DEPARTMENT OF PHARMACY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A CENTRAL UNIVERSITY)

M.PHARM. (PHARMACEUTICAL CHEMISTRY)
(W.E.F. SESSION 2022-23)

Course of study for M. Pharm. (Pharmaceutical Chemistry)

Course Code	Course	Credit Hours	Credit Points	Hrs./w k	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 Product	4	4	4	100
MPC105P	Pharmaceutical Chemistry Practical I	12	6	12	150
–	Seminar/Assignment	7	4	7	100
	Total	35	26	35	650
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
–	Seminar/Assignment	7	4	7	100
	Total	35	26	35	650

Schemes for internal assessments and end semester examinations
(Pharmaceutical Chemistry-MPC)

Course Code	Course	Internal Assessment				End Semester Exams		Total Marks
		Continuous Mode	Sessional Exams		Total	Marks	Duration	
			Marks	Duration				
Semester I								
MPC101T	Modern Pharmaceutical Analytical Techniques	10	15	1 Hr	25	75	3 Hrs	100
MPC102T	Advanced Organic Chemistry – I	10	15	1 Hr	25	75	3 Hrs	100
MPC103T	Advanced Medicinal chemistry	10	15	1 Hr	25	75	3 Hrs	100
MPC104T	Chemistry of Natural Product	10	15	1 Hr	25	75	3 Hrs	100
MPC105P	Pharmaceutical Chemistry Practical I	20	30	6 Hrs	50	100	6 Hrs	150
–	Seminar/Assignment	–	–	–	–	–	–	100
							Total	650
Semester II								
MPC201T	Advanced Spectral Analysis	10	15	1 Hr	25	75	3 Hrs	100
MPC202T	Advanced Organic Chemistry –II	10	15	1 Hr	25	75	3 Hrs	100
MPC203T	Computer Aided Drug Design	10	15	1 Hr	25	75	3 Hrs	100
MPC204T	Pharmaceutical Process Chemistry	10	15	1 Hr	25	75	3 Hrs	100
MPC205P	Pharmaceutical Chemistry Practical II	20	30	6 Hrs	50	100	6 Hrs	150
–	Seminar/Assignment	–	–	–	–	–	–	100
							Total	650

Course of study for M. Pharm. III Semester (Common for All Specializations)

Course Code	Course	Credit Hours	Credit Points
MRM 301T	Research Methodology and Biostatistics*	4	4
-	Journal club	1	1
-	Discussion / Presentation (Proposal Presentation)	2	2
-	Research Work	28	14
	Total	35	21

**Non University Examination*

Course of study for M. Pharm. IV Semester (Common for All Specializations)

Course Code	Course	Credit Hours	Credit Points
-	Journal club	1	1
-	Research Work	31	16
-	Discussion / Final Presentation	3	3
	Total	35	20

Semester wise credits distribution

Semester	Credit Points
I	26
II	26
III	21
IV	20
Co-curricular Activities (Attending Conference, Scientific Presentations and Other Scholarly Activities)	Minimum=02 Maximum=07*
Total Credit Points	Minimum=95 Maximum=100*

**Credit Points for Co-curricular Activities*

Schemes for internal assessments and end semester examinations (Semester III & IV)

Course Code	Course	Internal Assessment				End Semester Exams		Total Marks
		Continuous Mode	Sessional Exams		Total	Marks	Duration	
			Marks	Duration				
Semester III								
MRM301T	Research Methodology and Biostatistics*	10	15	1 Hr	25	75	3 Hrs	100
–	Journal club	–	–	–	25	–	–	25
–	Discussion / Presentation (Proposal Presentation)	–	–	–	50	–	–	50
–	Research work*	–	–	–	–	350	1 hr	350
							Total	525
Semester IV								
–	Journal club	–	–	–	25	–	–	25
–	Discussion / Presentation (Proposal Presentation)	–	–	–	50	–	–	50
–	Research work and Colloquium	–	–	–	–	400	1 hr	400
							Total	475

*Non University Examination

M.PHARM.(Pharmaceutical Chemistry)

Programme Outcomes

Postgraduatestudents will be able to:

PO1: **Fundamentals on advanced analytical instrumental techniques**: UV-Visible, IR, Spectro-flourimetry, Flame emission and Atomic absorption spectroscopy, NMR spectroscopy, Mass Spectroscopy, Chromatography, Electrophoresis and Immunological assays methods.

PO2: **Knowledge about advances in organic chemistry**: retrosynthesis, Organic intermediates, Nucleophilic reaction, electrophilic reactions, green chemistry, Peptide Chemistry, stereochemistry and asymmetric synthesis.

PO3: **Study of mechanism and synthetic applications OF compounds**: Ugi reaction,Brook rearrangement, Ullmann coupling reactions, Ozonolysis and Michael addition reaction, Synthetic Reagents & Applications, Wilkinson reagent, Witting reagent. Osmium tetroxide, Benzotriazol-1-yloxy) tris (dimethylamino) phosphoniumhexafluoro-phosphate (BOP).

PO4: **Advances in the field of medicinal chemistry**: drug discovery, lead discovery; identification, validation of drug targets, Receptors, artificial enzymes, Prodrug Design and Analog design, Stereochemistry and Drug action, Rational Design of Enzyme Inhibitors, Peptidomimetics.

