensic approaches to address challenges in healthcare, diagnostics, and legal investigations.		PSO2, PSO6	PSO3,
	CO4. evaluate the modern forensic methods and analytical tools for the detection of drugs, toxins, and biological evidence.		PSO6, PSO8	PSO7,
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	<b>Pharmaceutical Biotechnology</b> Brief introduction to Biotechnology with reference to pharmaceutical sciences, enzyme biotechnology- methods of enzyme immobilization and applications. Biosensors- Working and applications of biosensors in pharmaceutical industries. Brief introduction to protein engineering. Use of microbes in industry. Production of enzymes- general consideration - amylase, catalase, peroxidase, lipase, protease, penicillinase.	<b>08</b>	CO1, CO2, CO3	K1, K2, K3, K4
<b>Module 2:</b>	<b>Genetic engineering</b> Study of cloning vectors, restriction endonucleases and DNA ligase. Recombinant DNA technology. Application of genetic engineering in medicine. Application of r DNA technology and genetic engineering in the production of: i) Interferon ii) Vaccines- hepatitis- B iii) Hormones-Insulin. Brief introduction to PCR.	<b>08</b>	CO1, CO2, CO3	K2, K3, K4, K5, K6
<b>Module 3:</b>	<b>Immunity</b> Types of immunity- humoral immunity, cellular immunity, Structure of Immunoglobulins, Structure and Function of MHC c) Hypersensitivity reactions, Immune stimulation and Immune suppressions. General method of the preparation of bacterial vaccines, toxoids, viral vaccine, antitoxins, serum-immune blood derivatives and other products relative to immunity. Storage conditions and stability of official vaccines. Hybridoma technology- Production, Purification and Applications. Blood products and Plasma Substitutes.	<b>08</b>	CO1, CO2, CO3, CO4	K2, K3, K4, K5
<b>Module 4:</b>	<b>Fermentation techniques</b> Fermentation methods and general requirements, study of media, equipments,	<b>08</b>	CO1, CO2,	K2, K3, K4, K5

	sterilization methods, aeration process, stirring. Large scale production fermenter design and its various controls. Study of the production of - penicillins, citric acid, vitamin B12, glutamic acid, griseofulvin, blood products: collection, processing and storage of whole human blood, dried human plasma, plasma substitutes.		CO3	
<b>Module 5:</b>	<b>Forensic Analysis and Forensic Toxicology</b> Introduction to forensic science, role of a forensic scientist, theory of forensic analysis: comparative analysis. Classification of poisons based on physical states; study of common poison; mode of action, chemical properties; methods of administration and their action in the body. Analysis of drug of abuse: opiates, hallucinogens, depressants, stimulants and club drugs; breath testing of alcohol, collection and preservation of drug evidence, qualitative and quantitative analysis by colour tests, microcrystalline tests. Simultaneous analysis of multianalytes.	<b>10</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4
<b>Module 6:</b>	<b>Forensic Analysis of Biological Samples</b> Analysis of biological samples (Qualitative and Quantitative): Blood, semen, urine and saliva. Blood spatter analysis, DNA analysis. Hairs and fiber analysis, fingerprint analysis; Isolation, sample preparation.	<b>08</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
<b>Module 7:</b>	<b>Physical and Chemical Methods of Analysis in Forensic Science</b> Forensic analysis of explosives and gunshot residues, paints, arsons, and questioned documents. Lie detection – introduction, process, merits and demerits. Application of mass, GC-MS, FT-IR, SEM in forensic analysis. Applications of nondestructive testing probes including radiography, Xera– radiography Surface penetrations methods (SEM and Laser Probes), application of spectroscopic, chromatographic techniques such as GC-MS, FT-IR, UV-Visible spectroscopy, Atomic Absorption spectroscopy for forensic sample analysis.	<b>10</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
<b>Pedagogy:</b>	Lectures/ tutorials/ project work/ industry visits/viva/seminars/ term papers/assignments/ presentations/ self-study/Case Studies etc. or a combination of some of these. Session shall be interactive in nature to enable peer group learning.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. A. K. Sharma, Immunology: An Introductory Textbook, Pan Stanford Publishing Ltd., Singapore, 2019.</li> <li>2. A. Lucas, Forensic Chemistry, Forgotten Books, London, 2017.</li> </ol>			

	<ol style="list-style-type: none"> <li>3. D. S. T. Nicholl, An Introduction to Genetic Engineering, 3rd Ed., Cambridge University Press, Cambridge, 2008.</li> <li>4. F. A. Khan, Biotechnology Fundamentals, 3rd Ed., CRC Press, Boca Raton, 2020.</li> <li>5. J. A. Owen, J. Punt, S. A. Stranford, and P. P. Jones, Kuby Immunology, 7th Ed., W. H. Freeman &amp; Co., New York, 2013.</li> <li>6. K. Sambamurthy, Pharmaceutical Biotechnology: Fundamentals and Applications, New Age International (P) Ltd., New Delhi, 2006.</li> <li>7. O. R. Zaborsky, Immobilized Enzymes, CRC Press, Boca Raton, 1973.</li> <li>8. P. F. Stanbury, A. Whitaker, and S. J. Hall, Principles of Fermentation Technology, 2nd Ed., Butterworth-Heinemann, Oxford, 1995.</li> <li>9. R. Saferstein, Criminalistics: An Introduction to Forensic Sciences, Pearson Education, London, 2015.</li> <li>10. S. B. Primrose, Molecular Biotechnology, 2nd Ed., Blackwell Scientific Publications, Oxford, 1989.</li> </ol>
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. B. R. Glick and J. J. Pasternak, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Ed., ASM Press, Washington, D.C., 2010.</li> <li>2. C. Kokate, P. H. J. Pramod, and S. S. Jalalpure, Textbook of Pharmaceutical Biotechnology, Elsevier Health Sciences, New Delhi, 2011.</li> <li>3. D. J. A. Crommelin, R. D. Sindelar, and B. Meibohm, Pharmaceutical Biotechnology: Fundamentals and Applications, Springer Science &amp; Business Media, New York, 2013.</li> <li>4. D. J. A. Crommelin, R. D. Sindelar, and B. Meibohm, Pharmaceutical Biotechnology, 6th Ed., Springer International Publishing AG, Cham, 2024.</li> <li>5. G. Subramanian (Ed.), Biopharmaceutical Production Technology, Wiley-VCH, Weinheim, 2012.</li> <li>6. G. Walsh, Pharmaceutical Biotechnology: Concepts and Applications, John Wiley &amp; Sons Inc., Chichester, 2011.</li> <li>7. H. Harris and H. C. Lee, Introduction to Forensic Science and Criminalistics, 2nd Ed., CRC Press, Boca Raton, 2019.</li> <li>8. J. M. Walker and R. Rapley (Eds.), Molecular Biology and Biotechnology, 5th Ed., Royal Society of Chemistry, Cambridge, 2009.</li> <li>9. J. W. Goding, Monoclonal Antibodies: Principles and Practice, 3rd Ed., Academic Press, San Diego, 1996.</li> <li>10. M. M. Houck, Forensic Chemistry, Academic Press, London, 2015.</li> <li>11. R. A. Goldsby, T. J. Kindt, B. A. Osborne, and J. Kuby, Kuby Immunology, 6th Ed., W. H. Freeman, New York, 2007.</li> </ol>

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<b>Title of the Course</b>	Advance Pharmaceutical Chemistry-II
<b>Course Code</b>	CHH-6204
<b>Number of Credits</b>	4
<b>Theory/Practical</b>	Theory
<b>Level</b>	500
<b>Effective from AY</b>	2026-2027
<b>New Course</b>	Yes
<b>Bridge Course/ Value added Course</b>	No
<b>Course for advanced learners</b>	No

<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To provide comprehensive knowledge of peptidomimetics, natural products, and bioinorganic compounds.</li> <li>2. To explain drug-receptor interactions, molecular targets, and analytical techniques in pharmaceutical research.</li> <li>3. To impart understanding of bioinorganic and inorganic pharmaceuticals, nitric oxide signalling, and metal-based drug design.</li> <li>4. To develop the ability to design, evaluate, and strategize against drug resistance using modern tools such as combinatorial chemistry.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to	<b>Mapped to PSO</b>
	CO1. explain the concepts of peptidomimetics, lead compounds, receptors and bioinorganic compounds in pharmacy.	PSO1, PSO2
	CO2. classify the pharmacological role of peptidomimetics, drug receptors and bioinorganic compounds.	PSO2, PSO3

