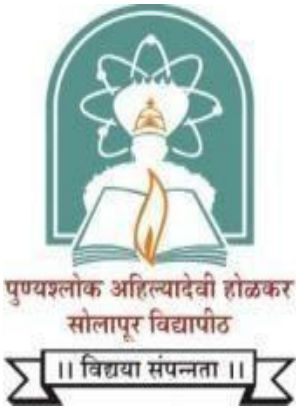
Punyashlok Ahilyadevi Holkar Solapur University, Solapur



NAAC Accredited-2022
'B^{++}'Grade (CGPA2.96)

Name of the Faculty: Science &Technology

(As per New Education Policy 2020)

Syllabus: Pharmaceutical Chemistry

Name of the Course: M.Sc. II (Sem. III &IV)

(Syllabus to be implemented from June 2024)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Faculty of Science & Technology
Nep 2020 Compliant Curriculum
MSc (Pharmaceutical Chemistry)
Program Preamble

The Master of Science (MSc) in Pharmaceutical Chemistry is a comprehensive and dynamic program designed to provide students with a deep understanding of the fundamental principles of Entrepreneurship, along with the practical skills required to apply this knowledge in various scientific and technological contexts. Aligned with the vision of the National Education Policy (NEP) 2020, the program offers a flexible, multidisciplinary, and learner-centric curriculum that encourages critical thinking, innovation, and holistic development. The MSc Pharmaceutical Chemistry program spans two years, with each year offering a progressively advanced curriculum designed to build a strong foundation in Pharmaceutical Chemistry while allowing for specialization and interdisciplinary learning. The curriculum is structured around several key components:

1. **Discipline Specific Core Courses:** These core courses form the backbone of the program, providing in-depth knowledge and understanding of essential Pharmaceutical Chemistry concepts, theories, and methodologies. Students will engage with topics from Advanced Spectroscopic Methods, Drug Development, Modern Pharmaceutical Analytical Techniques, Biochemistry, Advanced Organic Chemistry, Drugs and Heterocycles, Pharmaceutical Dosage Forms, Pharmaceutical Technology etc. ensuring a robust and comprehensive education in the multidisciplinary approach.

2. **Discipline Specific Elective Courses:** The program encourages intellectual exploration beyond the core discipline by offering a wide range of elective courses. These electives enable students to pursue their interests in diverse subjects, fostering creativity, critical thinking, and a well-rounded educational experience.

3. **Field Projects /Internships /Apprenticeships /Community Engagement Projects /On-Job Training:** To bridge the gap between theoretical knowledge and real-world applications, the program includes opportunities for field projects, internships, apprenticeships, and community engagement. These experiences provide students with practical insights, problem-solving abilities, and exposure to professional environments, enhancing their readiness for careers in Pharmaceutical Chemistry and related fields.

4. **Research Methodology and Research Projects:** Research is a critical component of the MSc Pharmaceutical chemistry program, with students acquiring skills in research methodology, data collection, analysis, and scientific inquiry. By engaging in independent research projects, students are encouraged to develop innovative solutions to complex scientific problems, preparing them for advanced studies and research-oriented careers.

Multiple Entry and Multiple Exit Options

In accordance with the NEP 2020, the MSc Pharmaceutical Chemistry program incorporates a Multiple Entry and Multiple Exit framework, offering students the flexibility to enter or exit the program at various stages. This approach ensures that students can tailor their educational journey according to their personal

and professional goals, with options to earn certificates, diplomas, or degrees based on the duration of study completed.

- **Year 1**
  Upon completion of the first year, students may exit with a **Diploma in Pharmaceutical Chemistry**

- **Year 2**
  Upon Completion of the two-year, student may exit with a **MSc Degree in Pharmaceutical Chemistry.**

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।। विद्यया संपन्नता ।।
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Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Faculty of Science & Technology
Nep 2020 Compliant Curriculum
MSc (Pharmaceutical Chemistry)
Program Outcomes (PO)

Students Post graduating from the Master of Science in Pharmaceutical Chemistry program will be able to:

Major Courses:

- **PO1**: Demonstrate in-depth knowledge and understanding of core concepts, theories, and methodologies in the chosen major discipline.
- **PO2**: Apply disciplinary knowledge to solve complex problems, analyze data, and make informed decisions in professional and research contexts.

Electives Courses:

- **PO3**: Explore diverse subjects beyond the core discipline, fostering a broad-based education and cultivating critical thinking and creativity.

Field Projects/Internship/Apprenticeship/Community Engagement Projects/ On Job Training/ Internship/Apprenticeship:

- **PO4**: Apply theoretical knowledge to real-world situations through field projects, internships, community engagement and On job Training for gaining practical experience and problem-solving skills.

Research Methodology and Research Project:

- **PO5**: Acquire research skills, including data collection, analysis, and interpretation, fostering a scientific approach to problem-solving to develop independent research projects handling capabilities.
- **PO6:** To develop the ability to present pharmaceutical chemistry research by means of an oral presentation, a scientific poster or a written report.

General Structure of the Course:

Level/ Difficulty	Semester	Paper Code	Title of the Paper	Semester exam			L	T	P	Credits
			Mandatory	**Theory**	**IA**	**Total**				
		DSC-5 2303301	Advanced Spectroscopic Methods	60	40	100	4	--	-	4
		DSC-6 2303302	Drug Development	60	40	100	4		-	4
			Elective (Anyone)							
		DSE-3 A 2303306	Modern Pharmaceutical Analytical Techniques	60	40	100	4		-	4
	III	**DSE-3 B 2303307**	Biochemistry	60	40	100	4		-	
			Field Project/RP/Internship/Apprenticeship/							
		RP 2303303	Research Project	60	40	100	4	-	0	4
			Practical							
6.5/400		**DSC-5 P 2303304**	Spectral Analysis	30	20	50	-	-	2	6
		DSC-6 P 2303305	Pharmaceutical Chemistry	30	20	50	-	-	2	
			Elective (Any one)							
		DSE-3A P 2303308	Modern Pharmaceutical Analytical Techniques	30	20	50			2	
		DSE-3B P 2303309	Biochemistry	30	20	50			2	
			Total for III semester	**330**	**220**	**550**	**16**	**550**	**6**	**22**
			Mandatory							
		DSC-7 2303401	Advanced Organic Chemistry	60	40	100	4	--	-	4
		DSC-8 2303402	Drugs and Heterocycles	60	40	100	4		-	4
			Elective (Any one)							
		DSE-4A 2303405	Pharmaceutical Dosage Forms	60	40	100	4		-	4
	IV	**DSE-4B 2303406**	Pharmaceutical Technology	60	40	100	4		-	
			Field Project/RP/Internship/Apprenticeship/							
		RP 2303403	Research Project	90	60	150	6	-	0	6
			Practical							
		DSC-7 P 2303404	Organic Preparations	30	20	50	-	-	2	4
			Elective (Any one)							
		DSE-4A P 2303407	Drug assay and drug formulations	30	20	50			2	
		DSE-4B P 2303408	Pharmaceutical Technology	30	20	50			2	
			Total for II semester	**330**	**220**	**550**	**18**	**550**	**4**	**22**

DSC- Discipline Specific Course, DSE- Discipline Elective course
RM- Research Methodology, OJT- On Job Training
RP – Research Project
L – Lecture, T – Tutorial, P – Practical Credits of Theory = 4 Hours of teaching per week
2 Credits of Theory = 4 Hours per week

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Students post graduating from the Master of Science in Pharmaceutical Chemistry will able to:

- **PSO 1:** Understand the basics of different subjects in pharmaceutical sciences.
- **PSO 2:** Analyze the relationships between pharmaceutical and medicinal chemistry, organic chemistry, pharmaceutics, pharmacology, and pharmacognosy.
- **PSO 3:** Understand how pharmaceutical sciences can be applied to drug analysis, drug safety, drug and formulation development, and efficacy in medicine.
- **PSO 4:** Develop the ability to present pharmaceutical chemistry research by means of an oral presentation, a scientific poster or a written report.