PO5: **Advanced knowledge and skills of pharmaceutical industries**: Stages of scale up process,Impurities in API, Unit operation Extraction, Distillation , Filteration, evaporation, crystallization, Unit process Nitration, Halogenation, oxidation , Reduction,Fermentation, Industrial safety,OHSAS 1800, ISO 14001.

PO6: **Advanced knowledge about chemistry of medicinal compounds from natural origin**: Drugs Affecting the Central Nervous System, Anticancer Drugs, Cardiovascular Drugs Neuromuscular Blocking Drugs, Anti-malarial drugs, Alkaloids, flavonoids, steroids, terpenoids, vitamins, Structural Characterization of natural compounds.

PO7: **Advanced knowledge about computer assisted drug design**: CADD in drug discovery, Quantitative Structure Activity Relationships, Molecular Modeling and Docking, Pharmacophore Mapping and Virtual Screening, In Silico Drug Design and Virtual Screening Techniques.

PO8: **Knowledge about Research Methodology & Biostatistics**: review of literature, strategies to eliminate errors/bias, values in medical ethics, CPCSEA guidelines for laboratory animal facility, Declaration of Helsinki.

First Semester

MODERN PHARMACEUTICAL ANALYTICAL TECHENIQUES(MPC 101T)

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
MPC101T	3	1	-	4 hours	25	75	100	4

Scope

This subject deals with various advanced analyticalinstrumental techniques for identification, characterization and quantification of drugs. Instruments dealt are NMR, Mass spectrometer, IR, HPLC, GC etc.

Objectives

After completion of course student is able to know, Chemicals and Excipients

- The analysis of various drugs in single and combination dosage forms
- Theoretical and practical skills of the instruments

THEORY 60 Hrs

1.	a. UV-Visible spectroscopy: Introduction, Theory, Laws, Instrumentation associated with UV-Visible spectroscopy, Choice of solvents and solvent effect and Applications of UV-Visible spectroscopy, Difference/ Derivative spectroscopy. b. 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, Data Interpretation. c. Spectroflourimetry: Theory of Fluorescence, Factors affecting fluorescence (Characteristics of drugs that can be analysed by flourimetry), Quenchers, Instrumentation and Applications of fluorescence spectrophotometer. d. Flame emission spectroscopy and Atomic absorption spectroscopy: Principle, Instrumentation, Interferences and Applications.	10 Hrs
2	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.	10 Hrs
3	Mass Spectroscopy: Principle, Theory, Instrumentation of Mass Spectroscopy, Different types of ionization like electron impact,	10 Hrs

	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 and Applications of Mass spectroscopy.	
4	Chromatography: Principle, apparatus, instrumentation, chromatographic parameters, factors affecting resolution, isolation of drug from excipients, data interpretation and applications of the following: a) Thin Layer chromatography b) High Performance Thin Layer Chromatography c) Ion exchange chromatography d) Column chromatography e) Gas chromatography f) High Performance Liquid chromatography g) Ultra High-Performance Liquid chromatography h) Affinity chromatography i) Gel Chromatography	10 Hrs
5	a. Electrophoresis: Principle, Instrumentation, Working conditions, factors affecting separation and applications of the following: a) Paper electrophoresis b) Gel electrophoresis c) Capillary electrophoresis d) Zone electrophoresis e) Moving boundary electrophoresis f) Iso electric focusing b. X-ray Crystallography: Production of X rays, Different X ray methods, Bragg's law, Rotating crystal technique, X ray powder technique, Types of crystals and applications of X-ray diffraction.	10 Hrs
6	a.Potentiometry: Principle, working, Ion selective Electrodes and Application of potentiometry. b. 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). TGA: Principle, instrumentation, factors affecting results, advantage and disadvantages, pharmaceutical applications.	10 Hrs

REFERENCES

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, 5 th 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, Vol 11, Marcel. Dekker Series
8. Spectroscopy of Organic Compounds, 2nd edn., P.S/Kalsi, Wiley estern Ltd., Delhi.
9. Textbook of Pharmaceutical Analysis, KA.Connors, 3rd Edition, John Wiley & Sons, 1982.

Course Outcomes

The student will try to learn:

CO1. Recognize, utilize and explain theoretical instrumentation and applications of Spectroscopic techniques likeUV, IR, Fluorimetry, FES and AAS.

CO2. Acknowledge, apply and clarify theoretical ideas, equipment, and uses of spectroscopic methods such as MR.

CO3. Understand, apply and clarify the theoretical ideas, instrumentation and uses of spectroscopic methods such as Mass Spectroscopy

CO4. Acknowledge, apply and clarify theoretical ideas, equipment, and uses of chromatographic methods such as gel chromatography, electrophoresis, TLC, HPTLC, lon exchange, Column GC, HPLC , affinity and X-ray Crystallography.

CO5. Recognize, utilize, and explain theoretical concepts, instrumentation and applications of potentiometry and thermal techniques like DSC, DTA and TGA.

Course Outcomes and their mapping with Programme Outcomes

CO	PO							
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO-1								
CO-2								
CO-3								
CO-4								
CO-5								

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

ADVANCED ORGANIC CHEMISTRY – I (MPC 102T)

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
MPC102T	3	1	–	4 hours	25	75	100	4

Scope

The subject is designed to provide in-depth knowledge about advances in organic chemistry, different techniques of organic synthesis and their applications to process chemistry as well as drug discovery.