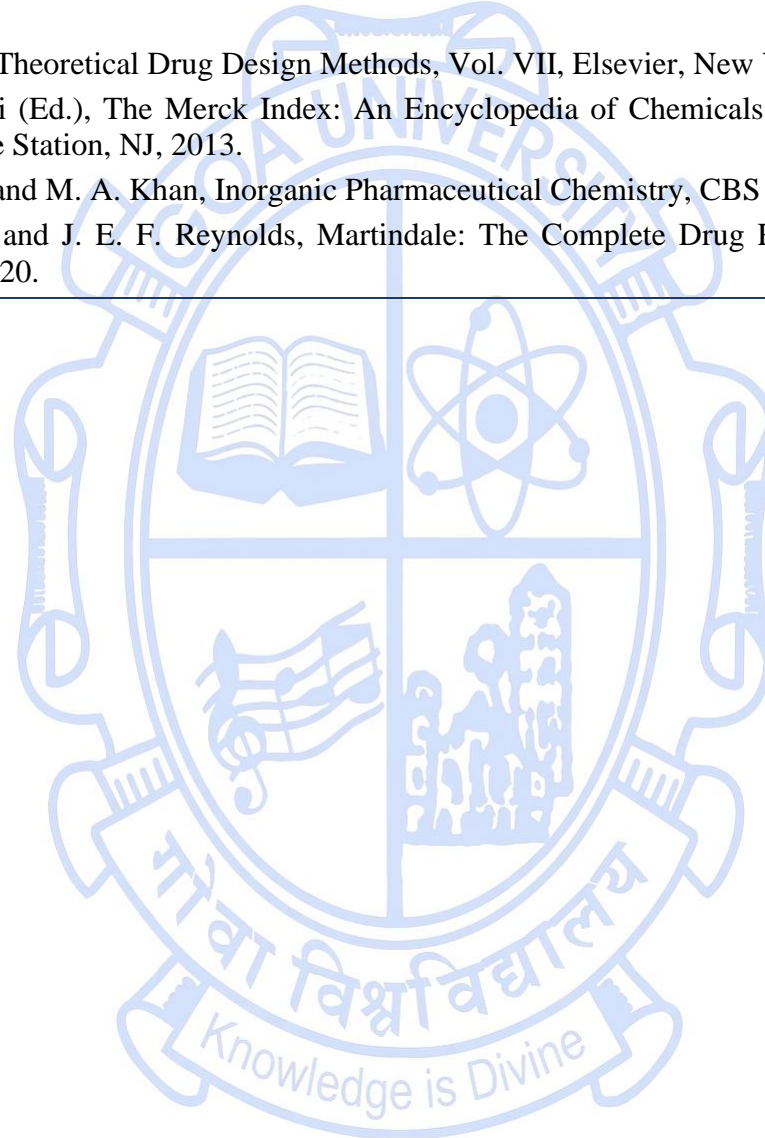
	CO3. apply cellular and molecular mechanisms for drug design and analysis		PSO2, PSO3, PSO6	
	CO4. analyse the strategies to improve the therapeutic effect and combat drug resistance by integrating concepts of medicinal chemistry		PSO6, PSO7, PSO8	
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b>	<b>Cognitive Level</b>
<b>Module 1:</b>	<p><b>Peptidomimetics chemistry</b></p> <p><b>Peptidomimetics:</b> Introduction, Therapeutic values of Peptidomimetics, design of peptidomimetics by manipulation of the amino acids, modification of the peptide backbone, incorporating conformational constraints locally or globally. Chemistry, biosynthesis, physiological role and pharmacological and therapeutic importance of prostaglandins, leukotrienes and thromboxones.</p>	<b>10</b>	CO1, CO2, CO3	K1, K2, K3, K4
<b>Module 2:</b>	<p><b>Study of natural products as leads for new pharmaceuticals for the following class of drugs</b></p> <p>Drugs affecting the central nervous system: morphine alkaloids.</p> <p>Anticancer drugs: paclitaxel and docetaxel, etoposide, and teniposide.</p> <p>Cardiovascular drugs: lovastatin, teprotide and dicoumarol.</p> <p>Neuromuscular blocking drugs: curare alkaloids.</p> <p>Anti-malarial drugs and analogues: chemistry of macrolide antibiotics (erythromycin, azithromycin, roxithromycin, and clarithromycin) and <math>\beta</math>-lactam antibiotics (cephalosporins and carbapenem)</p>	<b>12</b>	CO2, CO3, CO4	K1, K2, K3, K4
<b>Module 3:</b>	<p><b>Concept of receptors, structure of cell membrane and radioimmunoassay</b></p> <p>Introduction, targets, agonist, antagonist, partial agonist. receptors, Receptor types, Some novel molecular targets along with their pharmacodynamic agents: Polyketide synthase (Pks13), signal transducer and activator of transcription-3 (STAT-3) and sodium glucose cotransporter-2 (SGLT-2)</p> <p><b>Structure of cell membrane-</b> lipids, membrane proteins, membrane carbohydrates, passage through membrane and drug action that effects the structure of cell membranes</p>	<b>12</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4

	(antifungal, antibacterial and local anaesthetics). <b>Radioimmunoassay-</b> ELISA test, Radioimmunoassay of digitalis and insulin.			
<b>Module 4:</b>	<p><b>Medicinal applications of bioinorganic compounds</b> Metal complexes in medicine- cisplatin and its mode of action. gold and lithium compounds as drugs - metal complexes as probes of nucleic acid, metal ions in genetic regulations, metal dna and rna interaction – potential binding sites.</p> <p><b>Inorganic pharmaceuticals:</b> Pharmaceutical formulations, market preparations, storage conditions and uses of Haematinics: ferrous sulphate, ferrous fumarate, ferric ammonium citrate, ferrous ascorbate, carbonyl iron. Gastro-intestinal agents: antacids: aluminium hydroxide gel, magnesium hydroxide, magaldrate, sodium bicarbonate, calcium carbonate, acidifying agents, adsorbents, protectives, cathartics. Topical agents: silver nitrate, ionic silver, chlorhexidine gluconate, hydrogen peroxide, boric acid, bleaching powder, potassium permanganate. Dental products: calcium carbonate, sodium fluoride, denture cleaners, denture adhesives, mouth washes Medicinal gases: carbon dioxide, nitrous oxide, oxygen.</p>	<b>14</b>	CO1, CO2, CO3	K1, K2, K3, K4
<b>Module 5:</b>	<p><b>Nitric Oxide (Second Messenger)</b> Introduction, chemical properties of nitric oxide, reaction of nitric oxide with metals, interplay between the reactions of nitric oxide in biological systems, nitric oxide synthetase isoenzymes, mechanism of NOS-mediated nitric oxide biosynthesis, NOS inhibitors, cytotoxic role of nitric oxide, therapeutic significance of NOS inhibitors and nitric oxide.</p> <p><b>Combating drug resistance:</b> Causes for drug resistance, strategies to combat drug resistance in antibiotics and anticancer therapy, Genetic principles of drug resistance.</p>	<b>12</b>	CO1, CO2, CO3	K1, K2, K3, K4
<b>Pedagogy:</b>	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.
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. A. E. Goodman, Handbook of Pharmaceutical Chemistry and Drug Data, CRC Press, Boca Raton, 2018.</li> <li>2. B. G. Katzung, S. B. Masters, and A. J. Trevor, Basic and Clinical Pharmacology, 15th Ed., McGraw-Hill, New York, 2021.</li> <li>3. B. K. Sharma, Inorganic Pharmaceutical Chemistry, Latest Ed., Krishna Prakashan Media, Meerut, 2015.</li> <li>4. G. L. Patrick, An Introduction to Medicinal Chemistry, 6th Ed., Oxford University Press, Oxford, 2021.</li> <li>5. G. Thomas, Medicinal Chemistry: An Introduction, 2nd Ed., Wiley India Pvt. Ltd., New Delhi, 2008.</li> <li>6. H. P. Rang, M. M. Dale, J. M. Ritter, and R. J. Flower, Rang &amp; Dale's Pharmacology, 9th Ed., Elsevier, London, 2020.</li> <li>7. H. Singh and V. K. Kapoor, Medicinal and Pharmaceutical Chemistry, 3rd Ed., Vallabh Prakashan, Delhi, 2012.</li> <li>8. J. M. Beale and J. H. Block, Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, 12th Ed., Lippincott Williams &amp; Wilkins, Philadelphia, 2011.</li> <li>9. M. E. Wolff (Ed.), Burger's Medicinal Chemistry and Drug Discovery: Principles and Practice, 8th Ed., John Wiley &amp; Sons, Hoboken, 2021.</li> <li>10. T. Nogrady, Medicinal Chemistry: A Molecular and Biochemical Approach, 3rd Ed., Oxford University Press, Oxford, 2006.</li> <li>11. W. O. Foye, T. L. Lemke, and D. A. Williams, Foye's Principles of Medicinal Chemistry, 8th Ed., Lippincott Williams &amp; Wilkins, Philadelphia, 2020.</li> </ol>
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. A. F. Holleman and E. Wiberg, Inorganic Chemistry, 3rd Ed., Academic Press, San Diego, 2001.</li> <li>2. A. Guarna and A. Trabocchi, Peptidomimetics in Organic and Medicinal Chemistry, 1st Ed., Wiley, Hoboken, 2014.</li> <li>3. D. Lednicer, Strategies for Organic Drug Synthesis and Design, Wiley-Interscience, Hoboken, 2008.</li> <li>4. J. G. Hardman, L. E. Limbird, and A. G. Gilman (Eds.), Goodman &amp; Gilman's The Pharmacological Basis of Therapeutics, 13th Ed., McGraw-Hill, New York, 2017.</li> <li>5. J. P. Remington, Remington: The Science and Practice of Pharmacy, 22nd Ed., Lippincott Williams &amp; Wilkins, Philadelphia, 2012.</li> <li>6. J. S. Fruton, General Principles of Medicinal Chemistry, 2nd Ed., Wiley, New York, 2002.</li> </ol>