Semester – III

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***Teaching Scheme** **Lectures: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Advanced Spectroscopic Methods is one of the core courses in the Pharmaceutical Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts in Nuclear Magnetic Resonance Spectroscopy,13C-NMR Spectroscopy, Two-dimensional (2D) NMR spectroscopy, Mass Spectrometry. Students will study these subtopics in detail. By combining theoretical knowledge with spectral problems, the course aims to develop practical skills in analyzing and optimizing the spectroscopic concepts.

	Course Objectives:
•	To know the applications of IR spectroscopy
•	To understand the different types of NMR techniques and their applications for structural determination
•	To get skill for the confirmation of drug structure based on mass spectrometry
•	To analyze drug molecules based on all spectral techniques.
	Course Outcomes:
CO1:	The student is able to apply IR techniques to drug molecules.
CO2:	The student can determine the structure of drug molecules on the basis of different NMR techniques.
CO3:	The student can adopt the skill to interpret spectra of drug molecules.
CO4:	The student is able to analyze and confirm drug molecules by using spectral techniques.
Unit 1:	**Nuclear Magnetic Resonance Spectroscopy: [15]** **Weightage: 20M**
	General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, mechanism of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehyde and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides and mercapto), chemical exchange, effect of deuteration, complex spin-spin interaction between 2,3,4 and 5

	nuclei (first order spectra), virtual coupling. Stereochemistry, Hindered rotation, Fourier transforms technique, Nuclear Overhauser Effect (NOE) with examples
Unit 2:	**^{13}C-NMR Spectroscopy [15]** **Weightage: 20M**
	Elementary ideas, instrumental difficulties, FT technique advantages and disadvantages. Proton Noise Decoupling technique advantages and disadvantages, off-resonance technique, factors affecting chemical shifts, analogy with 1H NMR, calculations of chemical shift of hydrocarbons, different types of carbons (alkene, alkyne, allene, carbonyl, nitrile, oxime and aromatic carbons and effect of substituent on chemical shifts of carbons. Chemical shifts of solvents
Unit 3:	**Two-dimensional (2D) NMR spectroscopy: [15]** **Weightage: 20M**
	Introduction, DEPT, COSY and HETCOR techniques, (including interpretation of COSY and HETCOR spectra). NOESY, ROESY and 2D-INADEQUATE techniques
Unit 4:	**Mass Spectrometry [15]** **Weightage: 20M**
	Introduction, Ion production (EI, CI, FD & FAB), Ion analysis, Ion abundance, Factors affecting fragmentation, Fragmentation of different functional groups, Molecular ion peaks, Metastable peaks Nitrogen rule, McLafferty rearrangement, Retro-Diels Alder reaction. Problems based on joint application of IR, NMR & Mass spectroscopy.
	Reference books:
	1. Sharma B K: Instrumental methods of Chemical Analysis, Goel Publishing House 2. Silverstein R M, Bassler G C: Spectrometric Identification of Organic Compounds, John Wiley 3. Sharma Y R: Elementary Organic Spectroscopy, Jalandhar 4. Kalsi P S: Spectroscopy of Organic Compounds, New Age International Ltd. 5. D. L. Pavia, G.M. Lamp man, G. S. Kriz, 3rdEd. Introduction to Spectroscopy, Harcourt College publishers 6. V. M. Parikh: Absorption spectroscopy of organic molecules 7. D. H. Williams and I. Flemming: Spectroscopic methods in organic chemistry, McGraw Hill 8. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer-

Verlag (1986)
9. Atta -Ur-Rehman: One- and Two-dimensional NMR Spectroscopy- Elsevier (1989)
10. Joseph B. Lambert, Shurvell, Lightner: Organic structural spectroscopy- Cooks, Prentice-Hall (1998)
11. Field L. D., Kalman J.R. and Sternhell S: Organic structures from spectra- 4thEd. John Wiley and sons Ltd.
12. Jackmann and Sternhell S: NMR spectroscopy of Organic compounds

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year M.Sc. (Pharmaceutical Chemistry) Sem-III
Vertical: DSC
Course Code: 2303302
Course Name: Drug Development

***Teaching Scheme**	***Examination Scheme**
Lectures: 04 Hours/week, 04 Credits	**UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Drug Development is one of the core courses in the Pharmaceutical Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts in Concept of drug, Computer aided drug designing, Pharmacokinetics, Pharmacodynamics. Students will study these subtopics in detail. By combining theoretical knowledge with Computer aided drug designing, the course aims to develop skills in drug designing and optimizing the development of drugs.

	Course Objectives:
•	To understand the concept and sources of drug
•	To get ability to design structure of drug molecule based on SAR and CADD
•	To understand the concept of ADME
•	To know the mechanism of action of drug.
	Course Outcomes:
CO1:	The student is able to understand the concept and sources of drug
CO2:	The student can get ability to design structure of drug molecule based on SAR and CADD
CO3:	The student is able to understand the concept of ADME
CO4:	The student knows the details about the mechanism of action of drug.
Unit 1:	**Concept of drug** **[15]**

	Weightage: 20M
	Concept of drug, Sources of drugs, Drug development ,Lipinski rule of 5, Physico chemical properties of molecules: lipophilicity, electrokinetic parameters, steric parameters, pKa (eg. Cimetidine development), and solubility. Types of receptors, Protein and Protein Data Bases
Unit 2:	**Computer aided drug designing [15]** **Weightage: 20M**
	Structure and ligand-based drug designing, Lead and drug like properties, concept of lead identification and modification, Structure-activity relationship (SAR), Factors affecting bioactivity, History, and development of QSAR, Types of molecular descriptors, Methods of molecular descriptor selection, 2D QSAR modeling, Introduction to molecular docking and illustrations (NNRTIs and COX-inhibitors).
Unit 3:	**Pharmacokinetics [15]** **Weightage: 20M**
	Introduction to drug absorption, distribution, metabolism, elimination, and toxicity (ADMET). Pharmacokinetic models, bioavailability, Pharmacokinetic parameters (volume of distribution, elimination half-life, clearance). Concept of pro-drug and soft drug.
Unit 4:	**Pharmacodynamics [15]** **Weightage: 20M**
	Introduction to LD_{50}, ED_{50}, IC_{50}, MIC, MEC and Ki. Dose-response relationships, drug potency and efficacy. Principles of drug action, mechanisms of drug action, drug receptor interactions, combined effect of drugs.
	Reference books:
	1. Graham L. Patrick, An Introduction to Medicinal Chemistry, Fifth Edition, Oxford University Press 2. Edward H. Kerns and Li Di, Drug-like Properties: Concepts, Structure Design and Methods, Elsevier, 2008 3. Ashutosh Kar, Medicinal Chemistry, New Age International Publishers, Fourth Edition 4. Gupta, S. P. (2011) QSAR & Molecular Modeling. Anamaya Pub.: New Delhi. 5. Jayashree Ghosh, A Textbook of Pharmaceutical Chemistry, 3/eS, Chand Publications 6. Grigauge A, Introduction to Medicinal Chemistry; Wiley-VCH