Objectives

Upon completion of course, the student shall be to understand

- The principles and applications of retrosynthesis
- The mechanism & applications of various named reactions
- The concept of disconnection to develop synthetic routes for small target molecule.
- The various catalysts used in organic reactions.
- The chemistry of heterocyclic compounds

THEORY 60 Hrs

1 Basic Aspects of Organic Chemistry: 12 Hrs

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.

Addition reactions

a) Nucleophilicuni- and bimolecular reactions (SN1 and SN2)
b) Elimination reactions (E1 & E2; Hoffman &Saytzeff's rule)
c) Rearrangement reaction

2 Study of mechanism and synthetic applications of following named Reactions: 12 Hrs

Ugi reaction, Brook rearrangement, Ullmann coupling reactions, Dieckmann Reaction, Doebner-Miller Reaction, Sandmeyer Reaction, Mitsunobu reaction, Mannich reaction, Vilsmeyer-Haack Reaction, Sharpless asymmetric epoxidation, Baeyer-Villiger oxidation, Shapiro & Suzuki reaction, Ozonolysis and Michael addition reaction

3 Synthetic Reagents & Applications: 12

Aluminiumisopropoxide, N-bromosuccinamide, diazomethane, dicyclohexylcarbodimide, Wilkinson reagent, Witting reagent. Osmium tetroxide, titanium chloride, diazopropane, diethyl azodicarboxylate, Triphenylphosphine, Benzotriazol-1-yloxy) tris (dimethylamino) phosphoniumhexafluoro-phosphate (BOP). Hrs

Protecting groups

a. Role of protection in organic synthesis
b. Protection for the hydroxyl group, including 1,2-and1,3-diols: ethers, esters, carbonates, cyclic acetals & ketals
c. Protection for the Carbonyl Group: Acetals and Ketals
d. Protection for the Carboxyl Group: amides and hydrazides, esters
e. Protection for the Amino Group and Amino acids: carbamates and amides

4 Heterocyclic Chemistry: 12 Hrs

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, CombesQuinoline Synthesis, BernthsenAcridine Synthesis, Smiles rearrangement and Traube purine synthesis.

Synthesis of few representative drugs containing these hetrocyclic nucleus such as Ketoconazole, Metronidazole, Miconazole, celecoxib, antipyrin, Metamizole sodium, Terconazole, Alprazolam, Triamterene, Sulfamerazine, Trimethoprim, Hydroxychloroquine, Quinine, Chloroquine, Quinacrine, Amsacrine, Prochlorpherazine, Promazine, Chlorpromazine,Theophylline , Mercaptopurine and Thioguanine.

5 Synthon approach and retrosynthesis applications 12 Hrs

I. Basic principles, terminologies and advantages of retrosynthesis; guidelines for dissection of molecules. Functional group interconvertion and addition (FGI and FGA)
I. C-X disconnections; C-C disconnections – alcohols and carbonyl compounds; 1,2-, 1,3-,1,4-, 1,5-, 1,6-difunctionalized compounds
I. Strategies for synthesis of three, four, five and six-membered ring.

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, New York.
3. “Organic Chemistry” Clayden, Greeves, Warren and Woihers., Oxford University Press 2001.
4. “Organic Chemistry” Vol I and II. I.L. Finar. ELBS, Pearson Education Lts, Dorling Kindersley 9India) Pvt. Ltd.,.

5. A guide to mechanisms in Organic Chemistry, Peter Skyes (Orient Longman, New Delhi).
6. Reactive Intermediates in Organic Chemistry, Tandom and Gowel, Oxford & IBH Publishers.
7. Combinational Chemistry – Synthesis and applications – Stephen R Wilson & Anthony W Czarnik, Wiley – Blackwell.
8. Carey, Organic Chemistry, 5 th Edition (Viva Books Pvt. Ltd.)
9. Organic Synthesis – The Disconnection Approach, S. Warren, Wily India
10. Principles of Organic Synthesis, ROC Norman and JM Coxan, Nelson Thorns.
11. Organic Synthesis – Special Techniques. VK Ahluwalia and R Agarwal, Narosa Publishers.
12. Organic Reaction Mechanisms IV thEdtn, VK Ahluwalia and RK Parashar, Narosa Publishers

Course Outcomes

The student will try to learn:

CO1. To understand the Basic Aspects of Organic Chemistry like Organic intermediates, Types of reaction mechanisms.

CO2. To understand the mechanism & applications of various named reactions like Ugi reaction, Brook rearrangement, Ullmann coupling reaction etc.

CO3. To understand the Synthetic Reagents & Applications.

CO4. To understand the Heterocyclic Chemistry particularly Organic Name reactions with their respective mechanism, Synthesis of few representative drugs containing these hetrocyclic nucleus such as Ketoconazole, Metronidazole etc.

CO5. To understand the Synthon approach and retrosynthesis
Applications.

Course Outcomes and their mapping with Programme Outcomes

CO	PO							
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO-1								
CO-2								
CO-3								
CO-4								
CO-5								

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

ADVANCED MEDICINAL CHEMISTRY (MPC 103T)

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
MPC103T	3	1	–	4 hours	25	75	100	4

Scope

The subject is designed to impart knowledge about recent advances in the field of medicinal chemistry at the molecular level including different techniques for the rational drug design.