7. R. B. Silverman, The Organic Chemistry of Drug Design and Drug Action, 4th Ed., Academic Press, London, 2026.
8. R. Franke, Theoretical Drug Design Methods, Vol. VII, Elsevier, New York, Latest Ed.
9. S. Budavari (Ed.), The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals, 15th Ed., Merck, Whitehouse Station, NJ, 2013.
10. S. Firdous and M. A. Khan, Inorganic Pharmaceutical Chemistry, CBS EPublishers, New Delhi, 2010.
11. W. Allday and J. E. F. Reynolds, Martindale: The Complete Drug Reference, 40th Ed., Pharmaceutical Press, London, 2020.

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<b>Title of the Course</b>	Pharmacotherapeutics
<b>Course Code</b>	CHH-6205
<b>Number of Credits</b>	4
<b>Theory/Practical</b>	Theory
<b>Level</b>	500
<b>Effective from AY</b>	2026-2027
<b>New Course</b>	No
<b>Bridge Course/ Value added Course</b>	No
<b>Course for advanced learners</b>	No

<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To understand the different approaches to treat and manage various disease conditions.</li> <li>2. To acquire knowledge and skills in optimizing drug therapy of a patient by personalizing the treatment.</li> <li>3. To describe the therapeutic approach for management of various diseases.</li> <li>4. To study the rationale for drug therapy and plan through evidence-based medicines.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to	<b>Mapped to PSO</b>
	CO1. explain the pathophysiology, clinical features, and management of central nervous system and psychiatric disorders.	PSO1, PSO2
	CO2. prepare individualized therapeutic plans based on diagnosis, medicine therapy, and monitoring therapy.	PSO2, PSO3
	CO3. apply aetiology, pathogenesis, and rational pharmacotherapy of infectious and neglected tropical diseases.	PSO2, PSO3, PSO6

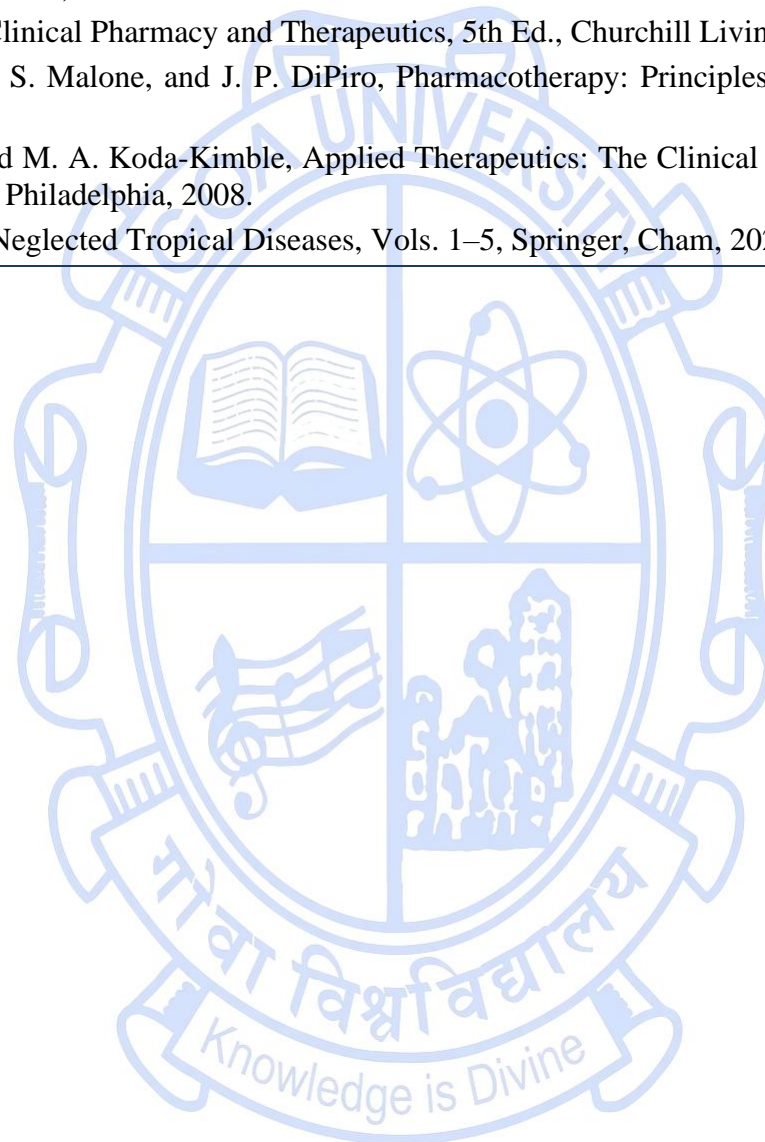
	CO4. evaluate the pharmacotherapy of oncological, musculoskeletal, dermatological, ophthalmic, and gynaecological diseases.		PSO6, PSO7, PSO8
<b>Content:</b>		<b>No of hours</b>	<b>Mapped to CO</b> <b>Cognitive Level</b>
<b>Module 1:</b>	<b>Diseases of central nervous system</b> Epilepsy, Parkinson's disease, stroke, Headache, alzheimer's disease, neuralgias and pain pathways and pain management. Psychiatric disorders: schizophrenia, depression, anxiety disorders, sleep disorders, drug induced psychiatric disorders.	<b>10</b>	CO1, CO2, CO3 K1, K2, K3, K4
<b>Module 2:</b>	<b>Infectious diseases</b> General guidelines for the rational use of antibiotics and surgical prophylaxis, urinary tract infections, respiratory tract infections, Gastroenteritis, tuberculosis, malaria, bacterial endocarditis, septicaemia. meningitis, HIV and opportunistic infections, rheumatic fever, dengue fever, H1N1, helminthiasis, fungal infections. Neglected tropical diseases: leishmaniasis, schistosomiasis, chagas, sleeping sickness.	<b>10</b>	CO1, CO2, CO3 K2, K3, K4
<b>Module 3:</b>	<b>Diseases of cardiovascular and respiratory system</b> Hypertension, Congestive cardiac failure, Acute coronary syndrome, Arrhythmias, Hyperlipidaemias, Asthma, Chronic obstructive airways disease, Drug induced pulmonary diseases. Case study on Combined Cardiovascular and Respiratory ( <b>any 2</b> ).	<b>10</b>	CO1, CO2, CO3 K2, K3, K4
<b>Module 4:</b>	<b>Diseases of gastrointestinal system and Polycystic Ovarian Disease</b> <b>gastrointestinal system:</b> Peptic ulcer diseases, Reflux esophagitis, Inflammatory bowel diseases, Jaundice & hepatitis, Cirrhosis, Diarrhoea and Constipation, Drug-induced liver disease, Alcoholic liver disease. <b>Polycystic Ovarian Disease:</b> Genetics of Polycystic Ovary Syndrome, Ovarian Dysfunction in Polycystic Ovary Syndrome (PCOS)	<b>08</b>	CO1, CO2, CO3 K2, K3, K4
<b>Module 5:</b>	<b>Oncological disorders</b> <b>Oncological:</b> General principles of cancer chemotherapy, pharmacotherapy of breast cancer, lung cancer, head & neck cancer, haematological malignancies, management of	<b>10</b>	CO1, CO2, CO3, K2, K3, K4

