

CENTRAL UNIVERSITY OF PUNJAB



Master of Pharmacy (Pharmaceutical Chemistry)

Session - 2026-28

**Department of Pharmaceutical Sciences and Natural
Products**

Course structure for M. Pharm. (Pharmaceutical Chemistry)

Course Code	Name of the course	Credit hours	Credit points	Hrs/ wk	Marks
SEMESTER I					
MPC101T	Modern Pharmaceutical Analytical Techniques	4	4	4	100
MPC102T	Advanced Organic Chemistry–I	4	4	4	100
MPC103T	Advanced Medicinal Chemistry	4	4	4	100
MPC104T	Chemistry of Natural Products	4	4	4	100
MPC105P	Pharmaceutical Chemistry Practical-I [#]	12	6	12	150
MPC106P	Communication Skills and Scientific Writing (P)	4	2	4	50
MPC594S	Seminar/Assignment	7	4	7	100
	Total	39	28	39	700
SEMESTER II					
MPC201T	Advanced Spectral Analysis	4	4	4	100
MPC202T	Advanced Organic Chemistry – II	4	4	4	100
MPC203T	Computer Aided Drug Design	4	4	4	100
MPC204T	Pharmaceutical Process Chemistry	4	4	4	100
MPC205P	Pharmaceutical Chemistry Practical-II [#]	12	6	12	150
MPC594S	Seminar/Assignment	7	4	7	100
XXX	Inter-Disciplinary Course (or through MOOC)	2	2	2	50
	Total	37	28	37	700
SEMESTER III					
MRM 301T	Research Methodology & Biostatistics	4	4	4	100
MPC302T	Journal club	1	1	1	25
MPC303T	Discussion/ Presentation (Proposal Presentation)	2	2	-	50
MPC599-1	Research Work	28	14	-	350
	Total	35	21	5	525
SEMESTER IV					
MPC401T	Journal club	1	1	1	25
MPC402T	Discussion / Presentation	3	3	-	75
MPC599-2	Research Work, thesis and viva-voce [#]	31	16	-	400
	Total	35	20	1	500

[#]To be evaluated by external expert

Examination pattern

Core, Discipline Elective, Compulsory Foundation,			Interdisciplinary Course, Value Added, Entrepreneurship, Innovation and skill development Courses	
	Marks	Evaluation	Marks	Evaluation
Internal Assessment	25	Various methods	-	-
Mid-semester test (MST)	25	Descriptive	50	Descriptive (70%) Objective (30%)
End-semester test (EST)	50	Descriptive (70%) Objective (30%)	50	Descriptive (70%) Objective (30%)

Objective Questions- one-word/sentence answers, fill-in the blanks, MCQs', and matching

Descriptive Questions- Short answer and essay type questions

Internal assessment- any two or more of the given methods: Surprise Tests, open book examination, assignments, term paper, etc.).

Evaluation criteria for practical:

Item	Synopsis	Performance	Practical Note book and continuous evaluation	Viva voce
Marks	20	50	50	30

Thesis/Dissertation Proposal (Third Semester)			Thesis/Dissertation (Fourth Semester)		
	Marks	Evaluation		Marks	Evaluation
Supervisor	200	Dissertation proposal and presentation	Supervisor	200	Continuous assessment (regularity in work, mid-term evaluation) dissertation report, presentation, final viva-voce
HoD and senior-most faculty of the department	150	Dissertation proposal and presentation	External expert, HoD and senior-most faculty of The department	200	Dissertation report (100), presentation (50), final viva-voce (50)

Evaluation pattern similar to third and fourth semester dissertation will apply for internship

Graduate attributes for M. Pharm. in Pharmaceutical Chemistry

After completing a Master of Pharmacy in Pharmaceutical Chemistry; the graduates will have a quality conscious service providing attitude by adopting the knowledge of spectral analysis and chromatographic techniques in manufacturing and Research & Development of drugs. They will have a perspective to develop efficacious, safe, and affordable drugs in a reasonable time using transformative digital technologies and will be able to implement Computer Aided Drug Design principles in modern drug discovery and development process in higher studies and at the industrial level. They will be able to apply the knowledge of chemistry for the development of synthetic methodologies including peptide chemistry, retro-synthesis and green chemistry for making the drugs affordable to the public and will be having an attribute to become self-reliant in APIs by the development of scale-up of APIs and intermediates, unit operations and industrial safety guidelines. The graduates will have a positive attitude to implement the sustainable development goals to make the planet safe for the next generations by implementing a circular economy and a philosophy to comprehend the socio-economy of medicines and make the world healthy. This program will also help graduates make careers in industry, government organizations or institutions of higher learning.

Semester 1

Course Title: Modern Pharmaceutical Analytical Techniques

Paper Code: MPC101T

Course Hours: 60h

L	T	P	Credits
4	0	0	4

Learning Outcomes:

After completing this course, the learner will be able to:

CLO1: Explain the principles, theory, and applications of UV-Vis, IR, and spectrofluorimetry, and apply them to analyze the structure and concentration of samples.

CLO2: Describe the instrumentation, operational mechanisms, and data interpretation of Nuclear Magnetic Resonance (NMR) and Mass Spectrometry techniques.

CLO3: Separate and identify components of complex mixtures by applying appropriate chromatographic techniques (e.g., HPLC, GC, TLC).

CLO4: Conceptualize the principles of electrophoresis and X-ray crystallography, and outline procedures for handling the instruments.

CLO5: Explain the instrumentation and principles of Thermal Analysis (DSC, DTA, TGA) to analyze thermal transitions and decomposition in materials.

Course Contents

Units/Hours	Content	Mapping with course learning outcomes
Unit 1 10 Hours	UV-Visible Spectroscopy • Introduction, Theory, Laws, and Instrumentation associated with UV-Visible spectroscopy • Choice of solvents and solvent effect • Applications of UV- Visible spectroscopy • Difference/ Derivative spectroscopy IR Spectroscopy • Theory, Modes of Molecular vibrations, Sample handling • Instrumentation of Dispersive and Fourier - Transform IR Spectrometer • Factors affecting vibrational frequencies • Applications of IR spectroscopy, data interpretation Spectrofluorimetry • Theory of Fluorescence • Factors affecting fluorescence (characteristics of drugs that can be analysed by fluorimetry), Quenchers, Instrumentation • Applications of fluorescence	CLO1

	spectrophotometer Flame Emission Spectroscopy and Atomic Absorption Spectroscopy • Principle, Instrumentation, Interferences and Applications. Learning activities: Learner will be engaged in hands on training on different instruments like UV, IR and spectrophotometer.	
Unit 2 10 Hours	NMR Spectroscopy • Quantum numbers and their role in NMR • Principle, Instrumentation, Solvent requirement in NMR • Relaxation process, NMR signals in various compounds • Chemical shift, Factors influencing chemical shift, Spin-Spin coupling, Coupling constant, Nuclear magnetic double resonance • Brief outline of principles of FT-NMR and ¹³C NMR • Applications of NMR spectroscopy Learning activities: Learner will be familiarized with the instrument and provided NMR for the characterization of compounds.	CLO2
Unit 3 10 Hours	Mass Spectroscopy • Principle, Theory, Instrumentation of Mass Spectroscopy • Different types of ionization like electron impact, chemical, field, FAB and MALDI, APCI, ESI, APPI Analyzers of Quadrupole and Time of Flight • Mass fragmentation and its rules • Meta stable ions • Isotopic peaks • Applications of Mass spectroscopy Learning activities: Learner will be provided mass spectra for the characterization of compounds.	CLO2
Unit 4 10 Hours	Chromatography Principle, apparatus, instrumentation, chromatographic parameters, factors affecting resolution, isolation of drug from excipients, data interpretation and applications of the following: • Thin Layer chromatography • Ion exchange chromatography	CLO3