Objectives

At completion of this course it is expected that students will be able to understand

- Different stages of drug discovery
- Role of medicinal chemistry in drug research
- Different techniques for drug discovery
- Various strategies to design and develop new drug like molecules for biological targets
- Peptidomimetics

THEORY 60 Hrs

1. 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. — 12 Hrs

2 Prodrug Design and Analog design: — 12 Hrs

a) Prodrug design: Basic concept, Carrier linked prodrugs/ Bioprecursors, Prodrugs of functional group, Prodrugs to improve patient acceptability, Drug solubility, Drug absorption and distribution, site specific drug delivery and sustained drug action. Rationale of prodrug design and practical consideration of prodrug design.

b) Combating drug resistance: Causes for drug resistance, strategies to combat drug resistance in antibiotics and anticancer therapy, Genetic principles of drug resistance.

c) 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.

3	a) 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, Anticonvulsant drugs, H1 & H2 receptor antagonist, COX1 & COX2 inhibitors, Adrenergic & Cholinergic agents, Antineoplastic and Antiviral agents. b) 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, Enantio selectivity in drug adsorption, metabolism, distribution and elimination.	12 Hrs
4	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.	12 Hrs
5	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.	12 Hrs

REFERENCES

1. Medicinal Chemistry by Burger, Vol I –VI.
2. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, 12 th Edition, Lppincott 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 Moore 80
5. Introduction to Quantitative Drug Design by Y.C. Martin.
6. Principles of Medicinal Chemistry by William Foye, 7th Edition, Ippincott 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, II Edition, Elsevier Publishers, New Delhi.
10. An Introduction to Medicinal Chemistry, Graham L.Patrick, III Edition, Oxford University Press, USA.
11. Biopharmaceutics and pharmacokinetics, DM.Brahmankar, Sunil B. Jaiswal II Edition, 2014, VallabhPrakashan, New Delhi.

12. Peptidomimetics in Organic and Medicinal Chemistry by Antonio Guarna and Andrea Trabocchi, First edition, Wiley publishers.

Course Outcomes

The student will try to learn:

CO1. To know about different stages of drug discovery.

CO2. To understand the Prodrug Design and Analog design.

CO3. To know about Medicinal chemistry aspects of drugs like Anti-hypertensive drugs, Psychoactive drugs etc. and Stereochemistry and Drug action.

CO4. To understand the Rational Design of Enzyme Inhibitors.

CO5. To know about Peptidomimetics and Chemistry of prostaglandins.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO								PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1				3							
CO2				3							

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

CHEMISTRY OF NATURAL PRODUCTS (MPC 104T)

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
MPC104T	3	1	-	4 hours	25	75	100	4

Scope

The subject is designed to provide detail knowledge about chemistry of medicinal compounds from natural origin and general methods of structural elucidation of such compounds. It also emphasizes on isolation, purification and characterization of medicinal compounds from natural origin.

Objectives

At completion of this course it is expected that students will be able to understand-

- Different types of natural compounds and their chemistry and medicinal importance
- The importance of natural compounds as lead molecules for new drug discovery
- The concept of rDNA technology tool for new drug discovery
- General methods of structural elucidation of compounds of natural origin
- Isolation, purification and characterization of simple chemical constituents from natural source

THEORY 60 Hrs

1. Study of Natural products as leads for new pharmaceuticals for the following class of drugs — 12 hrs
   a) Drugs Affecting the Central Nervous System: Morphine Alkaloids
   b) Anticancer Drugs: Paclitaxel and Docetaxel, Etoposide, and Teniposide
   c) Cardiovascular Drugs: Lovastatin, Teprotide and Dicoumarol
   d) Neuromuscular Blocking Drugs: Curare alkaloids
   e) Anti-malarial drugs and Analogues
   f) Chemistry of macrolid antibiotics (Erythromycin, Azithromycin, Roxithromycin, and Clarithromycin) and β - Lactam antibiotics (Cephalosporins and Carbapenem)

2 a) Alkaloids — 12 hrs

General introduction, classification, isolation, purification, molecular modification and biological activity of alkaloids, general methods of structural determination of alkaloids, structural elucidation and stereochemistry of ephedrine, morphine, ergot, emetine and reserpine.

b) Flavonoids

Introduction, isolation and purification of flavonoids, General

	methods of structural determination of flavonoids; Structural elucidation of quercetin. c) 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).	
3	a) 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). b) Vitamins Chemistry and Physiological significance of Vitamin A, B1, B2, B12, C, E, Folic acid and Niacin.	12 hrs
4	a) Recombinant DNA technology and drug discovery rDNA technology, hybridoma technology, New pharmaceuticals derived from biotechnology; Oligonucleotide therapy. Gene therapy: Introduction, Clinical application and recent advances in gene therapy, principles of RNA & DNA estimation b) Active constituent of certain crude drugs used in Indigenous system Diabetic therapy – Gymnemasylvestre, Salacia reticulate, Pterocarpusmarsupiam, Swertiachirata, Trigonellafoenumgraccum; Liver dysfunction – Phyllanthusniruri; Antitumor – Curcuma longa Linn.	12 hrs
5	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.	12 hrs

REFERENCES

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 – ScikelRuneckles, 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, Chapmannstall.