	nausea and vomiting, Palliative care. Case study on gastrointestinal system ( <b>any 2</b> ).		CO4	
<b>Module 6:</b>	<p><b>Other Diseases</b></p> <p>Bone and joint: Rheumatoid arthritis, osteoarthritis, gout, osteoporosis. Dermatological Diseases: Psoriasis, eczema and scabies, impetigo, drug induced skin disorders. Ophthalmology: Conjunctivitis, glaucoma.</p> <p>Diseases of renal system: Acute renal failure, chronic renal failure, renal dialysis, drug induced renal disease. Gynaecological disorders: Dysmenorrhea, hormone replacement therapy. Endocrine system: Diabetes Mellitus, thyroid diseases. Haematological diseases: Anaemia, deep vein thrombosis, drug induced haematological disorders.</p>	<b>12</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5
<b>Pedagogy:</b>	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.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. Avery's Drug Treatment, 4th Ed., Adis International Limited, Auckland, 1997.</li> <li>2. C. M. Porth, Principles of Pathophysiology, 3rd Ed., Lippincott Williams and Wilkins, Philadelphia, 2010.</li> <li>3. E. T. Herfindal, Clinical Pharmacy and Therapeutics, 3rd Ed., Lippincott Williams and Wilkins, Philadelphia, 1984.</li> <li>4. Harrison's Principles of Internal Medicine, Vols. 1–2, 20th Ed., McGraw-Hill Publications, New York, 2018.</li> <li>5. J. T. DiPiro, G. C. Yee, S. T. Haines, T. D. Nolin, V. L. Ellingrod, and L. M. Posey, Pharmacotherapy: A Pathophysiologic Approach, 12th Ed., McGraw-Hill Education, New York, 2014.</li> <li>6. J. T. DiPiro, Pharmacotherapy: A Pathophysiologic Approach, 7th Ed., McGraw-Hill Publishers, New York, 2008.</li> <li>7. R. S. Satoskar, N. Rege, and S. D. Bhandarkar, Pharmacology and Pharmacotherapeutics, Elsevier Health Sciences, New Delhi, 2017.</li> <li>8. S. L. Robbins, Pathologic Basis of Disease, 9th Ed., W. B. Saunders, Philadelphia, 2014.</li> <li>9. V. P. Arcangelo, A. M. Peterson, V. Wilbur, and J. A. Reinhold, Pharmacotherapeutics for Advanced Practice, 4th Ed., Lippincott Williams and Wilkins, Philadelphia, 2016.</li> </ol>			
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. L. L. Brunton, B. C. Knollmann, and R. Hilal-Dandan (Eds.), Goodman &amp; Gilman's The Pharmacological Basis of Therapeutics, 13th Ed., McGraw-Hill Education, New York, 2018.</li> <li>2. R. Mannhold and H. Buschmann, Neglected Tropical Diseases Drug Discovery and Development, Vol. 37, John Wiley &amp; Sons, Hoboken, 2019.</li> <li>3. R. Walker and C. Whittlesea, Clinical Pharmacy and Therapeutics, 5th Ed., Churchill Livingstone, Elsevier Health</li> </ol>			

Sciences, London, 2011.

4. R. Walker, Clinical Pharmacy and Therapeutics, 5th Ed., Churchill Livingstone, London, 2012.
5. C. B. Wells, S. Malone, and J. P. DiPiro, Pharmacotherapy: Principles and Practice, 4th Ed., McGraw-Hill, New York, 2016.
6. L. Young and M. A. Koda-Kimble, Applied Therapeutics: The Clinical Use of Drugs, 9th Ed., Lippincott Williams and Wilkins, Philadelphia, 2008.
7. P. J. Hotez, Neglected Tropical Diseases, Vols. 1–5, Springer, Cham, 2022.

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<b>Title of the Course</b>	Pharmaceutical Chemistry Practical-V
<b>Course Code</b>	CHH-6206
<b>Number of Credits</b>	4
<b>Theory/Practical</b>	Practical
<b>Level</b>	500
<b>Effective from AY</b>	2026-2027
<b>New Course</b>	Yes
<b>Bridge Course/ Value added Course</b>	No
<b>Course for advanced learners</b>	No

<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To translate certain theoretical concepts learnt earlier into experimental knowledge.</li> <li>2. To learn formulation, isolation, synthesis of medicinal</li> <li>3. To learn chemical analysis method and QSAR studies of drugs.</li> <li>4. To acquire hands on experience in chemical and computational laboratory techniques.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to	<b>Mapped to PSO</b>
	CO1. explain the theoretical aspects of drug synthesis, analysis and computational studies.	PSO1, PSO3
	CO2. synthesize and formulate various chemical moieties in small scale.	PSO1, PSO2, PSO4
	CO3. analyse drugs using various invitro methods	PO3, PSO6
	CO4. evaluate the percentage purity, physicochemical properties, bioactivity, quality and quantity of pharmaceutical or chemical substances.	PSO6, PSO7, PSO8

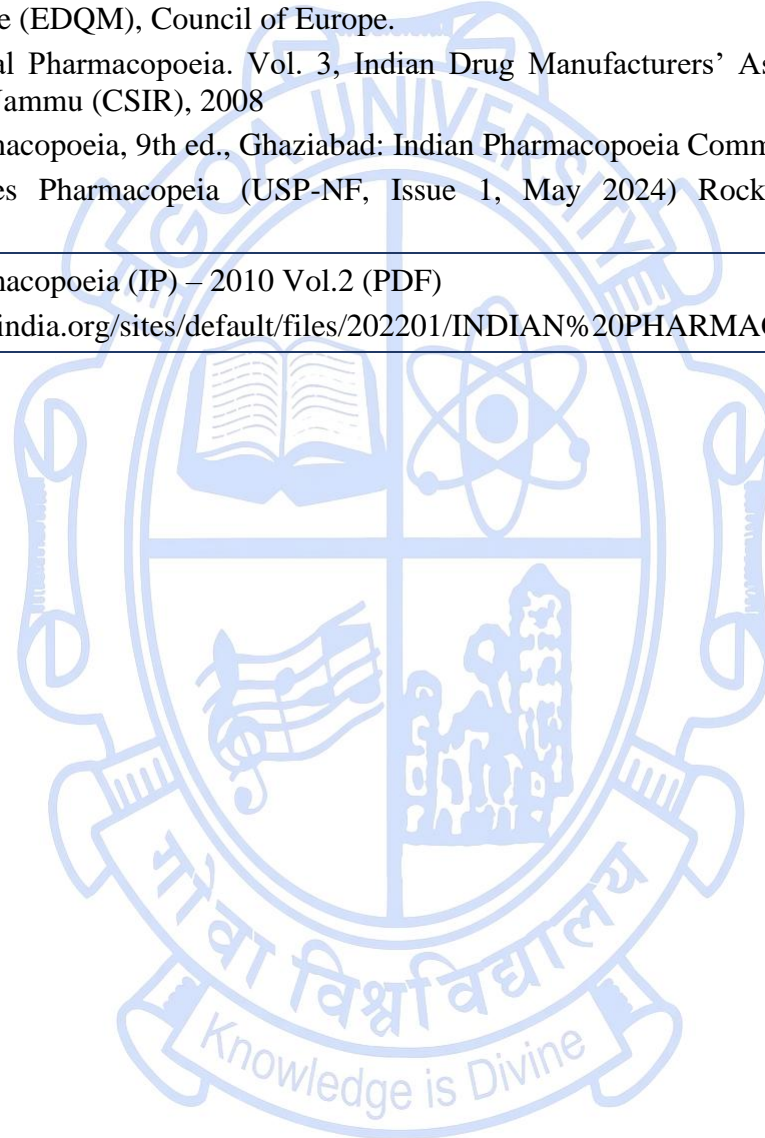
Content:		No of hours	Mapped to CO	Cognitive Level
<b>Module 1:</b>	<b>Formulation and labelling of pharmaceutical dosage as per cGMP Guidelines (Minimum 5 experiments of 4h each)</b> <ol style="list-style-type: none"> <li>i. Concentrated Dill Water</li> <li>ii. Merbromin solution NF 11</li> <li>iii. Cresol with soap solution I.P</li> <li>iv. Calamine Cream aqueous BPC</li> <li>v. Cough Expectorant and Antacid suspension</li> <li>vi. Simple ointment IP and Sulphur Ointment IP</li> <li>vii. Turpentine Liniment (BPC)</li> </ol>	<b>20</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4
<b>Module 2:</b>	<b>Screening of drugs/medicinal plants for the following biological activity (Minimum 10 experiments of 6h each)</b> <ol style="list-style-type: none"> <li>i. Antioxidant activity using DPPH radical scavenging,</li> <li>ii. Antioxidant activity using Ferric Reducing Antioxidant Power</li> <li>iii. Antidiabetic activity using alpha amylase inhibition assay [DNS method (3,5-dinitrosalicylic acid)]</li> <li>iv. Antidiabetic activity using <math>\alpha</math>-Glucosidase inhibition assay by PNPG (p-Nitrophenyl-<math>\beta</math>-D-glucopyranoside) method</li> <li>v. Acetylcholinesterase inhibition using DTNB(5,5'-dithiobis(2-nitrobenzoic acid) method</li> <li>vi. anti-inflammatory activity using egg albumin denaturation assay</li> <li>vii. Anti-microbial activity by disc diffusion method</li> <li>viii. Cytotoxicity study by MTT assay</li> <li>ix. Anticoagulant activity by prothrombin time.</li> <li>x. Antiulcer activity using using Titrimetric Method,</li> <li>xi. Antiemetic activity by emesis Model</li> </ol>	<b>60</b>	CO3, CO4	K1, K2, K3, K4