	7. Pandey S S, Dimmock J R, An Introduction to Drug Design; New Age International 8. Wolff Ed M EV, Burger's Medicinal Chemistry and Drug Discovery (6th Edition); John Wiley 9. Silverman R B, The Organic Chemistry of Drug Design and Drug Action; Academic Press 10. William Foye, Lippicott, Principles of Medicinal Chemistry (4th Edition); William and Wilkins 11. Kadam S S, Mahadik, Bothera, Principles of Medicinal Chemistry (11th Edition); Nirali Publication 12. Satoskar R S, Bhandarkar, Pharmacology and Pharmacotherapeutics; Popular Prakashan 13. Organic Chemistry: Clayden, Greeves, Warren and Wo

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***Teaching Scheme** **Lectures: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Modern Pharmaceutical Analytical Techniques is one of the core courses in the Pharmaceutical Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts in UV-Visible and IR spectroscopy, Chromatography, Analytical Techniques, Thermal Analysis. Students will study these subtopics in detail. By combining theoretical knowledge with numerical treatment, the course aims to develop practical skills in analyzing and optimizing the Analytical instruments.

	Course Objectives:
•	To know the application of UV-Visible and IR spectroscopy in drug analysis
•	To understand theoretical and practical aspects of the instruments
•	To analyze the various drugs in single and combination dosage forms
•	Structure elucidation of drugs and chemicals by various spectrometric methods
	Course Outcomes:

CO1:	The students can able to explain about instrument to be used for analysis of the drug.
CO2:	The students can get knowledge about chromatographic techniques to be used for qualitative and quantitative analysis of the drug.
CO3:	The students can able to interpret various spectrums of the drug of UV/IR
CO4:	The students caable to tell qualitative & quantitative analysis of the drug.
Unit 1:	**UV-Visible and IR spectroscopy [15]** **Weightage: 20M**
	UV-Visible spectroscopy: Introduction, Theory, Laws, Instrumentation associated with UV-Visible spectroscopy, Choice of solvents and solvent effect and Applications of UV- Visible spectroscopy. **IR spectroscopy:** Theory, Modes of Molecular vibrations, Sample handling, Instrumentation of Dispersive and Fourier - Transform IR Spectrometer, Factors affecting vibrational frequencies and Applications of IR spectroscopy
Unit 2:	**Chromatography [15]** **Weightage: 20M**
	Chromatography: Principle, apparatus, chromatographic parameters, factors affecting resolution, instrumentation, and applications of the following: a) Paper chromatography b) Thin Layer chromatography & HPTLC c) Column chromatography d) Ion exchange chromatography e) Affinity chromatography f) High Performance Liquid chromatography (HPLC) g) Gas chromatography (GC)
Unit 3:	**Analytical Techniques [15]** **Weightage: 20M**
	Potentiometry: Principle, working, Ion selective Electrodes and Application of potentiometry **Spectro fluorimetry:** Theory of Fluorescence, Factors affecting fluorescence, Quenchers, Instrumentation and Applications of fluorescence spectrophotometer **Flame emission spectroscopy (FES) and atomic absorption spectroscopy (AAS):** Principle, Instrumentation, Interferences and Applications.
Unit 4:	**Thermal Analysis [15]** **Weightage: 20M**
	Thermal Techniques: Principle, thermal transitions and Instrumentation (Heat flux and power-compensation and designs), Modulated DSC, Hyper DSC, experimental

	parameters (sample preparation, experimental conditions, calibration, heating and cooling rates, resolution, source of errors) and their influence, advantage and disadvantages, pharmaceutical applications. **Differential Thermal Analysis (DTA):** Principle, instrumentation and advantage and disadvantages, pharmaceutical applications, Derivative differential thermal analysis (DDTA). **Thermogravimetric analysis TGA:** Principle, instrumentation, factors affecting results, advantage and disadvantages, pharmaceutical applications.
	Reference books:
	1. Spectrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004. 2. Principles of Instrumental Analysis - Doglas A Skoog, F. James Holler, Timothy A. Nieman, 5th edition, Eastern press, Bangalore, 1998. 3. Instrumental methods of analysis – Willards, 7th edition, CBS publishers. 4. Practical Pharmaceutical Chemistry – Beckett and Stenlake, Vol II, 4th edition, CBS Publishers, New Delhi, 1997. 5. Organic Spectroscopy - William Kemp, 3rd edition, ELBS, 1991. 6. Quantitative Analysis of Drugs in Pharmaceutical formulation - P D Sethi, 3rd Edition, CBS Publishers, New Delhi, 1997. 7. Pharmaceutical Analysis- Modern methods – Part B - J W Munson, Volume 11, Marcel Dekker Series 38 8. Spectroscopy of Organic Compounds, 2nd edn., P.S/Kalsi, Wiley estern Ltd., Delhi. 9. Textbook of Pharmaceutical Analysis, KA. Connors, 3 rd Edition, John Wiley & Sons, 1982. 10. Organic Spectroscopy by Donald L. Pavia, 5th Edition.

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***Teaching Scheme** **Lectures: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Biochemistry is one of the core courses in the Pharmaceutical Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts of Biochemistry, Protein and Lipids, Nucleic acids, Vitamins and Co-enzymes, Bioinorganic Chemistry. Students will study these subtopics in detail. By combining theoretical knowledge with numerical treatment, the course aims to develop practical skills in analyzing and optimizing the Biochemistry concepts.

	Course Objectives:
•	To know the basic concepts of carbohydrates
•	To understand the classification and structures of proteins and lipids
•	To get knowledge about DNA, RNA and Vitamins etc.
•	To know the role of bioinorganic chemistry in our body
	Course Outcomes:
CO1:	The student knows the basic concepts of carbohydrates
CO2:	The student is able to understand the classification and structures of proteins and lipids
CO3:	The student is able to understand the role of bioinorganic chemistry, DNA, RNA and Vitamins etc
CO4:	Able to know the role of bioinorganic chemistry in our body
Unit 1:	**Introduction of Biochemistry: [15]** **Weightage: 20M**
	The molecular logic of life; Structural hierarchy in themolecular organization of Cells. The chemical unity of diverse living organisms, prokaryotic and Eukaryotic. Scope of the subject in pharmaceutical Sciences **Carbohydrates:** Classification, basic chemical structure, monosaccharides, aldoses, andketoses, cyclic structure of monosaccharides, stereoisomerisms, anomers and epimers. Reducing properties of monosaccharides, disaccharides, oiligosaccharides,