	• Column chromatography • Gas chromatography • High Performance Liquid chromatography • Ultra-High Performance Liquid chromatography • Affinity chromatography • Gel Chromatography Learning activities: Learner will be familiarized and trained in different chromatographic techniques like TLC, Column, HPLC, HPTLC and GC for the purification and characterization of compounds.	
Unit 5 10 Hours	Electrophoresis Principle, Instrumentation, working conditions, factors affecting separation and applications of the following: • Paper electrophoresis • Gel electrophoresis • Capillary electrophoresis • Zone electrophoresis • Moving boundary electrophoresis • Isoelectric focusing X ray Crystallography • Production of X rays • Different X ray diffraction methods • Bragg's law, Rotating crystal technique, X ray powder technique • Types of crystals and applications of X-ray diffraction Learning activities: Learner will be provided conceptual learning based on electrophoresis as well as handling of instruments.	CLO4
Unit 6 10 Hours	Potentiometry • Principle, working, ion selective electrodes • Application of potentiometry 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)	CLO5

	• Principle, instrumentation • Advantage and disadvantages • Pharmaceutical applications • Derivative differential thermal analysis (DDTA) TGA • Principle, instrumentation • Factors affecting results • Advantage and disadvantages • Pharmaceutical applications. Learning activities: Learner will be provided Web based learning to explain thermal techniques	
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REFERENCES

1. Spectrometric Identification of Organic compounds – Robert M Silverstein, 8th edition, John Wiley & Sons, 2015.
2. Principles of Instrumental Analysis – Douglas A Skoog, F. James Holler, Timothy A. Nieman, 6th edition, Cengage, 2014.
3. Instrumental methods of analysis – Willards, 7th edition, CBS publisher, 2004.
4. Practical Pharmaceutical Chemistry – Beckett and Stenlake, Vol II, 4th edition, CBS Publishers, New Delhi, 2007.
5. Organic Spectroscopy – William Kemp, 3rd edition, ELBS, 2008.
6. Quantitative Analysis of Drugs in Pharmaceutical formulation – P D Sethi, 3rd edition, CBS Publishers, New Delhi, 2007.
7. Pharmaceutical Analysis – Modern Methods – Part B – J W Munson, Vol 11, Marcel, Dekker Series 1984 (Reprint 2012)
8. Spectroscopy of Organic Compounds, 6th edⁿ., P. S. Kalsi, Wiley Eastern Ltd., Delhi, 2016.
9. Textbook of Pharmaceutical Analysis, KA. Connors, 3rd Edition, John Wiley & Sons, 2007.
10. Introduction to spectroscopy. 4th Edition, Pavia DL, Lampman GM, Kriz GS, Vryan JA.; Cengage Learning, 2008
11. Pharmaceutical quality by design: a practical approach. Schlindwein WS, Gibson M, editors. John Wiley & Sons; 2018.

Course Title: Advanced Organic Chemistry - I

L	T	P	Credits
4	0	0	4

Paper Code: MPC102T

Course Hours: 60h

Learning Outcomes:

After completing this course, the learner will be able to:

CLO 1: Define the fundamental principles, mechanisms, and stereochemistry of basic elimination and addition reactions.

CLO 2: Apply the mechanisms of key named organic reactions to propose synthetic routes for medicinal agents.

CLO 3: Utilize specific synthetic reagents and protecting groups for functional group transformations in complex molecule synthesis.

CLO 4: Identify nomenclature, structural characteristics, and classification of common heterocyclic systems.

CLO 5: Analyze synthetic pathways using disconnection approaches and predict reaction mechanisms for heterocyclic compound synthesis

Course Contents

Units/Hours	Content	Mapping with course learning outcomes
Unit 1 12 Hours	Basic Aspects of Organic Chemistry: 1. Organic intermediates: Carbocations, carbanions, free radicals, carbenes and nitrenes. Their method of formation, stability and synthetic applications. 2. Types of reaction mechanisms and methods of determining them, 3. Detailed knowledge regarding the reactions, mechanisms and their relative reactivity and orientations w.r.t addition, substitution, elimination and rearrangement reactions. 4. Chemistry of enolates Learning activities: Learner will be engaged in molecular models to explain the structure stability and conformation of organic intermediates to explain the stereochemistry in organic transformations and knowledge of reaction mechanisms.	CLO1
Unit 2 10 Hours	Study of Mechanism and Synthetic Applications of Following Named Reactions	CLO2

	• Ugi reaction, Brook rearrangement, Ullmann coupling reactions, Dieckmann Reaction, Doebner-Miller Reaction, Sandmeyer Reaction, Mitsunobu reaction, Mannich reaction, Vilsmeier-Haack Reaction, Sharpless asymmetric epoxidation, Baeyer-Villiger oxidation, Shapiro & Suzuki reaction, Ozonolysis and Michael addition reaction. Learning activities: Learner will be engaged hand on training in some of the named reactions with applications in organic and drug synthesis.	
Unit 3 12 Hours	Synthetic Reagents and Applications • Aluminiumisopropoxide, N-bromosuccinamide, diazomethane, dicyclohexylcarbodiimide, Wilkinson reagent, Witting reagent, Osmium tetroxide, titanium chloride, diazopropane, diethyl azodicarboxylate, Triphenylphosphine, Benzotriazol-1-yloxy) tris (dimethylamino) phosphonium hexafluoro-phosphate (BOP) Protecting Groups • Role of protection in organic synthesis • Protection for the hydroxyl group, including 1,2-and 1,3-diols: ethers, esters, carbonates, cyclic acetals & ketals • Protection for the Carbonyl Group: Acetal and Ketals • Protection for the Carboxyl Group: amides and hydrazides, esters • Protection for the Amino Group and Amino acids: carbamates and amides Learning activities: Learner will be engaged in performing experiments using various the synthetic reagents and protection of various functional groups.	CLO3
Unit 4 12 Hours	Heterocyclic chemistry: • Organic Name reactions with their respective mechanism and application involved in synthesis of drugs containing five, six membered and fused hetrocyclics such as Debus Radziszewski imidazole synthesis, Knorr Pyrazole Synthesis, Pinner Pyrimidine Synthesis, Combes Quinoline Synthesis,	CLO4

	Bernthsen Acridine Synthesis, Smiles rearrangement and Traube purine synthesis. Synthesis of few representative drugs containing these heterocyclic nucleus such as Ketoconazole, Metronidazole, Miconazole, celecoxib, antipyrin, Metamizole sodium, Terconazole, Alprazolam, Triamterene, Sulfamerazine, Trimethoprim, Hydroxychloroquine, Quinine, Chloroquine, Quinacrine, Amsacrine, Prochlorperazine, Promazine, Chlorpromazine, Theophylline, Mercaptopurine and Thioguanine. Learning activities: Learner will be engaged in performing the synthesis and characterization of some of the representative heterocyclic compounds as well as drugs based on these heterocycles.	
Unit 5 12 Hours	Synthon Approach and Retrosynthesis Applications - Basic principles, terminologies and advantages of retrosynthesis; guidelines for dissection of molecules - Functional group inter-conversion and addition (FGI and FGA) - C-X disconnections; C-C disconnections – alcohols and carbonyl compounds; 1,2-, 1,3-, 1,4-, 1,5-, 1,6-difunctionalized compounds - Strategies for synthesis of three, four, five and six-membered ring Learning activities: Learner will be engaged in Group discussion to explain disconnection approaches in synthesis	CLO5

Suggested Readings:

1. Advanced Organic chemistry, Reaction, Mechanisms and Structure. J March, John Wiley and Sons, New York.
2. Mechanism and Structure in Organic Chemistry. ES Gould, Hold Rinchart and Winston, New York.
3. Organic Chemistry. Clayden, Greeves, Warren and Wothers, Oxford University Press.
4. Organic Chemistry Vol I and II. I.L. Finar. ELBS, Pearson Education Lts, Dorling Kindersley India Pvt. Ltd.
5. A guide to mechanisms in Organic Chemistry, Peter Skyes (Orient Longman, New Delhi).