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, KrishanPrakashan.
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, 13 th edition.
15. Phytochemical methods of Harborne, Springer, Netherlands.
16. Burger's Medicinal Chemistry.

Course Outcomes

The student will try to learn:

CO1. To know about Natural products as leads for new pharmaceuticals like CNS, Anticancer Drugs, CVS etc.

CO2. To know about Alkaloids, Flavonoids and Steroid.

CO3. To know about Terpenoids and Vitamins.

CO4. To understand the Recombinant DNA technology and drug discovery and Active constituent of certain crude drugs used in Indigenous system.

CO5. To know about Structural Characterization of natural compounds.

Course Outcomes and their mapping with Programme Outcomes

CO	PO							
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO-1								
CO-2								
CO-3								
CO-4								
CO-5								

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

PHARMACEUTICAL CHEMISTRY PRACTICAL – I(MPC 105P)

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
MPC105P	–	–	12	12 Hrs.	50	100	150	6

1. Analysis of Pharmacopeial compounds and their formulations by UV Vis spectrophotometer, RNA & DNA estimation
2. Simultaneous estimation of multi component containing formulations by UV spectrophotometry
3. Experiments based on Column chromatography
4. Experiments based on HPLC
5. Experiments based on Gas Chromatography
6. Estimation of riboflavin/quinine sulphate by fluorimetry
7. Estimation of sodium/potassium by flame photometry

To perform the following reactions of synthetic importance

1. Purification of organic solvents, column chromatography
2. Claisen-schimidt reaction.
3. Benzyllic acid rearrangement.
4. Beckmann rearrangement.
5. Hoffmann rearrangement
6. Mannich reaction
7. Synthesis of medicinally important compounds involving more than one step along with purification and Characterization using TLC, melting point and IR spectroscopy (4 experiments)
8. Estimation of elements and functional groups in organic natural compounds
9. 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.
10. Some typical degradation reactions to be carried on selected plant constituents

Course Outcomes

The student will try to learn:

CO1. Recognize, utilize and explain theoretical instrumentation and applications of Spectroscopic techniques likeUV, IR, Fluorimetry, FES and AAS.

CO2. Acknowledge, apply and clarify theoretical ideas, equipment, and uses of spectroscopic methods such as MR.

CO3. Understand, apply and clarify the theoretical ideas, instrumentation and uses of spectroscopic methods such as Mass Spectroscopy

CO4. Acknowledge, apply and clarify theoretical ideas, equipment, and uses of chromatographic methods such as gel chromatography, electrophoresis, TLC, HPTLC, lon exchange, Column GC, HPLC , affinity and X-ray Crystallography.

CO5. Recognize, utilize, and explain theoretical concepts, instrumentation and applications of potentiometry and thermal techniques like DSC, DTA and TGA.

Course Outcomes and their mapping with Programme Outcomes

CO	PO							
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO-1								
CO-2								
CO-3								
CO-4								
CO-5								

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

Second Semester

ADVANCED SPECTRAL ANALYSIS (MPC 201T)

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
MPC201T	3	1	-	4 hours	25	75	100	4

Scope

This subject deals with various hyphenated analytical instrumental techniques for identification, characterization and quantification of drugs. Instruments dealt are LC-MS, GC-MS, ATR-IR, DSC etc.

Objectives

At completion of this course it is expected that students will be able to understand-

- Interpretation of the NMR, Mass and IR spectra of various organic compounds
- Theoretical and practical skills of the hyphenated instruments
- Identification of organic compounds

THEORY 60Hrs

1.	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.	12 Hrs
2	NMR spectroscopy: 1-D and 2-D NMR, NOESY and COSY, HECTOR, INADEQUATE techniques, Interpretation of organic compounds.	12 Hrs
3	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.	12 Hrs
4	Chromatography: Principle, Instrumentation and Applications of the following: a) GC-MS b) GC-AAS c) LC-MS d) LC-FTIR e) LC-NMR f) CE-MS g) High Performance Thin Layer chromatography h) Super critical fluid chromatography i) Ion Chromatography j) I-EC (Ion-Exclusion Chromatography) k) Flash chromatograph	12 Hrs
5	1. Thermalmethods of analysis Introduction, principle, instrumentation and application of DSC, DTA and TGA. 2. Raman Spectroscopy Introduction, Principle, Instrumentation and Applications. 3. Radio immuno assay	12 Hrs

Biological standardization , bioassay, ELISA, Radioimmuno assay of digitalis and insulin.

RFERENCES

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, 5 th edition, Eastern press, Bangalore, 1998.
3. Instrumental methods of analysis – Willards, 7 th edition, CBS publishers.
4. Organic Spectroscopy – William Kemp, 3 rd edition, ELBS, 1991.
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, 3 rd Edition, CBS Publishers, New Delhi, 1997.
7. Pharmaceutical Analysis– Modern methods – Part B – J W Munson, Volume 11, Marcel Dekker

Course Outcomes

The student will try to learn:

CO1. To know about Wood ward – Fieser rules, ATR-IR, Interpretation of organic compounds.

CO2. To know about 1-D, 2-D NMR and Interpretation of organic compounds.

CO3. To know about Mass Spectroscopy and its use in Interpretation of organic compounds.

CO4. To understand the Principle, Instrumentation and Applications of Chromatography like GC-MS, LC-MS, HPTLC, SFC etc.