	polysaccharides, structural studies methylation and periodate oxidation. Polysaccharide's structure and function of complex carbohydrates, proteoglycans, glycoproteins, Glycolipids, mucopolysaccharides
Unit 2:	**Protein and Lipids [15]** **Weightage: 20M**
	Protein: Classification and properties of amino acids, Primary, Secondary, Tertiary and Quaternary structure of protein. Synthesis, purification, characterization, and sequencing of protein molecules. **Lipids:** Classification, structure, and function of lipids. Acylglycerols, circulating lipids: lipoproteins, chylomicrons, LDL, HDL, and VLDL. Pathalogical changes in lipid levels. Formation of micelles, monolayers, bilayer, liposomes. Lipid metabolism: Beta oxidation of fatty acids
Unit 3:	**Nucleic acids, Vitamins and Co-enzymes [15]** **Weightage: 20M**
	Nucleic acids: Molecules of Heredity: Structure of deoxyribonucleic acid (DNA) and ribonucleicacid (RNA), DNA double helix, A, B, and Z forms of DNA, DNA as genetic material, genetic code, flow of genetic information, DNA replication, transcription and translation **Vitamins and Co-enzymes:** Classification, water-soluble and fat-soluble vitamins. Structure, dietary requirements, deficiency conditions, coenzyme forms.
Unit 4:	**Bioinorganic Chemistry [15]** **Weightage: 20M**
	Principles of coordination Chemistry related to Bioinorganic–Proteins, nucleic acids, and other metal binding biomolecules. Choice, uptake, and assembly of metal containing units in Biology. Control and utilization of metal ion concentration in cells. Metal ion folding and cross linking of biomolecules. Binding of metal ions and complexes to biomolecular active centers
	Reference books:
	1. Handbook of Biochemistry and Molecular Biology by Roger L. Lundblad 2. Fundamentals of Biochemistry A Textbook by H.P. Gajera, and S. V. Patel 3. Lehninger Principles of Biochemistry by David L. Nelson, Michael M. Cox.

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***Teaching Scheme** **Project work: 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Research is a critical component of the MSc Pharmaceutical chemistry program, with students acquiring skills in research methodology, data collection, analysis, and scientific inquiry. By engaging in independent research projects, students are encouraged to develop innovative solutions to complex scientific problems, preparing them for advanced studies and research-oriented careers.

	Course Objectives:
●	To know the basic idea behind the research.
●	To understand the terms for research project like introduction, background and significance, literature and review, research designs and methods, results and discussion, and conclusion etc.
●	To know the data collection and analysis/interpretation of data
●	To know the project report writing and submission.
	Course Outcomes: Students can able to understand -
CO1:	Basic idea behind the research.
CO2:	Terms for research project like introduction, background and significance, literature and review, research designs and methods, results and discussion, and conclusion etc.
CO3:	Knowledge of data collection and analysis/interpretation of data
CO4:	Project report writing and submission.
	Candidates are expected to work on assigned research project and submit the results at the end of the semester in the form a dissertation. Open defense of the student on his/her dissertation shall be arranged. This defense shall be in front of the panel of examiners. This will be valued for 40 marks. Project work involving organic synthesis/evaluation of biological studies or in-plant training in any of the pharmaceutical or chemical industry for at least 21 days will be considered. Project should be completed under the guidance of a faculty member in the same Department or Industry or research organization. In case of Industry / research

	organization one member of that body can also be included as project guide. **Guidelines for Assessment** • Quality of Literature survey and Novelty in the problem • Clarity of Problem definition and Feasibility of problem solution • Clarity of objective and scope • Quality of work attempted • Presentation skills

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***Teaching Scheme** **Practical: 04 Hours/week, 02 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**
Course Preamble: Spectral Analysis is one of the core courses in the Pharmaceutical Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding and interpretation of UV, IR, NMR and Mass spectra. Students will study these subtopics in detail. By combining theoretical knowledge with numerical treatment, the course aims to develop spectroscopic skills in analyzing organic compounds.	

	Course Objectives:
•	To identify the organic compounds by using UV, IR, 1H NMR, 13C NMR amd Mass spectra.
•	To understand the interpretation of the UV, IR, ^{1}H NMR, ^{13}C NMR, Mass spectra of various organic compounds
	Course Outcomes:
CO1:	Able to identify the organic compounds by using UV, IR, 1H NMR, 13C NMR amd Mass spectra.
CO2:	Able to understand the interpretation of the UV, IR, ^{1}H NMR, ^{13}C NMR, Mass spectra

	of various organic compounds
CO3:	**List of Practicals**
	Identification of Pharmaceutically important Intermediates by the analysis of their spectra. Photocopies of UV, IR, NMR and Mass spectra of standard compounds are to be interpreted to determine the structure of the compound. At the time of practical examination, candidates are expected to submit the Journal.
	References:
	1. A Textbook of Practical Organic Chemistry - A. I. Vogel. 2. Practical Organic Chemistry - Mann & Saunders. 3. A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke. 4. Organic Synthesis Collective Volumes by Blat. 5. Laboratory Handbook of Instrumental Drug Analysis by B.G. Nagavi. 6. Spctrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004. 7. Organic Spectroscopy - William Kemp, 3 rd edition, ELBS, 1991.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Pharmaceutical Chemistry) Sem-III** **Vertical: DSC** **Course Code: 2303305** **Course Name: Pharmaceutical Chemistry (Practical-II)**
***Teaching Scheme** **Lectures: 04 Hours/week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Preamble: Pharmaceutical Chemistry Practical is one of the core courses in the Pharmaceutical Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts in Drug synthesis / Molecular modeling: Synthesis of medicinally important compounds. Students will study the experiments in detail. By combining theoretical knowledge with Molecular modeling, the course aims to develop practical skills in Synthesis of medicinally important compounds.

	Course Objectives:
•	To acquire the knowledge and understanding of the basic experimental principles of

	pharmaceutical organic chemistry.
•	To draw the structures and synthesize simple pharmaceutically active organic compounds.
	Course Outcomes:
CO1:	Able to acquire the knowledge and understanding of the basic experimental principles of pharmaceutical organic chemistry.
CO2:	Able to draw the structures and synthesize simple pharmaceutically active organic compounds.
	List of Practicals
1.	Drug synthesis / Molecular modeling: Synthesis of medicinally important compounds: (TLC Analysis is recommended) **(Any five)** 1. Benzocain 2. Coumarins 3. Benzimidazole 4. Paracetamol 5. Iodoform 6. Phenyl azo-2 naphthol 7. 2-Phenyl quinoline-4-carboxylic acid from benzaldehyde. **(Note: Other suitable experiments may be added)**
	References:
	1. A Textbook of Practical Organic Chemistry - A. I. Vogel. 2. Practical Organic Chemistry - Mann & Saunders. 3. A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke. 4. Organic Synthesis Collective Volumes by Blat. 5. Reagents in Organic Synthesis by Fieser and Fieser. 6. Organic Practicals by Ahluwalia. 7. Systematic Lab Experiments in Organic Chemistry by Arun Sethi. (New Age).