6. Reactive Intermediates in Organic Chemistry, Tandon and Gower, Oxford & IBH Publishers.
7. Combinational Chemistry – Synthesis and applications – Stephen R Wilson & Anthony W Czarnik, Wiley – Blackwell.
8. Carey, Organic Chemistry, 5th Edition (Viva Books Pvt. Ltd.).
9. Organic Synthesis - The Disconnection Approach, S. Warren, Wiley India.
10. Principles of Organic Synthesis, R.C. Norman and J.M. Coxon, Nelson Thornes.
11. Organic Synthesis- Special Techniques. VK Ahluwalia and R Agarwal, Narosa Publishers.
12. Organic Reaction Mechanisms. VK Ahluwalia and RK Parashar, Narosa Publishers

The following are some of the modes of classroom transaction

- Lecture
- Group discussion
- Demonstration
- Team teaching
- Tutorial
- Self-learning

Transaction Mode

- PPT
- YouTube
- Google drive
- Google meet

Course Title: Advanced Medicinal Chemistry

Paper Code: MPC103T

Course Hours: 60h

L	T	P	Credits
4	0	0	4

Learning Outcomes

After completing this course, the learner will be able to:

CLO1: List the key types drug-enzyme and drug-receptor interactions and classify inhibitors based on their mechanism of action (competitive vs. non-competitive).

CLO2: Outline the stages of drug discovery from target identification to lead optimization, employ high-throughput screening and evaluate the pharmacokinetic (PK) and pharmacodynamic (PD) properties of drug candidates to determine suitability for further development

CLO3: Compare the metabolic stability and selectivity profiles of covalent versus non-covalent inhibitors.

CLO4: Identify common peptidomimetic modifications used to enhance metabolic stability (e.g., backbone modification), execute coupling procedures for the synthesis of amino acid analogs, maintaining specific stereochemical configurations.

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 12 Hours	Drug Discovery - Stages of drug discovery, lead discovery; identification, validation and diversity of drug targets Biological Drug Targets - Receptors, types, binding and activation, theories of drug receptor interaction, drug receptor interactions, agonists vs antagonists, artificial enzymes. Learning activities: Learner will be explained about drug interaction and target through molecular modeling studies	CLO1
Unit 2 12 Hours	Prodrug Design and Analog design Prodrug design Basic concept, Carrier linked prodrugs/ Bioprecursors, Prodrugs of functional group, Prodrugs to improve patient acceptability, Drug solubility, Drug absorption and	CLO2

	distribution, site specific drug delivery and sustained drug action. Rationale of prodrug design and practical consideration of prodrug design. Combating drug resistance Causes for drug resistance, strategies to combat drug resistance in antibiotics and anticancer therapy, Genetic principles of drug resistance. Analog Design Introduction, Classical & Non classical, Bioisosteric replacement strategies, rigid analogs, alteration of chain branching, changes in ring size, ring position isomers, design of stereo isomers and geometric isomers, fragments of a lead molecule, variation in inter atomic distance. Learning activities: Learner will be engaged in learning the methods and concepts used for prodrug design, drug targeting and modification of lead compounds in wet lab as well as using in silico tools to optimize their biological and physical properties.	
Unit 3 12 Hours	Medicinal chemistry aspects of the following class of drugs Systematic study, SAR, Mechanism of action and synthesis of new generation molecules of following class of drugs: a). Anti-hypertensive drugs, Psychoactive drugs, H1 & H2 receptor antagonist, COX1 & COX2 inhibitors, Antineoplastic and Antiviral agents. Stereochemistry and Drug action • Realization that stereo selectivity is a pre-requisite for evolution • Role of chirality in selective and specific therapeutic agents. • Case studies, enantioselectivity in drug adsorption, metabolism, distribution and elimination. Learning activities: Learner will be engaged in Group discussion to explain SAR, Mechanism of action and given hands on training for the	CLO2

	synthesis of selective drugs mentioned above.	
Unit 4 12 Hours	Rational Design of Enzyme Inhibitors Enzyme kinetics & Principles of enzyme inhibitors, Enzyme inhibitors in medicine, Enzyme inhibitors in basic research, rational design of non-covalently and covalently binding enzyme inhibitors. Learning activities: Learner will be engaged in performing experiments to determine the enzyme kinetics and <i>in silico</i> design of enzyme inhibitors having applications in medicinal chemistry.	CLO3
Unit 5 12 Hours	Peptidomimetics - 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 of prostaglandins, leukotrienes and thromboxones Learning activities: Learner will be engaged in performing coupling experiments, amino acid synthesis, stereochemistry of biomolecules and <i>in silico</i> experiments for design of peptidomimetics.	CLO4

Suggested Readings:

1. Medicinal Chemistry by Burger, Vol I –VI.
2. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams & Wilkins, Woltess Kluwer (India) Pvt. Ltd, New Delhi.
3. Comprehensive Medicinal Chemistry – Corwin and Hansch.
4. Computational and structural approaches to drug design edited by Robert M Stroud and Janet F Moor.
5. Introduction to Quantitative Drug Design by Y.C. Martin.
6. Principles of Medicinal Chemistry by William Foye, 7th Edition, Lippincott Williams & Wilkins, Woltess Kluwer (India) Pvt. Ltd, New Delhi.
7. Drug Design Volumes by Arienes, Academic Press, Elsevier Publishers, Noida, Uttar Pradesh.
8. Principles of Drug Design by Smith.
9. The Organic Chemistry of the Drug Design and Drug action by Richard B. Silverman, Elsevier Publishers, New Delhi.
10. An Introduction to Medicinal Chemistry, Graham L. Patrick, Oxford University Press, USA.
11. Biopharmaceutics and pharmacokinetics, DM. Brahmanekar, Sunil B. Jaiswal, Vallabh Prakashan, New Delhi.
12. Peptidomimetics in Organic and Medicinal Chemistry by Antonio Guarna and Andrea

Trabocchi, Wiley publishers.

The following are some of the modes of classroom transaction

- Lecture
- Group discussion
- Demonstration
- Team teaching

Transaction Mode

- Molecular Models
- PPT
- YouTube
- Software for *In silico* study
- Google meet

IQAC

Course Title: Chemistry of Natural Products

L	T	P	Credits
4	0	0	4

Paper Code: MPC104T**Course Hours: 60h****Learning Outcomes**

After completing this course, the learner will be able to:

CLO1: Illustrate the chemistry and structural modifications of natural leads to enhance pharmacological activity in drug discovery and development.

CLO2: Examine the nomenclature, synthesis, and structure-activity relationships (SAR) of alkaloids and steroids.

CLO3: Classify and **outline** the biosynthetic pathways and synthesis methods for terpenoids and vitamins.