CO5. To know about Thermal methods of analysis, Raman Spectroscopy and Radio immune assay.

Course Outcomes and their mapping with Programme Outcomes

CO	PO							
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO-1								
CO-2								
CO-3								
CO-4								
CO-5								

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

ADVANCED ORGANIC CHEMISTRY – II(MPC 202T)

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
MPC202T	3	1	–	4 hours	25	75	100	4

Scope

The subject is designed to provide in-depth knowledge about advances in organic chemistry, different techniques of organic synthesis and their applications to process chemistry as well as drug discovery.

Objectives

Upon completion of course, the student shall able to understand

- The principles and applications of Green chemistry
- The concept of peptide chemistry.
- The various catalysts used in organic reactions
- The concept of stereochemistry and asymmetric synthesis.

THEORY 60 Hrs

1. Green Chemistry: 12 Hrs
   a. Introduction, principles of green chemistry
   b. Microwave assisted reactions: Merit 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 heterocycles synthesis
   c. Ultrasound assisted reactions: Types of sonochemical reactions, homogenous, heterogeneous liquid-liquid and liquid-solid reactions, synthetic applications
   d. Continuous flow reactors: Working principle, advantages and synthetic applications
2. Chemistry of peptides 12 Hrs
   a. Coupling reactions in peptide synthesis
   b. Principles of solid phase peptide synthesis, t-BOC and FMOC protocols, various solid supports and linkers: Activation procedures, peptide bond 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.

3	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 sigmatrophic rearrangement reactions with examples.	12 Hrs
4	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, chiral ligands and chiral induction, 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	12 Hrs
5	Stereochemistry & 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 and catalytic asymmetric synthesis, enantiopure separation and Stereo selective synthesis with examples.	12 Hrs

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 Woihers., Oxford University Press 2001.
4. “Organic Chemistry” Vol I and II. I.L. Finar. ELBS, Sixth ed., 1995.
5. Carey, Organic chemistry, 5th edition (Viva Books Pvt. Ltd.)
6. Organic synthesis-the disconnection approach, S. Warren, Wily India
7. Principles of organic synthesis, ROCNorman and JMCoxan, 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 Outcomes

The student will try to learn:

CO1. To understand the principles and applications of Green chemistry.
CO2. To understand the concept of peptide chemistry.
CO3. To know about Photochemical Reactions and Pericyclic reactions.
CO4. To understand the various catalysts used in organic reactions.
CO5. To understand the concept of stereochemistry and asymmetric synthesis

Course Outcomes and their mapping with Programme Outcomes

CO	PO							
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO-1								
CO-2								
CO-3								
CO-4								
CO-5								

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

COMPUTER AIDED DRUG DESIGN(MPC 203T)

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
MPC203T	3	1	-	4 hours	25	75	100	4

Scope

The subject is designed to impart knowledge on the current state of the art techniques involved in computer assisted drug design.

Objectives

At completion of this course it is expected that students will be able to understand

- Role of CADD in drug discovery
- Different CADD techniques and their applications
- Various strategies to design and develop new drug like molecules.
- Working with molecular modelingsoftwares to design new drug molecules
- The in silico virtual screening protocols

Theory 60 Hrs

1. Introduction to Computer Aided Drug Design (CADD) 12 Hrs
   History, different techniques and applications.
   Quantitative Structure Activity Relationships: Basics
   History and development of QSAR: Physicochemical parameters and methods to calculate physicochemical parameters: Hammett equation and electronic parameters (sigma), lipophilicity effects and parameters (log P, pi-substituent constant), steric effects (Taft steric and MR parameters) Experimental and theoretical approaches for the determination of these physicochemical parameters.
2. Quantitative Structure Activity Relationships: Applications 12 Hrs
   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.
3. Molecular Modeling and Docking 12 Hrs
   a) Molecular and Quantum Mechanics in drug design.
   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)
4. Molecular Properties and Drug Design 12

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 modeling and generation of 3D-structure of protein.

Hrs

5 Pharmacophore Mapping and Virtual Screening 12 Hrs

Concept of pharmacophore, pharmacophore mapping, identification of Pharmacophore features and Pharmacophoremodeling; Conformational search used in pharmacophore mapping.

In Silico Drug Design and Virtual Screening Techniques

Similarity based methods and Pharmacophore base screening, structure based In-silico virtual screening protocols.

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, 1975, 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, lippincott Williams & Wilkins.
9. Comprehensive Medicinal Chemistry - Corwin and Hansch, Pergamon Publishers.

Computational and structural approaches to drug design edited by Robert M Stroud and Janet. F Moore

Course Outcomes

The student will try to learn:

CO1. Able to understand about Computer Aided Drug Design (CADD).
CO2. Able to understand Quantitative Structure Activity Relationships and their applications.
CO3. Able to understand Molecular Modeling and Docking.
CO4. Able to understand about Molecular Properties and Drug Design.
CO5. Able to understand Pharmacophore Mapping and Virtual Screening.