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Pharmaceutical Chemistry) Sem-III** **Vertical: DSE** **Course Code: 2303308** **Course Name: Modern Pharmaceutical Analytical Techniques (Practical-III)**

***Teaching Scheme**	***Examination Scheme**
Practical: 04 Hours/week, 02 Credits	**UA: 30 Marks** **CA: 20 Marks**

Course Preamble: Practicals on Modern Pharmaceutical Analytical Techniques is one of the core courses in the Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts in calibration of instruments. Students will study these experiments in detail. By combining theoretical knowledge with analytical techniques, the course aims to develop practical skills in analyzing and optimizing the drugs.

	Course Objectives:
•	To learn about different techniques, such as UV-Visible spectrophotometer / FTIR and Column chromatography etc
•	To understand the role of UV-Visible spectrophotometer / FTIR and Column, chromatography, pH meter, and flame photometry in pharmaceutical analysis
	Course Outcomes:
CO1:	Able to learn about different techniques, such as UV-Visible spectrophotometer / FTIR and Column chromatography etc
CO2:	Able to understand the role of UV-Visible spectrophotometer / FTIR and Column, chromatography, pH meter, and flame photometry in pharmaceutical analysis
	List of Practicals:
1.	Analysis of Pharmacopoeial compounds and their formulations by UV Vis spectrophotometer.
2.	Simultaneous estimation of multi component containing formulations by UV spectrophotometry
3.	Estimation of Riboflavin/Quinine sulphate by fluorimetry
4.	Estimation of sodium/potassium by flame photometry
5.	Calibration of glasswares/pH meter /UV-Visible spectrophotometer / FTIR spectrophotometer/ GC instrument / HPLC instrument
6.	Experiments based on Column chromatography
7.	Experiments based on HPLC

8.	Experiments based on Gas Chromatography
9.	Assay of Drugs and Raw materials as per official monographs (Indian pharmacopoeia)
10.	Determination of Pka and Log p of drugs.
11.	Validation of an analytical methods of drugs.
12.	Determination of purity by DSC in pharmaceuticals **(Note: Other suitable experiments may be added)**
	References:
	1. A Textbook of Practical Organic Chemistry - A. I. Vogel. 2. Practical Organic Chemistry - Mann & Saunders. 3. A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke. 4. Organic Synthesis Collective Volumes by Blat. 5. Reagents in Organic Synthesis by Fieser and Fieser. 6. Organic Practicals by Ahluwalia. 7. Systematic Lab Experiments in Organic Chemistry by Arun Sethi. (New Age). 8. Advanced Practical Medicinal Chemistry by Ashutosh Kar 9. Practical Pharmaceutical Chemistry-part two by A.H.Beckett and J.B. Stenlake. 10. Practical Pharmaceutical Analysis by Dr.G. Devala Rao. 11. Laboratory Handbook of Instrumental Drug Analysis by B.G. Nagavi. 12. Spectrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004. 13. Principles of Instrumental Analysis - Doglas A Skoog, F. James Holler, Timothy A. Nieman, 5 th edition, Eastern press, Bangalore, 1998. 14. Instrumental methods of analysis – Willards, 7 th edition, CBS publishers. 15. Organic Spectroscopy - William Kemp, 3 rd edition, ELBS, 1991. 16. Quantitative analysis of pharmaceutical formulations by HPTLC - P D Sethi, CBS Publishers, New Delhi. 17. Quantitative Analysis of Drugs in Pharmaceutical formulation - P D Sethi, 3 rd Edition, CBS Publishers, New Delhi, 1997. 18. Pharmaceutical Analysis- Modern methods – Part B - J W Munson, Volume 11, Marcel Dekker Series.

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **Second Year M.Sc. (Pharmaceutical Chemistry) Sem-III** **Vertical: DSE** **Course Code: 2303309** **Course Name: Biochemistry (Practical)**
***Teaching Scheme** **Practical: 04 Hours/week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Preamble: Biochemistry practical is one of the core courses in the Pharmaceutical Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts in extraction, isolation and microbial studies. Students will study these experiments in detail. By combining theoretical knowledge with practical skills, the course aims to develop skills of Biochemistry.

	Course Objectives:
•	To know the extraction and isolation process of plant products
•	To know the estimation of proteins and carbohydrates
	Course Outcomes:
CO1:	Able to know the extraction and isolation process of plant products
CO2:	Able to know the estimation of proteins and carbohydrates
	List of Practicals
1.	Estimation of carbohydrates
2.	Estimation of proteins
3.	Molar extinction coefficient of molecules
4.	Extraction and estimation of lipids
5.	Direct microscopic counts
6.	Total viable counts
7.	Control of microbial growth
8.	Determination of MIC (plate method)
9.	Isolation of Bacterial, animal, plant and plasmid DNA
10.	10. Agarose gel electrophoresis of DNA

16.	**(Note: Other suitable experiments may be added)**
	References:
	1. Practical Biochemistry by Damodaran Geetha K 2. Biochemistry Practical Book for Biomolecules & Food Analysis by Dr R Subashini 3. A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke. 4. Systematic Lab Experiments in Organic Chemistry by Arun Sethi. (New Age).

Semester IV

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Pharmaceutical Chemistry) Sem-IV** **Vertical: DSC** **Course Code: 2303401** **Course Name: Advanced Organic Chemistry**
***Teaching Scheme** **Lectures: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Advanced Organic Chemistry is one of the core courses in the Pharmaceutical Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts in Free radical reactions, Name reactions, Rearrangements and Reagents, Organoboranes. Students will study these subtopics in detail. By combining theoretical knowledge with reaction mechanism, the course aims to develop practical skills in designing the drug molecules.

	Course Objectives:
•	To understand the free radical, their reactions and applications.
•	To study different name reactions, reagents and rearrangements.
•	To know in detail chemistry of organoboranes.
•	To apply knowledge all types of reactions while designing the drug molecules.
	Course Outcomes:
CO1:	The student is able to understand the free radical, their reactions and applications.

CO2:	The student study different name reactions, reagents and rearrangements.
CO3:	The student knows in detail chemistry of organoboranes.
CO4:	The student able to apply knowledge all types of reactions while designing the drug molecules.
Unit 1:	**Free radical reactions [15]** **Weightage: 20M**
	Types of free radical reactions, detection by ESR, free radical substitution mechanism, mechanism at aromatic substrates, neighboring group assistance. Reactivity for aliphatic and aromatic substitution at a bridge head. Reactivity in attacking radicals. The effect of solvent on reactivity. Allylic hydrogenation (NBS), Oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salt, Sandmeyers reaction. Free radical rearrangement.
Unit 2:	**Name reactions: (15)** **Weightage: 20M**
	Darzen, Prins, Henry, Strecker amino acid synthesis. Bamford-Steven, Baylis-Hillmann, Corey-Fuchs Reaction, Julia Olefination, Mukaiyama aldol, Corey-Winter olefination, Shapiro, Ritter, Stille, Heck, Sonogashira, Suzuki, Negishi, Kumada, Hiyama, Tsuji-Trost, Duff, Chugaev, Petasis. Ring closing metathesis (Grubb's metathesis), Aldol-Tishchenko reaction (Evans-Tishchenko reaction).
Unit 3:	**Rearrangements and Reagents: (15)** **Weightage: 20M**
	Rearrangements: Payne, Eschenmoser fragmentation, Brook, Wagner-Meerwein, Wolf, Semipinacol, Epoxide rearrangement with lewis acid, Tiffeneau-Demjanov, von Richter, Wittig, Neber, Smiles, Steven, Hofmann, Iodolactonisation, Hoffmann-Loffler Fretag reaction **Reagents:** Lithium dialkylcuprate (LDC), DCC, DDQ, Organotin reagents, Peterson's synthesis, Trimethylsilyl iodide, PPA, Selenium dioxide
Unit 4:	**Organoboranes (15)** **Weightage: 20M**
	Preparation and properties of organoborane reagents e.g. RBH2, R2BH, R3B, 9-BBN, catechol borane. Thexylborane, cyclohexylborane , ICPBH2,-21-IPC2BH, Hydrboration mechanism, stereo and regeoselectivity, uses in synthesis of primary, secondary tertiary alcohols, aldehydes, ketones, alkenes. Synthesis of EE, EZ, ZZ dienes and alkyenes.