CLO3: Understanding the structure, properties, and reactions of sugars, **describe** the process of mutarotation and chain length modifications in sugars

CLO5: Analyze the structural characterization of natural products using advanced spectroscopic techniques (NMR, IR, Mass)

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 12 Hours	Study of Natural Products as Leads for New Pharmaceuticals for the Following Class of Drugs • Drugs affecting the Central Nervous System: Morphine Alkaloids • Anticancer Drugs: Paclitaxel and Docetaxel, Etoposide, and Teniposide • Cardiovascular Drugs: Lovastatin, Teprotide and Dicoumarol • Neuromuscular Blocking Drugs: Curare alkaloids • Anti-malarial drugs and Analogues • Chemistry of macrolid antibiotics (Erythromycin, Azithromycin, Roxithromycin, and Clarithromycin) and β - Lactam antibiotics (Cephalosporins and Carbapenem) Learning activities- Learner will be engaged in understanding principles and methodologies involved in drug discovery and development from natural resources	CLO1
Unit 2 12 Hours	Alkaloids • General introduction, classification, isolation, purification, molecular modification and biological	CLO2

	activity of alkaloids • General methods of structural determination of alkaloids • Structural elucidation and stereochemistry of ephedrine, morphine, ergot, emetine and reserpine Flavonoids • Introduction, isolation and purification of flavonoids • General methods of structural determination of flavonoids • Structural elucidation of quercetin Steroids • General introduction, chemistry of sterols, sapogenin and cardiac glycosides • Stereochemistry and nomenclature of steroids, chemistry of contraceptive agents male & female sex hormones (Testosterone, Estradiol, Progesterone), adrenocorticoids (Cortisone), contraceptive agents and steroids (Vit – D) Learning activities- Learner will be able to explain and perform various chemical tests for the identification of plant alkaloids to explain the structure and stereochemistry of steroids using ball and stick model.	
Unit 3 12 Hours	Terpenoids • Classification, isolation, isoprene rule and general methods of structural elucidation of Terpenoids • Structural elucidation of drugs belonging to mono (citral, menthol, camphor), di (retinol, Phytol, taxol) and tri terpenoids (Squalene, Ginsenoside) carotinoids (β carotene) Vitamins • Chemistry and Physiological significance of Vitamin A, B1, B2, B12, C, E, Folic acid and Niacin. Learning activities- Learner will be engaged in molecular models to explain the structure and stereochemistry of terpenoids, perform various identification tests to confirm their presence and familiarize with the use of various spectral techniques for the structure elucidation of terpenoids based drugs.	CLO3
Unit 4 12 Hours	a. Chemistry of Carbohydrates Introduction, classification, configuration and conformation, reactions of monosaccharides; oxidation, reduction, osazone formation, chain shortening and chain lengthening, mutarotation. Structure elucidation and chemistry of Glucose b. Active Constituent of Certain Crude Drugs Used in Indigenous System • Diabetic Therapy: Gymnema sylvestre, Salacia reticulata, Pterocarpus marsupium, Swertia chirata, Trigonella foenum graecum	CLO3

	• Liver dysfunction: <i>Phyllanthus niruri</i> • Antitumor: <i>Curcuma longa</i> Linn. Learning activities-Learner will be engaged in performing and handling various techniques/ experiments used in the isolation of active constituents of crude drugs including their characterization. Perform various experiments for the synthesis and functional group analysis in sugars including their stereochemical aspects.	
Unit 5 12 Hours	Structural Characterization of Natural Compounds • Structural characterization of natural compounds using IR, ¹HNMR, ¹³CNMR and MS Spectroscopy of specific drugs e.g., Penicillin, Morphine, Camphor, Vit-D, Quercetin and Digitalis glycosides. Learning activities: Learner will be provided spectral data for the identification of above-mentioned natural compounds	CLO5

Suggested Readings

1. Modern Methods of Plant Analysis, Peech and M.V. Tracey, Springer –Verlag, Berlin, Heidelberg.
2. Phytochemistry Vol. I and II by Miller, Jan Nostrant Rein Hld.
3. Recent advances in Phytochemistry Vol. I to IV – Scikel Runeckles, Springer Science & Business Media.
4. Chemistry of natural products Vol I onwards IWPAC.
5. Natural Product Chemistry Nakanishi Gggolo, University Science Books, California.
6. Natural Product Chemistry “A laboratory guide” – Rapheal Khan.
7. The Alkaloid Chemistry and Physiology by RHF Manske, Academic Press.
8. Introduction to molecular Phytochemistry – CHJ Wells, Chapmanstall.
9. Organic Chemistry of Natural Products Vol I and II by Gurdeep and Chatwall, Himalaya Publishing House.
10. Organic Chemistry of Natural Products Vol I and II by O.P. Agarwal, Krishan Prakashan.
11. Organic Chemistry Vol I and II by I.L. Finar, Pearson education.
12. Elements of Biotechnology by P.K. Gupta, Rastogi Publishers.
13. Pharmaceutical Biotechnology by S.P. Vyas and V.K. Dixit, CBS Publishers.
14. Biotechnology by Purohit and Mathur, Agro-Bios.
15. Phytochemical methods of Harborne, Springer, Netherlands.
16. Burger’s Medicinal Chemistry.

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- Lecture
- Group discussion
- Demonstration
- Tutorial

Transaction Mode

- PPT
- YouTube
- Google meet

Course Title: Organic Synthesis –I (Practical)

L	T	P	Credits
0	0	12	6

Paper Code: MPC105P**Course Hours: 180h****Learning Outcomes:**

After completing this course, the learner will be able to:

CLO1: Identify and assign R/S and E/Z configurations to chiral and geometric isomers using 3D structural representations.

CLO2: Explain safe laboratory practices, including identifying hazards, proper storage, and disposal procedures outlined in Material Safety Data Sheets (MSDS)

CLO3: Analyze the progress of an organic reaction by performing Thin Layer Chromatography (TLC), calculating *R_f* values, and comparing the composition of starting materials and products.

CLO4: Apply laboratory purification techniques, specifically crystallization, fractional distillation, or column chromatography, to isolate a pure organic compound

Course Content

Practical	Content/Title	Mapping with course learning outcome
1.	Analysis of Pharmacopoeial compounds and their formulations by UV Vis spectrophotometer, RNA & DNA estimation	CLO1
2.	Simultaneous estimation of multi component containing formulations by UV spectrophotometry	CLO1
3.	Experiments based on Column chromatography	CLO2
4.	Experiments based on HPLC	CLO3
5.	Experiments based on Gas Chromatography	CLO4
6.	Estimation of riboflavin/quinine sulphate by fluorimetry	CLO4
7.	Estimation of sodium/potassium by flame photometry	CLO4
8.	8. To perform the following reactions of synthetic importance: a. Purification of organic solvents, column chromatography b. Claisen-schmidt reaction c. Benzyllic acid rearrangement d. Beckmann rearrangement e. Hoffmann rearrangement f. Mannich reaction g. Synthesis of medicinally important compounds involving more than one step along with purification and Characterization using TLC, melting point and IR spectroscopy (4 experiments)	CLO4

	h. Estimation of elements and functional groups in organic natural compounds i. Isolation, characterization like melting point, mixed melting point, molecular weight determination, functional group analysis, co-chromatographic technique for identification of isolated compounds and interpretation of UV and IR data. j. Some typical degradation reactions to be carried on selected plant constituents	
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Suggested Readings:

1. Adams, R., Johnson, J.R., Wilcox, C.F. (1970). *Laboratory Experiments in Organic Chemistry*, The Macmillan Limited, London.
2. Mann, F. G. (2009). *Practical Organic Chemistry*. Pearson Education India.
3. Pasto, D.P., Johnson, C., Miller, M. (2010). *Experiments and Techniques in Organic Chemistry*, Prentice Hall.
4. Roberts, R.M., Gilbert, J.C., Rodewald, L.B., Wingrove, A.S. (1969). *An Introduction to Modern Experimental Organic Chemistry*, Ranehart and Winston Inc., New York.
5. Vogel, A.I. (latest edition). *Text Book of Practical Organic Chemistry*, Pearson
6. Williamson, K.L., Heath, D.C. (1999). *Macroscale and Microscale Organic Experiments*, Heath, D. C & Co., Lexington, MA.
7. Armarego, W. L., & Chai, C. (2012). *Purification of Laboratory Chemicals*. Butterworth-Heinemann.
8. Young, J. A. (Ed.). (1991). *Improving Safety in the Chemical Laboratory: a Practical Guide*. Wiley.
9. Zercher, C. A. (2010). *Organic Syntheses*. John Wiley & Sons.
10. Leonard, J., Lygo, B., Procter, G. (2013). *Advanced Practical Organic Chemistry*. CRC Press.
11. <https://www.vlab.co.in/broad-area-chemical-sciences>
12. <https://www.vlab.co.in/ba-nptel-labs-chemical-sciences>
13. <https://virtualchemlabs.com/virtual-lab.html>