Course Outcomes and their mapping with Programme Outcomes

CO	PO							
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO-1								
CO-2								
CO-3								
CO-4								
CO-5								

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

PHARMACEUTICAL PROCESS CHEMISTRY(MPC 204T)

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
MPC204T	3	1	-	4 hours	25	75	100	4

Scope

Process chemistry is often described as scale up reactions, taking them from small quantities created in the research lab to the larger quantities that are needed for further testing and then to even larger quantities required for commercial production. The goal of a process chemist is to develop synthetic routes that are safe, cost-effective, environmentally friendly, and efficient. The subject is designed to impart knowledge on the development and optimization of a synthetic route/s and the pilot plant procedure for the manufacture of Active Pharmaceutical Ingredients (APIs) and new chemical entities (NCEs) for the drug development phase.

Objectives

At completion of this course it is expected that students will be able to understand

- The strategies of scale up process of apis and intermediates
- The various unit operations and various reactions in process chemistry

Theory 60 Hrs

1. Process chemistry 12 Hrs
   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
2. Unit operations 12 Hrs
   a) Extraction: Liquid equilibria, extraction with reflux, extraction with agitation, counter current extraction.
   b) Filtration: Theory of filtration, pressure and vacuum filtration, centrifugal filtration,
   c) Distillation: azeotropic and steam distillation
   d) Evaporation: Types of evaporators, factors affecting evaporation.
   e) Crystallization: Crystallization from aqueous, non-aqueous solutions factors affecting crystallization, nucleation. Principle and general methods of Preparation of polymorphs, hydrates, solvates and amorphous APIs.
3. Unit Processes - I 12 Hrs
   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_2O_2, sodium hypochlorite, Oxygen gas, ozonolysis.

4 Unit Processes - II 12 Hrs

a) Reduction: Catalytic hydrogenation, Heterogeneous and homogeneous catalyst; Hydrogen transfer reactions, Metal hydrides. Case study on industrial reduction process.

b) Fermentation: Aerobic and anaerobic fermentation. Production of
   i. Antibiotics; Penicillin and Streptomycin,
   ii. Vitamins: B2 and B12
   iii. Statins: Lovastatin, Simvastatin

c) Reaction progress kinetic analysis
   i. Streamlining reaction steps, route selection,
   ii. Characteristics of expedient routes, characteristics of cost-effective routes, reagent selection, families of reagents useful for scale-up.

5 Industrial Safety 12 Hrs

a) MSDS (Material Safety Data Sheet), hazard labels of chemicals and Personal Protection Equipment (PPE)

b) Fire hazards, types of fire & fire extinguishers

c) Occupational Health & Safety Assessment Series 1800 (OHSAS-1800) and ISO-14001(Environmental Management System), Effluents and its management

REFERENCES

1. Process Chemistry in the Pharmaceutical Industry: Challenges in an Ever-Changing Climate-An Overview; K. Gadamasetti, CRC Press.
2. Pharmaceutical Manufacturing Encyclopedia, 3 rd edition, Volume 2.
3. Medicinal Chemistry by Burger, 6 th edition, Volume 1-8.
4. W.L. McCabe, J.C Smith, Peter Harriott. Unit operations of chemical engineering, 7th edition, McGraw Hill
5. Polymorphism in Pharmaceutical Solids .Dekker Series Volume 95 Ed: H G Brittain (1999)
6. Regina M. Murphy: Introduction to Chemical Processes: Principles, Analysis, Synthesis
7. Peter J. Harrington: Pharmaceutical Process Chemistry for Synthesis: Rethinking the Routes to Scale-Up
8. P.H.Groggins: Unit processes in organic synthesis (MGH)

9. F.A.Henglein: Chemical Technology (Pergamon)
10. M.Gopal: Dryden's Outlines of Chemical Technology, WEP East-West Press
11. Clausen,Mattson: Principle of Industrial Chemistry, Wiley Publishing Co.,
12. Lowenheim& M.K. Moran: Industrial Chemicals
13. S.D. Shukla & G.N. Pandey: A text book of Chemical Technology Vol. II, Vikas Publishing House
14. J.K. Stille: Industrial Organic Chemistry (PH)
15. Shreve: Chemical Process, McGrawhill.
16. B.K.Sharma: Industrial Chemistry, Goel Publishing House
17. ICH Guidelines
18. United States Food and Drug Administration official website www.fda.gov

Course Outcomes

The student will try to learn:

CO1. To understand the Process chemistry particularly scale up process, Case studies of API's.

CO2. To understand the Unit operations like Extraction, Filtration, Distillation etc.

CO3. To understand the Unit Processes like Nitration, Halogenation and Oxidation.

CO4. To understand the Unit Processes like Reduction, Fermentation and Reaction progress.

CO5. To know about Industrial Safety like MSDS, Fire hazards, OHSAS-1800 and ISO-14001.

Course Outcomes and their mapping with Programme Outcomes

CO	PO							
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO-1								
CO-2								
CO-3								
CO-4								
CO-5								

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

PHARMACEUTICAL CHEMISTRY PRACTICALS – II(MPC 205P)

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
MPC205P	–	–	12	12 hours	50	100	150	6