	Mechanism of addition of IPC2BH. Allyl boranes- synthesis, mechanism and uses.
	Reference books:
	1. A guidebook to Mechanism in Organic Chemistry (Orient- Longmens)- Peter Sykes 2. Organic Reaction Mechanism (Benjamin)-R. Bresslow 3. Mechanism and Structure in Organic Chemistry (Holt Reinhartwinston)- B. S. Gould 4. Organic Chemistry (McGraw Hill)-Hendrikson, Cram and Hammond 5. Basic principles of Organic Chemistry (Benjamin) J. D. Roberts and M. C. Caserio. 6. Reactive intermediates in Organic Chemistry 9 Jojn Wiley) N. S. Issacs. 7. Organic reaction mechanism (Mc Graw Hill) R. K. Bansal 8. Advanced organic chemistry, part B: Reaction and synthesis by Francis A. Carey, Richard Y. Sandburg. 9. Organic Chemistry by Clayden, Greeves, Warren and Wothers.

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***Teaching Scheme** **Lectures: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Drugs and Heterocycles is one of the core courses in the Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts in Classification, SAR, Mechanism of action and Synthesis of drugs and heterocycles. Students will study these subtopics in detail. By combining theoretical knowledge with reaction mechanism, the course aims to develop practical skills in designing the drug molecules with different heterocycles.

	Course Objectives:
•	To understand about drugs and heterocycles used in the treatment of various diseases.
•	To understand the chemistry of drugs and heterocycles with respect to their biological activity.
•	To know the metabolism, adverse effects and therapeutic value of drugs
•	To know the importance of SAR of drugs.

	Course Outcomes:
CO1:	The students can able to understand the use of the drugs and heterocycles.
CO2:	The students know about the structural activity relationship of the drug.
CO3:	The students can able to explain the synthesis of the drugs and heterocycles.
CO4:	The students can able to know the importance of SAR of drugs.
Unit 1:	Definition**,** Classification, SAR, Mechanism of action and Synthesis* of drugs for following classes: **[15]** **Weightage: 20M**
	Antibiotics: Penicillin: Ampicillin*, Amoxycillin. Cephalosporin: Cefadroxil, Cefixime*, Tetracycline, Chloramphenicol*, Amino glycosides: Streptomycin. **Sulfonamides**: Sulfapyridine, Sulfacetamide* and Sulfamethoxazole* **Antimalerials:** Quinine**,** Chloroquine* **Anticonvulsant:** Phenytoin* **Anesthetics:** Thiopental* **Sedative and hypnotics:** Diazepam* ●
Unit 2:	Definition**,** Classification, SAR, Mechanism of action and Synthesis* of drugs for following classes: **[15]** **Weightage: 20M**
	NSAIDs: Aspirin*, Ibuprofen*, Paracetamol*, Diclofenac*, Aceclofenac, Indomethacin, Nimesulide **Antidiabetics:** Insulin, Tolbutamide, Glipizide, Metformin* **Anti-hypertensive Drugs:** Captopril*, Atenolol, Methyldopa. **Antineoplastic:** Alkylating agent, Antimetabolites ●
Unit 3:	**Five-membered and Six-membered heterocycles** **[15]** **Weightage: 20M**
	Five-membered rings with two heteroatoms: Imidazole, Pyrazole, Oxazole, Thiazole. Six-membered rings with one heteroatom: Pyran, Pyridine Six-membered rings with two heteroatoms: Piperazine, Morphine, Thiomorphine, pyrimidines, pyrazines
Unit 4:	**Benzofused heterocycles:** **[15]** **Weightage: 20M**

	Benzopyrroles, Benzofuran, Indole, Benzothiophene, Benzoxazole, benzthiazole, Benzimidazole, Quinolines, Isoquinoline, Qunazolines
	Reference books:
	1. Comprehensive medicinal chemistry- Corwin and Hansch 2. Medicinal chemistry-Burgers (Vol-I-VI) 3. Principles of medicinal chemistry-William O. Foye 4. Textbook of medicinal chemistry- Vol-I&II- Surendra N Pandey 5. Principles of medicinal chemistry- S SKadam, K R Mahadik and K G Bothara 6. Introductory medicinal chemistry- Kennewell and Taylor 7. Wilson and Giswold`sText book of Organic medicinal and pharmaceutical chemistry- Jaimes N Delgado and William A Remere 8. Fundamentals of microbiology- Forpischer 9. Genetics of antibiotics producing microorganisms- G Sermouti 10. Organic Chemistry: Clayden, Greeves, Warren and Wo 11. Organic Synthesis: The Disconnection Approach: Stuart Warren 12. Designing Organic Synthesis: Stuart Warren

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Pharmaceutical Chemistry) Sem-IV** **Vertical: DSE** **Course Code: 2303405** **Course Name: Pharmaceutical Dosage Forms**
***Teaching Scheme** **Lectures: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Pharmaceutical Dosage Forms is one of the core courses in the Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the Dosage Forms, Drug Formulation, Drug delivery systems. Students will study these subtopics in detail. By combining theoretical knowledge of drug dosage and drug delivery systems, the course aims to develop practical skills of drug formulations.

	Course Objectives:
•	To get the information about the routes of administration of drug.
•	To know the different types of dosage forms and routes of administration of drug.

•	To understand the concept of formulations and Pre-formulation of drug.
•	To study the different types of drug delivery systems
	Course Outcomes:
CO1:	The student is able to get the information about the routes of administration of drug.
CO2:	The student knows the different types of dosage forms and routes of administration of drug.
CO3:	The student is able to understand the concept of formulations and Pre-formulation of drug.
CO4:	The student study the different types of drug delivery systems
Unit 1:	**Solid Dosage Forms [15]** **Weightage: 20M**
	Routes of administration, Types of dosage forms, Oral solids: tablets, types of tablets, methods of tablet production - wet granulation, coating of tablets. Quality control methods and measurement of tablet properties, packaging.
Unit 2:	**Other Dosage Forms [15]** **Weightage: 20M**
	Oral liquids: Suspensions and Emulsions: Definition, types, stability, suspending/ emulsifying agents, evaluation, and packaging. Parenterals, Ophthalmic products, Aerosols, Inhalation products. Topical lipids, semisolids, and powders.
Unit 3:	**Drug Formulation [15]** **Weightage: 20M**
	Concept of excipients, classifications with examples, colours, flavours and preservatives in formulations. Concept of Pre-formulation, factors influencing designing of dosage forms, drug excipients interaction, stability studies.
Unit 4:	**Drug delivery systems: [15]** **Weightage: 20M**
	Fundamental of novel drug delivery: Rationale of sustained release, controlled release dosage forms. Oral controlled drug delivery systems, mucosal drug delivery system, ocular drug delivery systems, parenteral drug delivery systems, transdermal drug delivery systems.