The following are some of the modes of classroom transaction

- Experimentation
- Group discussion
- Demonstration
- Self-learning

Transaction Mode

- PPT
- YouTube
- Google drive
- Google meet

Course Title: Communication Skills and Scientific Writing (P)

L	T	P	Credits
0	0	4	2

Paper Code: MPC106P

Course Hours: 30h

Learning Outcomes:

After completing this course, the learner will be able to:

CLO1: Communicate effectively (Verbal and Non-Verbal) and Improve proof-readings skills and language awareness so that one can spot mistakes and correct their own work

CLO2: Comprehend the behavioral needs for a pharmacist to function effectively in the areas of pharmaceutical operation. Develop interview skills

CLO3: Define an appropriate research problem

CLO4: Describe the objectives based on literature search

CLO5: Prepare poster and dissertation work

Course content:

UNIT/HOURS	CONTENT	MAPPING
Unit-1 9 hrs	•Communication Skills: Introduction, Definition, The Importance of Communication, The Communication Process– Source, Message, Encoding, Channel, Decoding, Receiver, Feedback, Context •Elements of Communication: Introduction, Face to Face Communication- Tone of Voice, Body Language (Non-verbal communication), Verbal Communication, Physical Communication •Communication Styles: Introduction, The Communication Styles Matrix with example for each- Direct Communication Style, Spirited Communication Style, Systematic Communication Style, Considerate Communication Style	CLO1, CLO3, CLO4
Unit-2 9 hrs	•Effective Written Communication: Introduction, When and When Not to Use Written Communication- Complexity of the Topic, Amount of Discussion' Required, Shades of Meaning, Formal Communication •Writing Effectively: Subject Lines, Put the Main Point First, Know Your Audience, Organization of the Message •Interview Skills: Purpose of an interview, Do's and Don'ts of an interview •Giving Presentations: Dealing with Fears, Planning your Presentation, Structuring Your Presentation, Delivering Your Presentation, Techniques of Delivery •Group Discussion: Introduction, Communication skills in group discussion, Do's and Don'ts of group	CLO3, CLO4, CLO5

	discussion	
Unit-3 6 hrs	Technical writing: Scientific writing, Writing research paper, Poster preparation and Presentation and Dissertation. Literature Search & Management: Techniques for searching databases like Google Scholar, reading papers critically, and using reference management tools like Zotero or EndNote.	CLO1, CLO5
Unit-4 6 hrs	The Anatomy of a Scientific Paper: IMRaD (Introduction, Methods, Results, and Discussion) Methods: Detailed description of procedures to allow for reproducibility. Results: Objective presentation of data through text, core tables, and figures. Discussion & Conclusion: Interpretation of results, address limitations, and relate findings to existing literature. Introduction & Abstract: background, research gap, and summary	CLO4, CLO4

Recommended Books

1. Basic communication skills for Technology, Andreja. J. Ruther Ford, 2nd Edition, Pearson Education, 2011
2. Communication skills, Sanjay Kumar, Pushpalata, 1stEdition, Oxford Press, 2011
3. Organizational Behaviour, Stephen.P. Robbins, 1stEdition, Pearson, 2013
4. Brilliant- Communication skills, Gill Hasson, 1stEdition, Pearson Life, 2011
5. The Ace of Soft Skills: Attitude, Communication and Etiquette for success, Gopala Swamy Ramesh, 5thEdition, Pearson, 2013
6. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Green hall, 1st Edition Universe of Learning LTD, 2010
7. Communication skills for professionals, Konar nira, 2ndEdition, New arrivals PHI, 2011
8. Personality development and soft skills, Barun K Mitra, 1stEdition, Oxford Press, 2011
9. Soft skill for everyone, Butter Field, 1st Edition, Cengage Learning india pvt. ltd, 2011
10. Soft skills and professional communication, Francis Peters SJ, 1stEdition, Mc Graw Hill Education, 2011
11. Effective communication, John Adair, 4thEdition, Pan Mac Millan, 2009
12. Bringing out the best in people, Aubrey Daniels, 2ndEdition, Mc Graw Hill, 1999

Course Title: Seminar/Assignment
Paper Code: MPC594S

L	T	P	Credits	Marks
0	0	0	4	100

Learning outcome: Students who successfully complete this course will be able to

- **Identify and list** key papers, authors, and foundational definitions related to the topic.
- **Summarize and paraphrase** the main arguments, methodologies, and conclusions of the literature in your own words.
- **Use** the findings from the literature to frame a specific research question or practical problem.
- **Compare and contrast** different studies, identify themes, and **detect gaps** or contradictions in the research.

Evaluation criteria:

- Literature survey/background information
- Organization of content
- Physical presentation
- Questions and answers
- Report evaluation

IQAC

Semester –II

Course Title: Advanced Spectral Analysis

Paper Code: MPC201T

Course Hours: 60hr

L	T	P	Credits
4	0	0	4

Learning Outcomes

After completion of the course, student shall be able to understand:

CLO1: Explain the underlying principles and theories of UV-Visible, Infrared (IR), and spectrofluorimetry, including electronic and vibrational transitions

CLO2: Outline the components of NMR and Mass Spectrometry to identify molecular structure

CLO3: Apply chromatographic techniques (e.g., TLC, HPLC, Column) to separate and identify constituents of a mixture based on partition or distribution coefficients

CLO4: Analyze thermal behavior, transitions (DSC/DTA/TGA), molecular scattering (Raman), and radio-immunoassay techniques to determine physicochemical properties.

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 12 Hours	UV and IR spectroscopy: Wood ward – Fieser rule for 1,3- butadienes, cyclic dienes and α , β -carbonyl compounds and interpretation compounds of enones. ATR-IR, IR Interpretation of organic compounds Learning activities: Learner will be provided hands on training to different instruments like UV, IR and spectrofluorimetry.	CLO1
Unit 2 11 Hours	NMR Spectroscopy: 1-D and 2-D NMR, NOESY and COSY, HECTOR, INADEQUATE techniques, Interpretation of organic compounds Learning activities: Learner will be provided NMR for the characterization of compounds.	CLO2
Unit 3 10 Hours	Mass Spectroscopy: Mass fragmentation and its rules, Fragmentation of important functional groups like alcohols, amines, carbonyl groups and alkanes, Meta stable ions, Mc Lafferty rearrangement, Ring rule, Isotopic peaks, Interpretation of organic compounds. Learning activities: Learner will be provided Mass spectra for the characterization of compounds.	CLO2
Unit 4 12 Hours	Chromatography: Principle, Instrumentation and Applications of the	CLO3

	following: • GC-MS • GC-AAS • LC-MS • LC-FTIR • LC-NMR • CE-MS • High Performance Thin Layer chromatography • Super critical fluid chromatography • Ion Chromatography • I-EC (Ion- Exclusion Chromatography) • Flash chromatography Learning activities: Learner will be provided experience of chromatography by using different techniques like TLC, Column, HPLC, HPTLC and GC.	
Unit 5 12 Hours	Structure elucidation of following compounds by spectroscopic techniques using like UV, IR, Mass, NMR (¹H and ¹³C) a. Carvone, Citral, Menthol b. Luteolin, Kaempferol c. Nicotine, Caffeine d. Glycyrrhizin Learning activities: Learner will be provided spectral data of various natural and synthetic compounds for their characterization and structure elucidation using various spectroscopic techniques.	CLO4

REFERENCES:

1. Spectrometric Identification of Organic compounds - Robert M Silverstein, John Wiley & Sons.
2. Principles of Instrumental Analysis - Douglas A Skoog, F. James Holler, Timothy A. Nieman, Eastern press, Bangalore.
3. Instrumental methods of analysis – Willards, CBS publishers.
4. Organic Spectroscopy - William Kemp, ELBS.
5. Quantitative analysis of Pharmaceutical formulations by HPTLC - P D Sethi, CBS Publishers, New Delhi.
6. Quantitative Analysis of Drugs in Pharmaceutical formulation - P D Sethi, CBS Publishers, New Delhi.
7. Pharmaceutical Analysis- Modern methods – Part B - J W Munson, Volume 11, Marcel Dekker Series

L	T	P	Credits
4	0	4	4

Learning Outcomes

After completing this course, the student shall able to understand:

CLO1: Explain the 12 principles of green chemistry and analyze their applications in reducing hazardous substances in chemical processes.