	<ul style="list-style-type: none"> <li>xii. physiologically-based pharmacokinetic and quantitative systems pharmacology model for modeling amyloid aggregation in Alzheimer's disease using PBP software</li> <li>xiii. invitro antitubercular activity using foam reduction method</li> <li>xiv. Antitubercular activity by Almar blue assay method.</li> <li>xv. DNA cleavage activity by Gel electrophoresis method.</li> <li>xvi. Anthelmintic activity using earthworm</li> <li>xvii. Antidepressant activity by Monoamine oxidase (MAO-A/B) inhibition assay</li> <li>xviii. Hypolipidemic activity using HMG-CoA reductase inhibition assay</li> <li>xix. Antiulcer activity of acid neutralizing capacity and H<sup>+</sup>/K<sup>+</sup> - ATPase inhibition activity.</li> <li>xx. Antidiarrheal activity using Castor oil-related enzyme assays</li> </ul>			
<b>Module 3:</b>	<p><b>Synthesis of drugs (minimum 4 for 6h each)</b></p> <ul style="list-style-type: none"> <li>i. Synthesis of the barbital</li> <li>i. Synthesis of the 3,4-dihydro-1-hydroxy-4-oxophthalazine</li> <li>ii. Synthesis of the Phenacetin</li> <li>iii. Synthesis of the Acetylcysteine</li> <li>iv. Synthesis of the Betamipron</li> <li>v. Synthesis of the Dichloramine-T</li> <li>vi. Synthesis of the 5-Diazouracil</li> <li>vii. Synthesis of the p-Hydroxypropiofenone</li> </ul>	<b>24</b>	CO1, CO2, CO4	K1, K2, K3, K4
<b>Module 4:</b>	<p><b>Synthesis of drugs (minimum 2 for 8h each)</b></p> <ul style="list-style-type: none"> <li>i. Synthesis of the paracetamol</li> <li>ii. Synthesis of the dapsone</li> <li>iii. Synthesis of the zolimidine</li> <li>iv. Synthesis of the diazepam</li> </ul>	<b>16</b>	CO2, CO4	K2, K3, K4, K5

	v. Synthesis of the Phenacetin vi. Synthesis of the Ibuprofen			
<b>Pedagogy:</b>	Students should be given suitable hands-on learning, pre- and post-lab assignments and explanations revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. A. H. Kibbe, Handbook of Pharmaceutical Excipients, 6th Ed., Pharmaceutical Press, London, 2009.</li> <li>2. A. I. Vogel, Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Prentice Hall, Harlow, 2011.</li> <li>3. A. K. Ghosh, Pharmacological Methods: Laboratory Manual, 3rd Ed., Kolkata University Press, Kolkata, 2010.</li> <li>4. A. R. Gennaro, Remington: The Science and Practice of Pharmacy, 22nd Ed., Lippincott Williams &amp; Wilkins, Philadelphia, 2012.</li> <li>5. C. K. Kokate, A. P. Purohit, S. B. Gokhale, Pharmacognosy, 53rd Ed., Nirali Prakashan, Pune, 2021.</li> <li>6. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry: Part B – Reactions and Synthesis, 5th Ed., Springer, New York, 2007.</li> <li>7. H. P. Rang, M. M. Dale, J. M. Ritter, R. J. Flower, Pharmacology, 9th Ed., Elsevier, London, 2016.</li> <li>8. Indian Pharmacopoeia, 9th Ed., Indian Pharmacopoeia Commission, Ghaziabad, 2022.</li> <li>9. J. Mohan, Organic Analytical Chemistry, Narosa Publishing House, New Delhi, 2014.</li> <li>10. L. K. Ghosh, In Vitro Techniques in Pharmacology, 1st Ed., Springer, New Delhi, 2012.</li> <li>11. Lednicer and L. A. Mitscher, The Organic Chemistry of Drug Synthesis, 6 Vols., John Wiley &amp; Sons, New York, 2009.</li> <li>12. R. K. Bansal, Laboratory Manual in Organic Chemistry, 5th Ed., New Age International, New Delhi, 2016.</li> <li>13. R. K. Maheshwari, Textbook of Pharmaceutics, 2nd Ed., CBS Publishers, New Delhi, 2015.</li> <li>14. S. K. Gupta, Uma Singh, T. Velpandian, Analytical Toxicology for Poisoning Management and Toxicovigilance, Varosa Publishing House, New Delhi, 2002.</li> <li>15. S. S. Pandey and A. K. Tripathi, Pharmacological Screening Methods in Laboratory Animals, Jaypee Brothers, New Delhi, 2018.</li> <li>16. V. K. Sharma, Biological Screening of Natural Products, 2nd Ed., Academic Publishers, New Delhi, 2015.</li> </ol>			
<b>References/ Readings:</b>	1. British Pharmacopoeia (BP 2025, Jan. 2025), London: Medicines and Healthcare Products Regulatory Agency (MHRA).			

	<ol style="list-style-type: none"> <li>2. European Pharmacopoeia (Ph. Eur.), 11<sup>th</sup> Ed., 2022, Strasbourg: European Directorate for the Quality of Medicines &amp; HealthCare (EDQM), Council of Europe.</li> <li>3. Indian Herbal Pharmacopoeia. Vol. 3, Indian Drug Manufacturers' Association (IDMA) and Regional Research Laboratory, Jammu (CSIR), 2008</li> <li>4. Indian Pharmacopoeia, 9th ed., Ghaziabad: Indian Pharmacopoeia Commission.</li> <li>5. United States Pharmacopoeia (USP-NF, Issue 1, May 2024) Rockville, MD: United States Pharmacopoeial Convention.</li> </ol>
<b>Web Resources:</b>	<ol style="list-style-type: none"> <li>1. Indian Pharmacopoeia (IP) – 2010 Vol.2 (PDF)  <a href="https://qps.nhsrindia.org/sites/default/files/202201/INDIAN%20PHARMACOPOEIA%202010%20Volume%202.pdf">https://qps.nhsrindia.org/sites/default/files/202201/INDIAN%20PHARMACOPOEIA%202010%20Volume%202.pdf</a>,</li> </ol>

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<b>Title of the Course</b>	Pharmaceutical Chemistry Practical-VI
<b>Course Code</b>	CHH-6207
<b>Number of Credits</b>	4
<b>Theory/Practical</b>	Practical
<b>Level</b>	500
<b>Effective from AY</b>	2026-2027
<b>New Course</b>	Yes
<b>Bridge Course/ Value added Course</b>	No
<b>Course for advanced learners</b>	No