1. Synthesis of organic compounds by adapting different approaches involving (3 experiments)
   a) Oxidation
   b) Reduction/hydrogenation
   c) Nitration
2. Comparative study of synthesis of APIs/intermediates by different synthetic routes (2 experiments)
3. Assignments on regulatory requirements in API (2 experiments)
4. Comparison of absorption spectra by UV and Wood ward – Fieser rule
5. Interpretation of organic compounds by FT-IR
6. Interpretation of organic compounds by NMR
7. Interpretation of organic compounds by MS
8. Determination of purity by DSC in pharmaceuticals
9. Identification of organic compounds using FT-IR, NMR, CNMR and Mass spectra
10. To carry out the preparation of following organic compounds
11. Preparation of 4-chlorobenzhydrylpiperazine. (an intermediate for cetirizine HCl).
12. Preparation of 4-iodotolene from p-toluidine.
13. $NaBH_4$ reduction of vanillin to vanillyl alcohol
14. Preparation of umbelliferone by Pechhman reaction
15. Preparation of triphenyl imidazole
16. To perform the Microwave irradiated reactions of synthetic importance (Any two)
17. Determination of log P, MR, hydrogen bond donors and acceptors of selected drugs using softwares
18. Calculation of ADMET properties of drug molecules and its analysis using softwares
    Pharmacophoremodeling
19. 2D-QSAR based experiments
20. 3D-QSAR based experiments
21. Docking study based experiment
22. Virtual screening based experimentSynthesis of organic compounds by adapting different approaches involving (3 experiments)
    a) Oxidation
    b) Reduction/hydrogenation
    c) Nitration

23. Comparative study of synthesis of APIs/intermediates by different synthetic routes (2 experiments)
24. Assignments on regulatory requirements in API (2 experiments)
25. Comparison of absorption spectra by UV and Wood ward – Fieser rule
26. Interpretation of organic compounds by FT-IR
27. Interpretation of organic compounds by NMR
28. Interpretation of organic compounds by MS
29. Determination of purity by DSC in pharmaceuticals
30. Identification of organic compounds using FT-IR, NMR, CNMR and Mass spectra
31. To carry out the preparation of following organic compounds
32. Preparation of 4-chlorobenzhydrylpiperazine. (an intermediate for cetirizine HCl).
33. Preparation of 4-iodotolene from p-toluidine.
34. $NaBH_4$ reduction of vanillin to vanillyl alcohol
35. Preparation of umbelliferone by Pechhman reaction
36. Preparation of triphenyl imidazole
37. To perform the Microwave irradiated reactions of synthetic importance (Any two)
38. Determination of log P, MR, hydrogen bond donors and acceptors of selected drugs using softwares
39. Calculation of ADMET properties of drug molecules and its analysis using softwares
    Pharmacophoremodeling
40. 2D-QSAR based experiments
41. 3D-QSAR based experiments
42. Docking study based experiment

Virtual screening based experiment

Course Outcomes

The student will try to learn:

CO1. To know about Wood ward - Fieser rules, ATR-IR, Interpretation of organic compounds.

CO2. To know about 1-D, 2-D NMR and Interpretation of organic compounds.

CO3. To know about Mass Spectroscopy and its use in Interpretation of organic compounds.

CO4. To understand the Principle, Instrumentation and Applications of Chromatography like GC-MS, LC-MS, HPTLC, SFC etc.

CO5. To know about Thermal methods of analysis, Raman Spectroscopy and Radio immune assay.

Course Outcomes and their mapping with Programme Outcomes

CO	PO							
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO-1								
CO-2								
CO-3								
CO-4								
CO-5								

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

Third Semester

RESEARCH METHODOLOGY & BIOSTATISTICS (MRM 301T)

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
MPM301T	3	1	-	4 hours	25	75	100	4

UNIT – I

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.

UNIT – II

Biostatistics: Definition, application, sample size, importance of sample size,factors influencing sample size, dropouts, statistical tests of significance, typeof significance tests, parametric tests(students "t" test, ANOVA, Correlationcoefficient, regression), non-parametric tests (wilcoxan rank tests, analysis ofvariance, correlation, chi square test), null hypothesis, P values, degree offreedom, interpretation of P values.

UNIT – III

Medical Research: History, values in medical ethics, autonomy, beneficence, non-maleficence, double effect, conflicts between autonomy andbeneficence/non-maleficence, euthanasia, informed consent, confidentiality, criticisms of orthodox medical ethics, importance of communication, controlresolution, guidelines, ethics committees, cultural concerns, truth telling, online business practices, conflicts of interest, referral, vendor relationships, treatment of family members, sexual relationships, fatality.

UNIT – IV

CPCSEA guidelines for laboratory animal facility: Goals, veterinary care, quarantine, surveillance, diagnosis, treatment and control of disease, personalhygiene, location of animal facilities to laboratories, anesthesia, euthanasia, physical facilities, environment, animal husbandry, record keeping, SOPs, personnel and training, transport of lab animals.

UNIT – V

Declaration of Helsinki: History, introduction, basic principles for all medicalresearch, and additional principles for medical research combined withmedical care.

Course Outcomes

The student will try to learn:

CO1. Describe the General Research Methodology.

CO2. Explain Biostatistics i.e., sample size, statistical tests of significance, Biostatistics* parametric tests, non-parametric tests, analysis of variance etc.

CO3. To know about the Medical Research i.e., History, values in medical ethics, autonomy, beneficence, non- maleficence etc.

CO4. Describe the CPCSEA guidelines for laboratory animal facility.

CO5. Explain Declaration of Helsinki

Course Outcomes and their mapping with Programme Outcomes

CO	PO							
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO-1								
CO-2								
CO-3								
CO-4								
CO-5								

Weightage: 1-Sightly; 2-Moderately; 3-Strongly