CLO2: Describe the fundamental concepts of peptide chemistry, including synthesis, structure, and purification.

CLO3: Implement the principles of photochemistry and pericyclic reactions (e.g., Diels-Alder) to predict and design various organic transformations.

CLO4: Identify various catalysts (including biocatalysts) and apply their mechanism of action to improve efficiency in organic reactions.

CLO5: Apply techniques of asymmetric synthesis and chiral resolution to design methods for resolving chiral drugs

Course content

Unit/Hours	Content	Mapping with course learning outcome
Unit 1 12 Hours	Green Chemistry: - Introduction, principles of green chemistry - Microwave assisted reactions: merits and demerits of its use, increased reaction rates, mechanism, superheating effects of microwave, effects of solvents in microwave assisted synthesis, microwave technology in process optimization, its applications in various organic reactions and heterocyclic synthesis. - Ultrasound assisted reactions: types of sonochemical reactions, homogenous, heterogeneous liquid-liquid and liquid-solid reactions, synthetic application - Continuous flow reactors: working principle, advantages and synthetic applications. Learning activities: Learner will be engaged in practical's using greener synthetic routes such as microwave assisted synthesis and ultrasound and sonication assisted reactions for the synthesis of various key intermediates and drug molecules.	CLO1
Unit-2 12 Hours	Chemistry of peptides: - Coupling reactions in peptide synthesis - Principles of solid phase peptides synthesis, t-BOC and Fmoc protocols, various solid supports and linkers: Activation procedures, peptide and bond	CLO2

	formation, deprotection and cleavage from resin, low and high HF cleavage protocols, formation of free peptides and peptide amides, purification and case studies, site-specific chemical modifications of peptides. c) Segment and sequential strategies for solution phase peptide synthesis with any two case studies d) Side reactions in peptide synthesis: Deletion peptides, side reactions initiated by proton abstraction, protonation, over-activation and side reactions of individual amino acids Learning activities: Learner will be engaged in practical's involving coupling, protection/deprotection and coupling reactions for peptide synthesis.	
Unit-3 12 Hours	Photochemical reactions - Basic principles of photochemical reactions. Photo-oxidation, photo-addition and photo-fragmentation Pericyclic reactions - Mechanism, Types of pericyclic reactions such as cyclo addition, electrocyclic reaction and Sigmatropic rearrangement reactions with examples Learning activities: Learner will be engaged in solving exercises related to the mechanism of photochemical and pericyclic chemistry including rearrangements reactions in these with suitable examples and their applications in organic and medicinal chemistry.	CLO3
Unit-4 12 Hours	Catalysis: a) Types of catalysis, heterogeneous and homogenous catalysis, advantages and disadvantages b) Heterogeneous catalysis–preparation, characterization, kinetics, supported catalysts, catalyst deactivation and regeneration, some examples of heterogeneous catalysis used in synthesis of drugs c) Homogenous catalysis, hydrogenation, hydroformylation, hydrocyanation, Wilkinson catalysts, Ziegler-Natta catalysts, some examples of homogenous catalysis used in synthesis of drugs	

	d) Transition-metal and Organo-catalysis in organic synthesis: Metal-catalyzed reactions e) Biocatalysis: Use of enzymes in organic synthesis, immobilized enzymes/cells in organic reaction f) Phase transfer catalysis - theory and applications Learning activities: Learner will be familiarize with the science of catalysis, their synthetic applications in various key organic transformations and will be engaged in hand-on synthesis using various catalysts/phase transfer catalyst in some important organic transformations of organic and medicinal interests.	
Unit-5 12 Hours	Stereochemistry and Asymmetric Synthesis a) Basic concepts in stereochemistry – optical activity, specific rotation, racemates and resolution of racemates, the Cahn, Ingold, Prelog (CIP) sequence rule, meso compounds, pseudo asymmetric centres, axes of symmetry, Fischers D and L notation, cis-trans isomerism, E and Z notation. b) Methods of asymmetric synthesis using chiral pool, chiral auxiliaries, chiral ligands and chiral induction and catalytic asymmetric synthesis, enantiopure separation and Stereo selective synthesis with examples. Learning activities: Learner will be engaged in Molecular models to understand and explain the stereochemistry of various chiral natural and organic molecules and performing asymmetric synthesis.	CLO5

REFERENCES:

1. Advanced Organic chemistry, Reaction, mechanisms and structure, J March, John Wiley and sons, New York.
2. Mechanism and structure in organic chemistry, ES Gould, Hold Rinchart and Winston, NewYork.
3. Organic Chemistry Clayden, Greeves, Warren and Wothers., Oxford University Press.
4. Organic Chemistry” Vol I and II. I.L. Finar. ELBS.
5. Carey, Organic chemistry, Viva Books Pvt. Ltd.

6. Organic synthesis-the disconnection approach, S. Warren, Wiley India.
 7. Principles of organic synthesis, ROC Norman and JM Coxan, Nelson Thorns.
 8. Organic synthesis- Special techniques VK Ahluwalia and R Aggarwal, Narosa Publishers.
 9. Organic reaction mechanisms IV edtn, VK Ahluwalia and RK Parashar, Narosa Publishers
- .

Course Title: Fundamentals of Computer Aided Drug Design

L	T	P	Credits
4	0	0	4

Paper Code: MPC203T

Course Hours: 60h

Learning outcome:

After completing this course, the learner will be able to:

CLO1: Explain the role of CADD, including structure-based (SBDD) and ligand-based (LBDD) approaches, in accelerating the drug discovery pipeline.

CLO2: Analyze various CADD techniques—such as molecular docking, pharmacophore modeling, QSAR, and ADMET prediction—to determine their appropriate applications in lead identification and optimization.

CLO3: Apply rational drug design strategies, including Lipinski's Rule of 5 and scaffold hopping, to design drug-like molecules with improved pharmacokinetic profiles.

CLO4: Implement molecular modeling software (e.g., AutoDock, Discovery Studio, Schrodinger) to simulate, visualize, and analyze ligand-target interactions and optimize binding affinities

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 12 Hours	Introduction to Computer Aided Drug Design (CADD): History, different techniques and applications. Quantitative Structure Activity Relationships: Basics. History and development of QSAR: Physiochemical parameters and methods to calculate physiochemical parameters: Hammett equation and electronic parameters (sigma), lipoiphilicity effects and parameters (log P, pi-substituent constant), steric effects (Taft steric and MR parameters) Experimental and theoretical approaches for the determination of these physiochemical parameters. Learning activities: Learner will be engaged in group discussion to explain 2D-QSAR, 3D-QSAR and importance of statistical parameters	CLO1
Unit 2 12 Hours	Quantitative structure Activity Relationships: Applications Hansch analysis, Free Wilson analysis and relationship between them, Advantages and disadvantages: Deriving 2D-QSAR equations. 3D-QSAR approaches and contour map analysis. Statistical methods used in QSAR analysis and importance of statistical parameters. Learning activities: Learner will be engaged in group discussion to explain 2D-QSAR, 3D-QSAR and importance of statistical parameter	CLO1
Unit 3 12 Hours	Molecular Modeling and Docking: a) Molecular and Quantum Mechanics in drug design.	CLO2

	b) Energy Minimization Methods: comparison between global minimum conformation and bioactive conformation. c) Molecular docking and drug receptor interactions: rigid docking, flexible docking and extra-precision docking. Agents acting on enzymes such as DHFR, HMG-CoA reductase and HIV protease, choline esterase (AChE & BchE) Learning activities: Learner will be engaged in molecular modeling of compounds.	
Unit 4 12 Hours	Molecular Properties and Drug Design: a) Prediction and analysis of ADMET properties of new molecules and its importance in drug design. b) De novo drug design: Receptor/enzyme-interaction and its analysis, Receptor/enzyme cavity size prediction, predicting the functional components of cavities, Fragment based drug design. c) Homology modelling and generation of 3D-structure of protein. Learning activities: Learner will study Molecular model to explain interactions between ligand and drug target	CLO3
Unit 5 12 Hours	Pharmacophore Mapping and Virtual Screening: Concept of pharmacophore, pharmacophore mapping, identification of Pharmacophore features and Pharmacophore's modelling; Conformational search used in pharmacophore mapping. In-silico Drug Design and Virtual Screening Techniques. Similarity based methods and Pharmacophore based screening, structure based In-silico virtual screening protocols. Learning activities: Learner will be engaged in Pharmacophore band structure based <i>In-silico</i> virtual screening protocols	CLO2, CLO3