<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To translate certain theoretical concepts learnt earlier into experimental knowledge.</li> <li>2. To learn formulation, isolation, synthesis of medicinal</li> <li>3. To learn chemical analysis method and QSAR studies of drugs.</li> <li>4. To acquire hands on experience in chemical and computational laboratory techniques.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to	<b>Mapped to PSO</b>
	CO1. explain the theoretical aspects of drug synthesis, analysis and computational studies.	PSO1, PSO3
	CO2. synthesize and formulate various chemical moieties in small scale.	PSO1, PSO2, PSO4
	CO3. analyse drugs using various quality control methods.	PO3, PSO6
	CO4. evaluate the percentage purity, partition coefficient, physicochemical properties quality and quantity of pharmaceutical or chemical substances.	PSO6, PSO7, PSO8

Content:		No of hours	Mapped to CO	Cognitive Level
<b>Module 1:</b>	<p><b>Synthesis of drug, drug like molecules and biomolecules (Minimum 6 experiments of 6h each)</b></p> <ol style="list-style-type: none"> <li>i. Tolbutamide from toluene sulfonamide and butyl isocyanates.</li> <li>ii. Sulphaacetamide from p-aminosulphonamide</li> <li>iii. Celecoxib from 4-methyl acetophenone and ethyltrifluoroacetate</li> <li>iv. Antipyrine from phenyl hydrazine</li> <li>v. Triphenyl imidazole (2, 4, 5-triphenyl imidazole) from benzil.</li> <li>vi. 1,3-pyrazole from phenyl hydrazine</li> <li>vii. Isoniazid from Isonicotinic acid</li> <li>viii. pyruvic acid from tartaric acid</li> <li>ix. Preparation of oleic acid</li> <li>x. <math>\alpha</math>-D-glucopyranose pentaacetate from glucose</li> <li>xi. L-proline from Glutamic acid</li> </ol>	<b>36</b>	CO2, CO3, CO4	K2, K3, K4, K5
<b>Module 2:</b>	<p><b>Separation of mixtures of biomolecules using HPLC (Minimum 3 experiments of 6h each)</b></p> <ol style="list-style-type: none"> <li>i. Purification of hemoglobin variants (HbA, HbF, HbS) using Ion Exchange HPLC.</li> <li>ii. Separation of protein mixtures (albumin, globulins) using Size Exclusion HPLC.</li> <li>iii. Separation of amino acid mixture (tryptophan, tyrosine, and phenylalanine) in serum</li> <li>iv. Separation of water-soluble vitamins (B<sub>1</sub>, B<sub>2</sub>, B<sub>6</sub>, B<sub>12</sub>, C) using C18 columns.</li> <li>v. Separation of phytochemicals in plant extracts. (containing 2-3 mixtures)</li> </ol>	<b>18</b>	CO1, CO2, CO3	K2, K3, K4, K5, K6
<b>Module 3:</b>	<p><b>Spectrophotometric estimation of enzymes ((Minimum 3 experiments of 4h each)</b></p> <ol style="list-style-type: none"> <li>i. Determination of catalase activity</li> <li>ii. Determination of catacholase activity.</li> <li>iii. Determination of invertase activity.</li> </ol>	<b>12</b>	CO1, CO2, CO3	K2, K3, K4, K5, K6

	<ul style="list-style-type: none"> <li>iv. Determination of papain activity.</li> <li>v. Determination of pectinase activity.</li> </ul>			
<b>Module 4:</b>	<p><b>Experiments on Lipids, carotenoids and nucleic acids (Minimum 3 experiments of 4h each)</b></p> <ul style="list-style-type: none"> <li>i. Identification tests for lipids and nucleic acids</li> <li>ii. (Oleic acid, stearic acid, RNA, DNA)</li> <li>iii. Isolation of RNA from Yeast</li> <li>iv. Isolation of lycopene in tomatoes</li> <li>v. Isolation of genomic DNA</li> <li>vi. Extraction of lipids using solvent extraction techniques.</li> </ul>	<b>12</b>	CO1, CO2, CO3	K2, K3, K4,
<b>Module 5:</b>	<p><b>Estimation of the following biomolecules (Minimum 4 experiments of 4h each)</b></p> <ul style="list-style-type: none"> <li>i. estimation of cholesterol using Zak's method.</li> <li>ii. estimation of total sugars using anthrone method.</li> <li>iii. estimation of protein estimation using Folin-Ciocalteau methods.</li> <li>iv. reducing sugars using DNSA method.</li> <li>v. estimation of DNA using diphenylamine method.</li> <li>vi. estimation of RNA using orcinol reaction.</li> <li>vii. estimation of Proteins estimation using Biuret method.</li> </ul>	<b>16</b>	CO1, CO2, CO3, CO4	K2, K3, K4, K5, K6
<b>Module 6:</b>	<p><b>Thin layer/Paper chromatography experiments (Minimum 2 experiments of 4h each)</b></p> <ul style="list-style-type: none"> <li>i. Separation of plant pigments (spinach leaf pigments)</li> <li>ii. Separation of sugars (paper chromatography with aniline sulfate or orcinol detection)</li> <li>iii. Separation of sugars</li> <li>iv. Separation of lipids.</li> <li>v. Separation of Nucleotides</li> </ul>	<b>08</b>	CO1, CO2, CO3, CO4	K2, K3, K4, K5, K6

<b>Module 7:</b>	<b>Estimation of Partition Coefficient of the following (<i>Minimum 1 experiments of 6h each</i>)</b> <ol style="list-style-type: none"> <li>i. Phenyl Butazone between Octanol and Water</li> <li>ii. Methyldopa between Octanol and Water</li> <li>iii. acetic acid between butanol and water</li> </ol>	<b>06</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
<b>Module 8:</b>	<b>Screening of drugs/medicinal plants for the following biological activity (<i>Minimum 2 experiments of 6h each</i>)</b> <ol style="list-style-type: none"> <li>i. Larvicidal activity using malarial larvae.</li> <li>ii. Insecticidal activity using film residue method (Rice weevil, Bemisia tabaci, Sitophilus oryzae).</li> <li>iii. Antioxidant activity using Hydrogen peroxide scavenging,</li> <li>iv. Antidiabetic activity using alpha amylase inhibition assay (iodine method)</li> <li>v. anti-inflammatory assay using bovine serum albumin</li> <li>vi. Anti-microbial activity by serial dilution method.</li> <li>vii. Antiurolithiatic activity activity using Egg permeation assay</li> </ol>	<b>12</b>	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
<b>Pedagogy:</b>	Students should be given suitable hands-on learning, pre- and post-lab assignments and explanations revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.			
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. A. A. Siddiqui and S. Siddiqui, Natural Products Chemistry Practical Manual: For Science and Pharmacy Courses, CBS Publishers, New Delhi, 2008.</li> <li>2. A. I. Vogel, A. R. Tatchell, and B. S. F. Hannaford, Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Prentice Hall, Harlow, England, 2011.</li> <li>3. A. Leach, Molecular Modelling: Principles and Applications, Longman, Harlow, 1998.</li> <li>4. F. D. King, Medicinal Chemistry: Principles and Practice, Royal Society of Chemistry, Cambridge, 1994.</li> <li>5. J. Bassett, J. Mendham, and R. C. Denny (Revised by G. H. Jeffery), Vogel's Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education, New Delhi, 2007.</li> <li>6. J. E. F. Reynolds, Martindale: The Extra Pharmacopoeia, 30th Ed., The Pharmaceutical Press, London, 1993.</li> </ol>			