	Reference books:
	1. The theory and practice of Industrial pharmacy (CBS) Leon Lachman, 2. Dispensing of pharmaceuticals (CBS) Cooper and Gunn 3. The Science and Practice of Pharmacy by Remington 4. Biopharmaceutics and Pharmacokinetics by Brahmankar 5. Pharmaceutical dosage forms and drug delivery systems by Ansel 6. The science of dosage forms design by Aulton

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***Teaching Scheme** **Lectures: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Pharmaceutical Technology is one of the core courses in the Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts in API manufacturing units, Unit Process, Unit operation in tableting, Validation. Students will study these subtopics in detail. By combining theoretical knowledge with unit processes, the course aims to develop the skills of industrial processes.

	Course Objectives:
•	To understand the API unit processes
•	To know plant layout of different unit processes
•	To study the various kinds of unit operations
•	To understand the different types validations and Regulatory guidelines
	Course Outcomes:
CO1:	The student is able to understand the API unit processes
CO2:	The student knows plant layout of different unit processes
CO3:	The student study the various kinds of unit operations
CO4:	The student is able to understand the different types validations and Regulatory guidelines

Unit 1:	**API manufacturing units** **[15]** **Weightage: 20M**
	Chemical process, Chemical plants/Industry, Process flow diagram, Factors affecting chemical processes, Reaction systems, Reactors used in API manufacturing, Plant layout and Effluent Treatment Plant (ETP).
Unit 2:	**Unit Process** **[15]** **Weightage: 20M**
	Scale up techniques, plant layout of Oxidation: oxidation of Methanol, Liquid phase oxidation with oxygen-Acetaldehyde to Acetic acid, Halogenation: Technical Halogenations-Manufacturing processes for monochloroacetic acid, Chloral, Monochlorobenzene, and Vinyl chloride (Ethylene and Acetylene), Nitration: Typical industrial Nitration process (Nitrobenzene, and α-Nitronaphthalene); Esterification: Esterification by organic acid, Manufacture of Vinyl acetate and Cellulose related to active pharmaceutical ingredients (API) manufacturing-plant layout, Technology transfer.
Unit 3:	**Unit operation in tableting** **[15]** **Weightage: 20M**
	Milling/Mixing, Granulation, Screening, Drying, Blending, Compression, Coating, Plant layout.
Unit 4:	**Validation** **[15]** **Weightage: 20M**
	Validation, Qualifications (DQ, IQ, OQ, PQ), Master plan of validation, Process validation, cleaning validation, Computer system validation, Utilities validation, Validation of manufacturing equipment and analytical instruments, Analytical method validation, Regulatory guidelines.
	Reference books:
	Reference books: 1. The Theory and Practice of Industrial Pharmacy (CBS) by Leon Lachman 2. The Science and Practice of Pharmacy by Remington 3. Pharmaceutical Process Chemistry for Synthesis: Rethinking the Routes to Scale-Up, Peter J. Harrington, John Wiley and Sons Inc. Publication 2011.

4. Strategies for Organic Drug Synthesis and Design by Daniel Lednicer, 2nd Edition, John Wiley and Sons Inc. Publication, 2008
5. Process Chemistry in Pharmaceutical Industry, Kumar Gadamasetti, Vol I & II, CRC Press; First edition, 2007.
6. Practical Process Research and Development, Neal G. Anderson, Academic Press., 2000
7. Principles of Process Research and Chemical Development in the Pharmaceutical Industry by O. Repic, John Wiley & Sons. Inc Publication New York, NY, 1998.
8. Organic Synthesis, Groggins P. H, (Third Edition). P. H. Groggins. McGraw-Hill, New York, 1947.
9. Fire Safety Management by Satish Tandon, Arise Publishers & Distributors; 1st edition, 2008.
10. Pollution Prevention of Chemical Processes, Allen David, Wiley-Blackwell, 1996.
11. The Treatment and Handling of Wastes, Bradshaw, A.D. Chapman and Hall for the Royal Society; First Edition edition, 1992.
12. Good Pharmaceutical Manufacturing Practice: Rationale and Compliance by Sharp John, CRC Press; 1st edition, 2004
13. Management Information Systems by Laudon Kenneth C. Prentice Hall; 12th edition, 2011.
14. Plant Design and Economics for Chemical Engineers by Peters, Max S., McGraw-Hill Science/Engineering/Math; 5 editions, 2002.
15. Textbook of Pharmaceutical Validation (First Edition), by A. A. Kulkarni, V.S. Kashikar, A.H. Hosmani, I.D. Gonjari, Pharma Career Publications
16. ICH Guidelines, www.ich.org
17. WHO Guidelines
18. GMP Guidelines
19. P.H.Groggins: Unit processes in organic synthesis (MGH)
20. F.A.Henglein: Chemical Technology (Perga mon)
21. M.G.Rao & M. Sitting: Outlines of Chemical Technology (EWP)
22. Clausen, Mattson: Principle of Industrial Chemistry

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***Teaching Scheme** **Project work: 06 Credits**	***Examination Scheme** **UA: 90 Marks** **CA: 60 Marks**

Course Preamble: Research Project is one of the core courses in the Pharmaceutical Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts in Project work involving organic synthesis/evaluation of biological studies or in-plant training in any of the pharmaceutical or chemical industry. The course aims to develop research skills in Pharmaceutical Chemistry.

	Course Objectives:
•	To know the basic idea behind the research.
•	To understand the terms for research project like introduction, background and significance, literature and review, research designs and methods, results and discussion, and conclusion etc.
•	To know the data collection and analysis/interpretation of data
•	To know the project report writing and submission.
	Course Outcomes: Students can able to understand the -
CO1:	Basic idea behind the research.
CO2:	Terms for research project like introduction, background and significance, literature and review, research designs and methods, results and discussion, and conclusion etc.
CO3:	Knowledge of data collection and analysis/interpretation of data
CO4:	Project report writing and submission.
•	Candidates are expected to work on assigned research project and submit the results at the

	end of the semester in the form a dissertation. Open defense of the student on his/her dissertation shall be arranged. This defense shall be in front of the panel of examiners. This will be valued for 40 marks. Project work involving organic synthesis/evaluation of biological studies or in-plant training in any of the pharmaceutical or chemical industry for at least 21 days will be considered. Project should be completed under the guidance of a faculty member in the same Department or Industry or research organization. In case of Industry / research organization one member of that body can also be included as project guide. **Guidelines for Assessment** • Quality of Literature survey and Novelty in the problem • Clarity of Problem definition and Feasibility of problem solution • Clarity of objective and scope • Quality of work attempted • Presentation skills

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***Teaching Scheme** **Practical: 04 Hours/week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Preamble: Organic Preparations is one of the core courses in the Pharmaceutical Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts in multi-stage preparations. The course aims to develop practical skills in synthesizing drug molecules.