REFERENCES:

1. Computational and structural approaches to drug discovery, Robert M Stroud and Janet. F Moore, RCS Publishers.
2. Introduction to Quantitative Drug Design by Y.C. Martin, CRC Press, Taylor & Francis group.
3. Drug Design by Ariens Volume 1 to 10, Academic Press, Elsevier Publishers.
4. Principles of Drug Design by Smith and Williams, CRC Press, Taylor & Francis.
5. The Organic Chemistry of the Drug Design and Drug action by Richard B. Silverman, Elsevier Publishers.
6. Medicinal Chemistry by Burger, Wiley Publishing Co.
7. An Introduction to Medicinal Chemistry –Graham L. Patrick, Oxford University Press.
8. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, Ippincott Williams & Wilkins.
9. Comprehensive Medicinal Chemistry – Corwin and Hansch, Pergamon Publishers.
10. Computational and structural approaches to drug design edited by Robert M Stroud and Janet. F Moore.

Course Title: Process Chemistry**Paper Code: MPC204T****Course Hours: 60h**

L	T	P	Credits
4	0	0	4

Learning outcome:

After completing this course, the learner will be able to:

CLO1: List the key stages, equipment, and safety requirements involved in the scale-up from laboratory to pilot plant for APIs.

CLO 2: Analyze pilot-plant data to identify potential bottlenecks (e.g., mass transfer limitations) and define the design space for robust manufacturing

CLO3: Describe the mechanism and operating principles of critical unit operations and their role in ensuring product purity.

CLO4: Apply process analytical technology (PAT) and safety guidelines to manage exothermic reactions and purification steps.

CLO5: Interpret the hazard symbols, hazard statements, and precautionary statements found on an MSDS and **implement** appropriate safety protocols based on MSDS guidelines when handling reagents.

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 12 Hours	Process chemistry Introduction, Synthetic strategy, Stages of scale up process: Bench, pilot and large-scale process. In-process control and validation of large-scale process. Case studies of some scale up process of APIs. Impurities in API, types and their sources including genotoxic impurities Learning activities: Learner will be provided training involving case studies on scale up of APIs.	CLO1 CLO2
Unit 2 12 Hours	Unit operations <i>Extraction:</i> Liquid equilibria, extraction with reflux, extraction with agitation, counter current extraction. <i>Filtration:</i> Theory of filtration, pressure and vacuum filtration, centrifugal filtration, <i>Distillation:</i> azeotropic and steam distillation <i>Evaporation:</i> Types of evaporators, factors affecting evaporation. <i>Crystallization:</i> Crystallization from aqueous, non-aqueous solutions factors affecting crystallization, nucleation. Principle and general methods of Preparation of polymorphs, hydrates, solvates and amorphous APIs. Learning activities: Learner will be engaged in group discussion to understand Extraction, filtration, distillation, evaporation and crystallization processes	CLO3

Unit 3 12 Hours	Unit Processes-I a) Nitration: Nitrating agents, Aromatic nitration, kinetics and mechanism of aromatic nitration, process equipment for technical nitration, mixed acid for nitration b) Halogenation: Kinetics of halogenations, types of halogenations, catalytic halogenations. Case study on industrial halogenation process. c) Oxidation: Introduction, types of oxidative reactions, Liquid phase oxidation with oxidizing agents. Nonmetallic Oxidizing agents such as H ₂ O ₂ , sodium hypochlorite, Oxygen gas, ozonolysis. Learning activities: Learner will be engaged in group discussion to conceptualize and understand unit processes for nitration, halogenation and oxidation and their applications.	CLO3 CLO4
Unit 4 12 Hours	Unit Processes - II Reduction: Catalytic hydrogenation, Heterogeneous and homogeneous catalyst; Hydrogen transfer reactions, Metal hydrides. Case study on industrial reduction process. Fermentation: Aerobic and anaerobic fermentation. Production of Antibiotics; Penicillin and Streptomycin, Vitamins: B2 and B12 Statins: Lovastatin, Simvastatin Reaction progress kinetic analysis Streamlining reaction steps, route selection, Characteristics of expedient routes, characteristics of cost-effective routes, reagent selection, families of reagents useful for scale-up. Learning activities: Learner will be engaged in group discussion to understand unit processes for reduction, fermentation and reaction progress kinetic analysis	CLO2
Unit 5 12 Hours	Industrial Safety MSDS (Material Safety Data Sheet), hazard labels of chemicals and Personal Protection Equipment (PPE) Fire hazards, types of fire & fire extinguishers Occupational Health & Safety Assessment Series 1800 (OHSAS-1800) and ISO-14001 (Environmental Management System), Effluents and its management Learning activities: Learner will be provided Awareness about industrial safety protocols	CLO5

REFERENCES:

1. Process Chemistry in the Pharmaceutical Industry: Challenges in an Ever- Changing Climate-An Overview; K. Gadamasetti, CRC Press.
2. Process Chemistry in the Pharmaceutical Industry, Volume 2: Challenges in an Ever Changing Climate, K. Gadamasetti & Tamim Braish, CRC Press (2020).
3. Pharmaceutical Manufacturing Encyclopedia, 3rd edition, Volume2.
4. Medicinal Chemistry by Burger, 6th edition, Volume1-8.
5. W.L. McCabe, J.C Smith, Peter Harriott. Unit operations of chemical engineering, 7th edition, McGrawHill
6. Polymorphism in Pharmaceutical Solids. Dekker Series Volume 95 Ed: H G Brittain(1999)
7. Regina M. Murphy: Introduction to Chemical Processes: Principles, Analysis, Synthesis
8. Peter J. Harrington: Pharmaceutical Process Chemistry for Synthesis: Rethinking the Routes to Scale-Up
9. P.H. Groggins: Unit processes in organic synthesis(MGH)
- 10.F.A. Henglein: Chemical Technology (Pergamon)
- 11.M. Gopal: Dryden's Outlines of Chemical Technology, WEP East-West Press
- 12.Clausen, Mattson: Principle of Industrial Chemistry, Wiley Publishing Co.,
- 13.Lowenheim & M.K. Moran: Industrial Chemicals
- 14.Process development Fine chemicals from Grams to Kilograms. Stan Lee & Graham Robinson, Oxford University Press (2008).
15. Pharmaceutical Process Chemistry (as per PCI Regulations), A. Tiwari, V. Tiwari, First Edition, Nirali Prakashan (2023).
16. A Textbook on Principles of Pharmaceutical Process Chemistry, A.K. Verma, P. Mishra, Lexicon International Publisher (2022).
17. S.D. Shukla & G.N. Pandey: A text book of Chemical Technology Vol. II, Vikas Publishing House
18. J.K. Stille: Industrial Organic Chemistry (PH)
19. Shreve: Chemical Process, McGrawhill.
20. B.K. Sharma: Industrial Chemistry, Goel Publishing House
- 21 ICH Guidelines
22. United States Food and Drug Administration official website www.fda.gov