	<ol style="list-style-type: none"> <li>7. J. Mohan, Organic Analytical Chemistry, Narosa Publishing House, New Delhi, 2014.</li> <li>8. J. Moini, Pharmaceutical Laboratory Procedures, 1st Ed., Cengage Learning India Pvt. Ltd., New Delhi, 2010.</li> <li>9. K. A. Connors, Textbook of Pharmaceutical Analysis, 3rd Ed., Wiley-Interscience, New York, 1990.</li> <li>10. K. V. Raman, Computers in Chemistry, Tata McGraw-Hill, New Delhi, 1993.</li> <li>11. L. F. Fieser and K. L. Williamson, Organic Experiments, 7th Ed., D. C. Heath, Lexington, 1992.</li> <li>12. N. K. Vishnoi, Advanced Practical Organic Chemistry, 3rd Ed., Vikas Publishing House, New Delhi, 2009.</li> <li>13. N. S. Gnanpragasam and G. Ramamurthy, Organic Chemistry: Lab Manual, Viswanathan S. Printers &amp; Publishers Pvt. Ltd., Chennai, 2009.</li> <li>14. R. K. Bansal, Laboratory Manual in Organic Chemistry, 5th Ed., New Age International, New Delhi, 2016.</li> <li>15. S. Delvin, Green Chemistry, Swarup &amp; Sons, New Delhi, 2005.</li> <li>16. S. K. Pundir and A. Bansal, Computers for Chemists, Pragati Prakashan, Meerut, 2010.</li> <li>17. Y. Zhou, Y. Fu, W. Yin, J. Li, W. Wang, F. Bai, S. Xu, Q. Gong, T. Peng, Y. Hong, D. Zhang, D. Zhang, Q. Liu, Y. Xu, H. E. Xu, H. Zhang, H. Jiang, and H. Liu, "Kinetics-Driven Drug Design Strategy for Next-Generation Acetylcholinesterase Inhibitors to Clinical Candidate," Journal of Medicinal Chemistry, Vol. 64, No. 4, 2021, pp. 1844–1855.</li> </ol>
<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. British Pharmacopoeia, BP 2025, Medicines and Healthcare Products Regulatory Agency (MHRA), London, 2025.</li> <li>2. European Pharmacopoeia, Ph. Eur., 11th Ed., European Directorate for the Quality of Medicines &amp; HealthCare (EDQM), Council of Europe, Strasbourg, 2022.</li> <li>3. Indian Herbal Pharmacopoeia, Vol. 3, Indian Drug Manufacturers' Association (IDMA) and Regional Research Laboratory (CSIR), Jammu, 2008.</li> <li>4. Indian Pharmacopoeia, 9th Ed., Indian Pharmacopoeia Commission, Ghaziabad, 2022.</li> <li>5. United States Pharmacopoeia, USP-NF, Issue 1, United States Pharmacopoeial Convention, Rockville, MD, 2024.</li> </ol>
<b>Web Resources:</b>	<ol style="list-style-type: none"> <li>1. Indian Pharmacopoeia (IP) – 2010 Vol.2 (PDF)  <a href="https://qps.nhsrindia.org/sites/default/files/202201/INDIAN%20PHARMACOPOEIA%202010%20Volume%202.pdf">https://qps.nhsrindia.org/sites/default/files/202201/INDIAN%20PHARMACOPOEIA%202010%20Volume%202.pdf</a>.</li> </ol>

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<b>Title of the Course</b>	Pharmaceutical Chemistry Practical-VII
<b>Course Code</b>	CHH-6208
<b>Number of Credits</b>	4
<b>Theory/Practical</b>	Practical
<b>Level</b>	500
<b>Effective from AY</b>	2026-2027
<b>New Course</b>	No
<b>Bridge Course/ Value added Course</b>	No
<b>Course for advanced learners</b>	Yes

<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	<ol style="list-style-type: none"> <li>1. To translate certain theoretical concepts learnt earlier into experimental knowledge.</li> <li>2. To learn pharmacophore mapping, molecular docking, DFT, Network pharmacology and molecular dynamics</li> <li>3. To evaluate Insilco studies of the drugs.</li> <li>4. To provide hands-on experience of computational chemistry.</li> </ol>	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	CO 1. explain the theoretical aspects of various computational studies.	PSO1, PSO3
	CO 2. analyze the results of computational studies.	PSO2, PSO4
	CO 3. perform the various insilico studies of drug like molecules.	PSO5, PSO6
	CO 4. design and evaluate the therapeutic efficiency of a particular molecules	PSO7, PSO8

Content:		No of hours	Mapped to CO	Cognitive Level
<b>Module 1:</b>	<p><b>Pharmacophore Mapping</b> using Pharma Gist or Ligand Scout/ ZINC Pharmer. (Any 2 drug series 8h)</p> <p>Ligand Preparation by energy minimization, Feature Extraction [Hydrogen bond donor (HBD), Hydrogen bond acceptor (HBA), Hydrophobic center (HYD), Aromatic ring (ARO) Positive/negative ionizable groups] Pharmacophore Model Generation, Validation of Pharmacophore (Assess model reliability using ROC curve, enrichment factor, and RMSD), Virtual Screening (ZINC or PubChem databases), best fit scores and drug-likeness parameters calculation</p> <p>Note : <i>Demonstration step by step with example 8h</i></p>	24	CO1, CO2	K1, K2, K3, K4, K5, K6
<b>Module 2:</b>	<p><b>Molecular docking using Autodock 4.2,</b> (Any 2 drug series with 5 molecules 8h)</p> <p>Small molecule preparation, Macromolecule preparation, Grid preparation, docking and complex preparation, analysis of docked molecules using pymol or discovery studio</p> <p>Note : <i>Demonstration step by step with example 8h</i></p>	24	CO1, CO2	K1, K2, K3, K4, K5, K6
<b>Module 3:</b>	<p><b>Network pharmacology using Cytoscape</b> (Any 2 drugs 8h).</p> <p>Data acquisition and processing, using Genecards, TTD, STRING, PPI, Network construction and prediction using Gene Ontology and KEGG</p> <p>Note : <i>Demonstration step by step with example 8h</i></p>	24	CO1, CO2, CO3	K2, K3, K4, K5, K6
<b>Module 4:</b>	<p>A <b>molecular dynamics</b> (MD) simulation of drug receptor complex using NAMD software- preparing the system (water box and ions for neutrality), Energy minimization upto 10,000 steps, setting up the simulation NVT and NPT equilibration, running (50-100ns simulation), and analysing (RMSD, RMSF, hydrogen bonds, and radius of gyration) the results (Any 2 best drug receptor complex obtained by molecular docking 8h).</p> <p>Note : <i>Demonstration step by step with example 8h</i></p>	24	CO1, CO2, CO3	K2, K3, K4, K5, K6
<b>Module 5:</b>	<p><b>Density Functional Theory (DFT) Studies using ORCA</b></p> <p>Ligand (Molecule) Preparation, Setting up ORCA Input File, Running ORCA</p>	24	CO1, CO2,	K2, K3, K4, K5,

	<p>Calculation, Geometry Optimization, Frontier Molecular Orbital (FMO) Analysis (Visualize HOMO/LUMO orbitals using Avogadro), Vibrational Frequency Analysis, Molecular Electrostatic Potential (MEP) Mapping, Calculate various properties from HOMO, LUMO value Energy difference (<math>\Delta E</math>), ionization energy (IE), electron affinity, electronegativity, electronic chemical potential, chemical hardness (<math>\eta</math>), chemical softness (<math>\sigma</math>), electrophilicity index (<math>\omega</math>), Total energy, dipole moment)</p> <p>Note : <i>Demonstration step by step with example 8h</i></p> <p><b>Perform the Comparative DFT Study (Any 2 experiments 8h)</b></p> <ol style="list-style-type: none"> <li>i. Any 4 NSAIDs</li> <li>ii. Curcumin analogues</li> <li>iii. Deazaflavin derivatives</li> </ol>	CO3, CO4	K6
<b>Pedagogy:</b>	Students should be given suitable hands-on learning, pre- and post-lab assignments and explanations revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.		
<b>Texts:</b>	<ol style="list-style-type: none"> <li>1. A. Hinchliffe, <i>Molecular Modelling for Beginners</i>, John Wiley &amp; Sons, 2nd Ed., Chichester, 2008.</li> <li>2. A. R. Leach, <i>Molecular Modelling: Principles and Applications</i>, Pearson Education Limited, 2nd Ed., Harlow, 2001.</li> <li>3. C. Hansch, and A. Leo, <i>Exploring QSAR: Fundamentals and Applications in Chemistry and Biology</i>, American Chemical Society, 1st Ed., Washington D.C., 1995.</li> <li>4. C. J. Cramer, <i>Essentials of Computational Chemistry: Theories and Models</i>, John Wiley &amp; Sons, 2nd Ed., Chichester, 2004.</li> <li>5. D. C. Young, <i>Computational Chemistry: A Practical Guide for Applying Techniques to Real-World Problems</i>, John Wiley &amp; Sons, 1st Ed., New York, 2001.</li> <li>6. F. Jensen, <i>Introduction to Computational Chemistry</i>, John Wiley &amp; Sons, 3rd Ed., Chichester, 2017.</li> <li>7. I. N. Levine, <i>Quantum Chemistry</i>, Pearson Education, 7th Ed., Boston, 2013.</li> <li>8. J. M. Haile, <i>Molecular Dynamics Simulation: Elementary Methods</i>, John Wiley &amp; Sons, 1st Ed., New York, 1992.</li> <li>9. K. I. Ramachandran, G. Deepa, and K. Namboori, <i>Computational Chemistry and Molecular Modeling: Principles and Applications</i>, Springer, 1st Ed., New York, 2008.</li> <li>10. M. De Vivo, M. Masetti, G. Bottegoni, and A. Cavalli, <i>Computational Drug Discovery and Design</i>, Springer, 1st Ed., New York, 2016.</li> </ol>		