	Course Objectives:
•	To understand the type of reaction involved in the multistep preparation
•	To study the mechanism involved in the multistep preparation and their applications

•	**Course Outcomes:**
CO1:	Able to understand the type of reaction involved in the multistep preparation
CO2:	Able to study the mechanism involved in the multistep preparation and their applications
	List of Practicals:
	Two /Three stages organic preparations (Any five) (TLC Analysis is recommended)
1.	1. Preparation of Benzanilide by Beckmann rearrangement
2.	2. Preparation of Antharanilic acid
3.	3. Preparation of Phthalimide
4.	4. Preparation of N- Bromosuccinamide
5.	5. Preparatin of p- Aminobenzoic acid
6.	6. Preparation of p- chloronitrobenzene by Sandmeyer reaction
7.	7. Preparation of p- Iodonitrobenzene by Sandmeyer reaction
8.	8. Pinacol- Pinacolone rearrangement
9.	9. Preparation of Acetophenones by Fries rearrangement
10.	10. Preparation of aromatic aldehydes by Vilsmer Hack reaction or R. T.
	References:
	1. A Textbook of Practical Organic Chemistry - A. I. Vogel. 2. Practical Organic Chemistry - Mann & Saunders. 3. A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke. 4. Organic Synthesis Collective Volumes by Blat. 5. Reagents in Organic Synthesis by Fieser and Fieser. 6. Organic Practicals by Ahluwalia. 7. Systematic Lab Experiments in Organic Chemistry by Arun Sethi. (New Age).

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Pharmaceutical Chemistry) Sem-IV** **Vertical: DSE** **Course Code: 2303407** **Course Name: Drug assay and drug formulations (Practical-II)**
***Teaching Scheme** **Practical: 04 Hours/week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Preamble: Pharmaceutical Dosage Forms is one of the core courses in the Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the Assay, Evaluation, Plant Layout, Process Flow chart, Validation. By combining theoretical knowledge of drug dosage and drug delivery systems, the course aims to develop practical skills of drug formulations and drawing Plant Layout.

	Course Objectives:
•	To study the assay of various tablets and capsules
•	To understand the Plant Layout of Tablet Unit and Process Flow chart of parenteral formulation
•	To prepare different kinds of emulsions, suspensions and syrups.
	Course Outcomes:
CO1:	Able to study the assay of various tablets and capsules
CO2:	Able to understand the Plant Layout of Tablet Unit and Process Flow chart of parenteral formulation
CO3:	Able to prepare different kinds of emulsions, suspensions and syrups.
	List of Practicals
1.	Assay of Paracetamol Tablet
2.	Assay of Chloramphenicol Capsule
3.	Assay of Aspirin Tablet
4.	Assay of Vitamin-C
5.	Preparation and Evaluation of Tablet
6.	Draw Plant Layout of Tablet Unit
7.	Draw Process Flow chart of parenteral formulation

8.	Validation of UV-Visible spectroscopic analytical method
9.	Performance Qualification of IR
10.	Evaluation of Packaging Material (Glass/Plastic)
11.	Preparation of weak Iodine solution
12.	Preparation of Paracetamol Suspension
13.	Preparation of Castor Oil Emulsion
14.	Preparation of Simple Syrup IP
15.	Preparation of Lemon Syrup
16.	Preparation of Sodium chloride eye lotion
17.	Preparation of Methyl salicylate Ointment **(Note: Other suitable experiments may be added)**
	References:
	1. Advanced Practical Medicinal Chemistry by Ashutosh Kar 2. Practical Pharmaceutical Chemistry-part two by A.H.Beckett and J.B. Stenlake. 3. Practical Pharmaceutical Analysis by Dr.G. Devala Rao. 4. Laboratory Handbook of Instrumental Drug Analysis by B.G. Nagavi. 5. Indian pharmacacopoeia. 6. ICH guidelines-(Q2) Analytical method validation.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Pharmaceutical Chemistry) Sem-IV** **Vertical: DSE** **Course Code: 2303408** **Course Name: Pharmaceutical Technology (Practical-II)**
***Teaching Scheme** **Practical: 04 Hours/week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Preamble: Pharmaceutical Technology is one of the core courses in the Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts in Pre-formulation studies, Study of Stability drug. The course aims to develop the formulations of drug.

	Course Objectives:
•	To study the stability of drug at different temperature
•	To study the solubility of drug in different solutions.
	Course Outcomes:
CO1:	Able to study the stability of drug at different temperature
CO2:	Able to study the solubility of drug in different solutions.
	List of Practicals
1.	Pre-formulation studies: Drug-drug interaction and drug excipient interaction in physical mixture.
2.	Determination of solubility of Paracetamol in water, 0.1N HCl, 0.1N NaOH, Phosphate buffer pH 6.8 and 7.4
3.	Study of Stability drug: Room Temperature, UV light, and Sun light (**Note:** Other suitable experiments may be added)
	References:
	3. Quantitative analysis of pharmaceutical formulations by HPTLC - P D Sethi, CBS Publishers, New Delhi. 4. Quantitative Analysis of Drugs in Pharmaceutical formulation - P D Sethi, 3 rd Edition, CBS Publishers, New Delhi, 1997. 5. Pharmaceutical Analysis- Modern methods – Part B - J W Munson, Volume 11, 4. Indian pharmacacopoeia. 5. ICH guidelines-(Q2) Analytical method validation.

Nature of Examination:
Each semester will have theory external assessment examination of 60 marks each (2.5 hrs. duration) and 40 marks college assessment. The practical examination of Semesters III to IV will be conducted at the end of each semester. Duly certified copy of laboratory record must be produced at the time of examination.

Practical Examination of M. Sc. II
The practical examination will be of 3 days for each semester.

Semester III:

Practical courses each : 30 (UA)+ 20 (CA)
Research Project work : 60 (UA) + 40 (CA)

Semester IV:

Practical courses each : 30 (UA)+ 20 (CA)
Research Project work : 90 (UA) + 60 (CA)

** The evaluation of Research Project will be done by both external and internal examiners at the time of examination.

Nature of question paper (M. Sc. II):

Time: 2 ½ hours Maximum Marks: 60

Instructions

1. All questions are compulsory
2. All questions carry equal marks.
3. Figures to the right indicate full marks.
4. Use of log tables and calculators is allowed.

Question Paper

Q 1. A) Choose correct alternative **Marks 8 (1 x 8)**
Sub-questions (i) to (viii)

B) Fill in the blanks **Marks 4 (1 x 4)**
Sub questions (i) to (iv)

Q 2. Answer the following (any six) **Marks 12 (2 x 6)**
Sub-questions (a) to (h)

Q 3. Answer the following (any three) **Marks 12 (3 x 4)**
Sub-questions (a) to (d)

Q 4. Answer the following (any two) **Marks 12 (6 x 2)**
Sub-questions (a) to (c)

Q 5. Answer the following (any two) **Marks 12 (6 x 2)**
Sub-questions (a) to (c)

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