Course code	Course Title	Credits
MPC205P	Pharmaceutical Chemistry Practical- II	6

- Synthesis of organic compounds by adapting different approaches involving (3experiments) a) Oxidation
b) Reduction/hydrogenation
c) Nitration
- Comparative study of synthesis of APIs/intermediates by different synthetic routes (2 experiments)
- Assignments on regulatory requirements in API (2 experiments) of absorption spectra by UV and Wood ward – Fieser rule
- Interpretation of organic compounds by FT-IR
- Interpretation of organic compounds by NMR
- Interpretation of organic compounds by MS
- Determination of purity by DSC in pharmaceuticals
- Identification of organic compounds using FT-IR, NMR, CNMR and Mass spectra
- To carry out the preparation of following organic compounds
- Preparation of 4-chlorobenzhydrylpiperazine (an intermediate for cetirizine HCl)
- Preparation of 4-iodotoluene from p-toluidine
- NaBH₄ reduction of vanillin to vanillyl alcohol
- Preparation of umbelliferone by Pechhman reaction
- Preparation of triphenyl imidazole
- To perform the Microwave irradiated reactions of synthetic importance (Any two)
- Determination of log P, MR, hydrogen bond donors and acceptors of selected drugs using softwares
- Calculation of ADMET properties of drug molecules and its analysis using softwares
- Pharmacophore modelling
- 2D-QSAR based experiments
- 3D-QSAR based experiments
- Docking study based experiment
- Virtual screening based experiment

- <https://www.vlab.co.in/broad-area-chemical-sciences>
- <https://www.vlab.co.in/ba-nptel-labs-chemical-sciences>
- <https://virtualchemlabs.com/virtual-lab.html>

L	T	P	Credits	Marks
0	0	0	4	100

Learning outcome: Students who successfully complete this course will be able to

- Analyze and synthesize key themes, debates, and research gaps from literature to evaluate the current state of knowledge on a given topic
- Explain and summarize complex information in a structured written report to demonstrate conceptual understanding of a given topic.
- Outline and present key concepts of a topic, transforming detailed report information into a concise PowerPoint presentation.

Evaluation criteria:

- Literature survey/background information
- Organization of content
- Physical presentation
- Questions and answers
- Report evaluation

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Semester III

Course Title: Research Methodology & Biostatistics

L	T	P	Credits
4	0	0	4

Paper Code: MRM301T

Course Hours: 60h

Learning Outcomes:

After completing this course, the learner will be able to:

CLO1: Analyze scientific literature to identify gaps and **formulate** a precise, ethical research problem

CLO2: Interpret commonly reported statistical measures and **analyze** various data types using appropriate statistical software to determine scientific validity.

CLO3: Demonstrate skills for scholarly investigations by **applying** research principles and methodologies in clinical practice scenarios

CLO4: Explain and **demonstrate** ethical principles for the care and breeding of laboratory animals in biomedical research.

CLO5: Summarize the history, ethical principles, and regulatory guidelines governing human care in medical research.

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 12 Hours	General Research Methodology: Research, objective, requirements, practical difficulties, review of literature, study design, types of studies. Strategies to eliminate errors/bias, controls, randomization, crossover design, placebo, blinding techniques. Learning activities: Learner will be engaged in literature search and study design	CLO1, CLO2
Unit 2 12 Hours	Biostatistics: Definition, application, sample size, importance of sample size, factors influencing sample size, dropouts, 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. Learning activities: Learner will be engaged in Web based learning to explain concepts of biostatistics in research problem and analysis of different type of statistical data	CLO2
Unit 3 12 Hours	Medical Research History, values in medical ethics, autonomy,	CLO3

	beneficence, non-maleficence, double effect, conflicts between autonomy and beneficence/non-maleficence, euthanasia, informed consent, confidentiality, criticisms of orthodox medical ethics, importance of communication, control resolution, guidelines, ethics committees, cultural concerns, truth telling, online business practices, conflicts of interest, referral, vendor relationships, treatment of family members, sexual relationships, fatality Learning activities: Learner will be engaged to get familiarize with terms related to medical research and ethics in medical research	
Unit 4 12 Hours	CPCSEA Guidelines for Laboratory Animal Facility Goals, veterinary care, quarantine, surveillance, diagnosis, treatment and control of disease, personal hygiene, location of animal facilities to laboratories, anesthesia, euthanasia, physical facilities, environment, animal husbandry, record keeping, SOPs, personnel and training, transport of lab animals Learning activities: Learner will be engaged to develop a comprehensive understanding of ethical and practical consideration in care and use of animal in research settings.	CLO4
Unit 5 12 Hours	Declaration of Helsinki History, introduction, basic principles for all medical research, and additional principles for medical research combined with medical care Learning activities: Learner will be engaged in understanding profound history and principles applicable to medical research	CLO5

Suggested Readings:

1. Gupta, S. (2005). *Research methodology and statistical techniques*, Deep & Deep Publications (p) Ltd. New Delhi.
2. Kothari, C. R. (2008.) *Research Methodology(s)*, New Age International (p) Limited. New Delhi
3. Best J. W., Khan J. V. (Latest Edition) *Research in Education*, Prentice Hall of India Pvt. Ltd.
4. *Safe Science: Promoting a Culture of Safety in Academic Chemical Research*; National Academic Press, www.nap.edu.

5. Creswell, D., & Creswell, J. W. (2017). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*.

The following are some of the modes of classroom transaction

- Lecture
- Group discussion
- Demonstration

Transaction Mode

- PPT
- YouTube
- Google drive

Course Title: Journal Club

Paper Code: MPC302T

L	T	P	Credits	Marks
0	0	0	1	25

**Course Title: Discussion/ Presentation
(Proposal Presentation)**

Paper Code: MPC303T

L	T	P	Credits	Marks
0	0	0	2	50

Course Title: Research Work

Paper Code: MPC599-1

L	T	P	Credits	Marks
0	0	0	14	350

Learning outcome: Students who successfully complete this course will be able to

- **Formulate** a research problem by **analyzing** existing literature and **develop** a detailed synopsis outlining objectives, methodology, and significance.
- **Apply** theoretical knowledge to **construct** experimental procedures and **demonstrate** proficiency in executing techniques within the laboratory setting to gather data.
- **Analyze** experimental data using statistical tools to **differentiate** between significant findings and extraneous variables, and **interpret** results to draw valid conclusions.

Evaluation criteria:

- Literature survey/background information
- Organization of content
- Physical presentation
- Questions and answers
- Report evaluation

Semester IV

Course Title: Journal Club

Paper Code: MPC401T

L	T	P	Credits	Marks
0	0	0	1	25

Course Title: Discussion/ Presentation

Paper Code: MPC402T

L	T	P	Credits	Marks
0	0	0	3	75

Course Title: Research Work, Thesis and viva-voce

Paper Code: MPC599-2

L	T	P	Credit s	Marks
0	0	0	16	400

Learning outcome: Students who successfully complete this course will be able to

- Develop a research synopsis by analyzing literature to identify research gaps and formulating a specific research problem.
- Apply scientific laboratory techniques to execute a predetermined methodology and generate experimental data
- Analyze experimental data using statistical tools to interpret the findings and validate the research hypothesis

Evaluation criteria:

- Literature survey/background information
- Organization of content
- Physical presentation
- Questions and answers
- Thesis evaluation
- Viva-voce

The following are some of the **classroom transactional modes**

1. Lecture
2. Demonstration
3. Lecture cum demonstration
4. Project method
5. Seminar
6. Group Discussion
7. Focused group discussion
8. Team teaching
9. Experimentation
10. Tutorial
11. Problem solving
12. Self-learning

The following **tools** can be used in **different transactional modes**:

- PPT
- Facebook
- WhatsApp
- Video
- Multimedia packages
- TED Talks
- Google drive

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