<b>References/ Readings:</b>	<ol style="list-style-type: none"> <li>1. A. D. Becke, and R. G. Parr, Density Functional Theory of Atoms and Molecules, Oxford University Press, 1st Ed., Oxford, 1989.</li> <li>2. A. R. Katritzky, and J. M. Lagowski, Principles of Quantum Chemistry, Marcel Dekker, 1st Ed., New York, 1974.</li> <li>3. D. A. Case, and T. A. Darden, The Amber Biomolecular Simulation Programs, University of California Press, 1st Ed., San Francisco, 2005.</li> <li>4. J. M. Haile, Molecular Dynamics Simulation: Elementary Methods, John Wiley &amp; Sons, 1st Ed., New York, 1992.</li> <li>5. M. R. Berthold, Computational Tools for Chemical Biology, Springer, 1st Ed., Berlin, 2009.</li> <li>6. P. Bajorath, Chemoinformatics for Drug Discovery, Wiley, 1st Ed., Hoboken, 2013.</li> <li>7. P. Willett, Pharmacophore Perception, Development, and Use in Drug Design, CRC Press, 1st Ed., Boca Raton, 1995.</li> <li>8. R. Todeschini, and V. Consonni, Molecular Descriptors for Chemoinformatics, Wiley-VCH, 2nd Ed., Weinheim, 2009.</li> <li>9. W. Koch, and M. C. Holthausen, A Chemist's Guide to Density Functional Theory, Wiley-VCH, 2nd Ed., Weinheim, 2001.</li> </ol>
<b>Web Resources:</b>	<ol style="list-style-type: none"> <li>1. Indian Pharmacopoeia (IP) – 2010 Vol.2 (PDF)  <a href="https://qps.nhsrindia.org/sites/default/files/202201/INDIAN%20PHARMACOPOEIA%202010%20Volume%202.pdf">https://qps.nhsrindia.org/sites/default/files/202201/INDIAN%20PHARMACOPOEIA%202010%20Volume%202.pdf</a> </li> </ol>

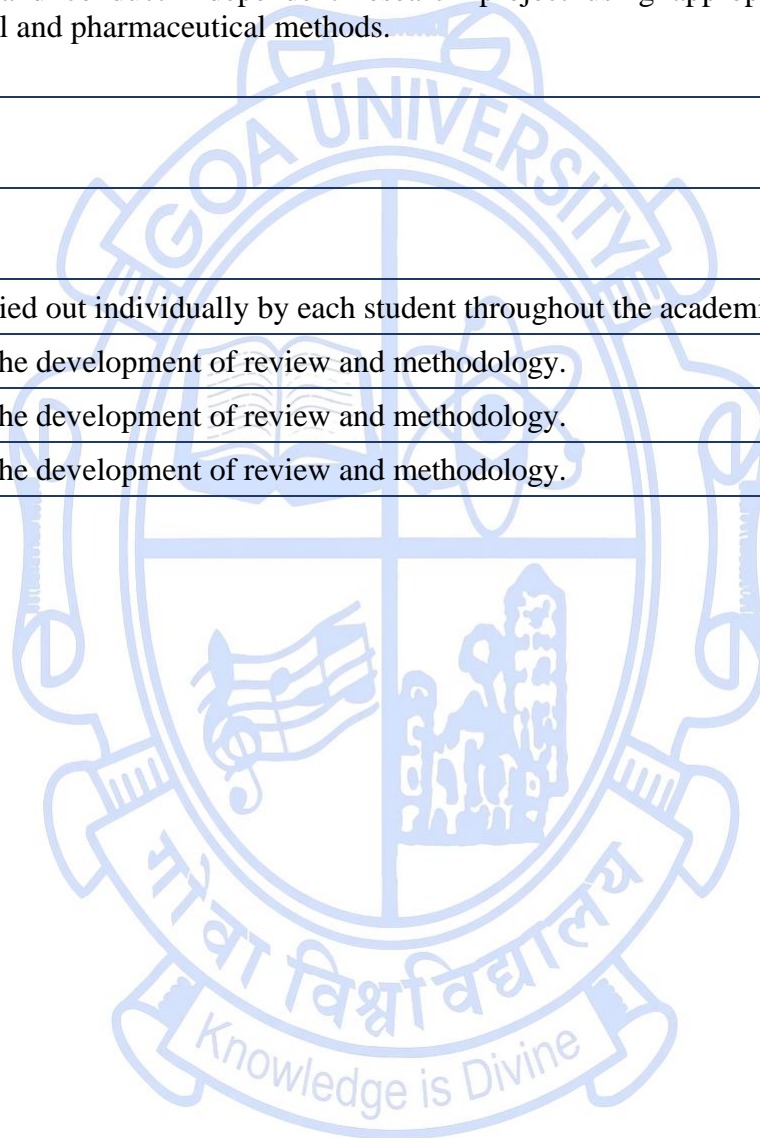
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**DISSERTATION (40 Credits)**

<b>Title of the Course</b>	Discipline Specific Dissertation (DSD)	
<b>Course Code</b>	CHH-6501	
<b>Number of Credits</b>	40	
<b>Theory/Practical</b>	Practical	
<b>Level</b>	500	
<b>Effective from AY</b>	2026-27	
<b>New Course</b>	Yes	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	Level 400 Courses	
<b>Course Objectives:</b>	To develop the skills of preparing and conducting independent research.	
<b>Course Outcomes:</b>	Students will be able to	<b>Mapped to PSO</b>
	CO 1. explain the principles and techniques used in chemical, biological and pharmaceutical analysis	PSO1, PSO2
	CO 2. use appropriate chemical and pharmaceutical methods to solve experimental problems.	PSO2, PSO3
	CO 3. analyze and interpret experimental data to draw meaningful conclusions.	PSO3, PSO4, PSO5

	CO 4. Design and conduct independent research project using appropriate drug, chemical and pharmaceutical methods.		PSO6, PSO7, PSO8
<b>Content</b>		<b>No of hours</b>	<b>Mapped to CO</b> <b>Cognitive Level</b>
<b>Module 1:</b>	As per OA-35A	1200	CO1, CO2, CO3, CO4      K1, K2, K3, K4, K5, K6
<b>Pedagogy:</b>	Dissertation carried out individually by each student throughout the academic year.		
<b>Texts:</b>	As required for the development of review and methodology.		
<b>Reference/readings</b>	As required for the development of review and methodology.		
<b>Web Resources</b>	As required for the development of review and methodology.		

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**DISSERTATION (20 Credits)**

<b>Title of the Course</b>	Discipline Specific Dissertation (DSD)	
<b>Course Code</b>	CHH-6502	
<b>Number of Credits</b>	20	
<b>Theory/Practical</b>	Dissertation	
<b>Level</b>	500	
<b>Effective from AY</b>	2026-2027	
<b>New Course</b>	No	
<b>Bridge Course/ Value added Course</b>	No	
<b>Course for advanced learners</b>	No	
<b>Pre-requisites for the Course:</b>	Level 400 courses	
<b>Course Objectives:</b>	To develop the skills of preparing and conducting independent research.	
<b>Course Outcomes:</b>	Students will be able to:	<b>Mapped to PSO</b>
	CO 1. explain the principles and techniques used in chemical, biological and pharmaceutical analysis	PSO1, PSO2
	CO 2. use appropriate chemical and pharmaceutical methods to solve experimental problems.	PSO2, PSO3
	CO 3. analyze and interpret experimental data to draw meaningful conclusions.	PSO3, PSO4, PSO5
	CO 4. Design and conduct independent research project using appropriate drug, chemical	PSO6, PSO7, PSO8

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

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