M. Pharm. Pharmaceutical Chemistry (1st Year)

Total Contact Hours = 34 Total Marks = 600 Total Credits = 25

SEMESTER 1st		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MPHA7- 101	Advanced Organic Chemistry -I	3	1	-	40	60	100	4
MPHA7- 102	Modern Analytical Techniques	3	1	-	40	60	100	4
MPHA7- 103	Medicinal Chemistry - I	3	1	-	40	60	100	4
MPHA7- 104	Basics of Pharmaceutical Research - I	3	1	-	40	60	100	4
MPHA7-105	Pharmaceutical Chemistry Lab - I	-	-	14	60	40	100	7
MPHA7- 106	Seminar	-	-	4	100	-	100	2
Total	**Theory = 5 Lab = 1**	**12**	**4**	**18**	**320**	**280**	**600**	**25**

Total Contact Hours = 32 Total Marks = 600 Total Credits = 26

SEMESTER 2nd		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MPHA7 –207	Chemistry of Natural Products	4	-	-	40	60	100	4
MPHA7 – 208	Advanced Organic Chemistry - II	4	-	-	40	60	100	4
MPHA7 – 209	Computer Aided Drug Design	4	-	-	40	60	100	4
MPHA7 – 210	Pharmaceutical Process Chemistry	4	-	-	40	60	100	4
MPHA7 - 211	Pharmaceutical Chemistry Practicals	-		12	60	40	100	6
MPHA7 - 212	Seminar/Assignment	-	4	-	100	-	100	4
Total	**Theory = 5 Lab = 1 Seminar=1**	**16**	**4**	**12**	**320**	**280**	**600**	**26**

Overall

Semester	Marks	Credits
1st	600	25
2nd	600	26
Total	**1200**	**51**

ADVANCED ORGANIC CHEMISTRY - I

Subject Code – MPHA7-101 **L T P C** **Duration – 45 Hrs**
3 1 0 4

UNIT– I (10 Hrs)

Mechanisms and Methods for Determination: Thermodynamic Requirements for Reaction, Kinetic Requirements for Reaction, Basic Mechanistic Concepts, Kinetics Versus Thermodynamic Control. Methods for Determining Mechanisms:

1. Non-Kinetic: Identification of Products, Determination of the Presence of Intermediate, Isolation of an Intermediate, Detection of an Intermediate, trapping of an Intermediate and Addition of Suspected Intermediate, Study of Catalysis, Isotopic Labelling Stereochemical Evidences and Crossover Experiments.
2. Kinetic Studies: First Order Reactions, Second Order Reactions, Third Order Reactions, Determination of the Order of Reaction and Reversible Reactions.

UNIT-II (10 Hrs)

Stereochemistry: Elements of Symmetry: Plane of Symmetry and Center of Symmetry, Alternating Axis of Symmetry, Simple Axis of Symmetry. Kinds of Molecules Displaying Optical Activity: Compounds with a Chiral Carbon Atom, Compounds with other Quadrivalent Chiral Atoms, Compounds with Tervalent Chiral Atoms Suitably Substituted Adamantanes. Optical Isomerism in Compounds Containing No Chiral Atom: Biphenyls, Allenes, Compounds with Exocylic Double Bonds, Spiranes, Chirality due to a Helical Shape, Chirality caused by Restricted Rotation of other Types. Cis-Trans Isomerism: Resulting from Double Bonds, Monocyclic Compounds, Fused Ring Systems, Out-In Isomerism. Enantiotopic and Diastereotopic Atoms, Groups and Faces. Chirality and Importance of Chiral Drugs, Techniques for Preparing Chiral Drugs (Chirality Pool, Enzymatic Transformation and Assymetric Synthesis)

UNIT-III (10 Hrs)

Alkylation of Nucleophilic Carbon, Enolates and Enamines: Generation of Carbanions by Deprotonation, Regioselectivity and Stereoselectivity in Enolate Formation, Other Means of Generating Enolates, Alkylation of Enolates, Oxygen Versus Carbon as the Site of Alkylation, Alkylation of Aldehydes, Esters, Amides and Nitriles. the Nitrogen Analogs of Enols and Enolates Enamines and Imine Anions

UNIT-IV (15 Hrs)

Electrophilic Additions to Carbon - Carbon Multiple Bonds: Addition of Hydrogen Halides, Hydration and Other Acid-Catalysed Additions, Oxymercuration, Addition of Halogens to Alkenes, Electrophilic Substitution Alpha to Carbonyl Groups, Addition of Allenes and Alkynes. Addition at Double Bonds via Organoboranes: Hydroboration, Reactions of Organoboranes, Enantioselective Hydroboration, Hydroboration of Alkynes.

Reactive Intermediates: Generation of Carbocation, Carbanions, Carbenes, Nitrenes/Nitrenium Ions and Free Radicals, Stability, Structure and Reactivity of these Intermediate

Elimination Reactions: E2, E1 and E1cb Mechanisms, Orientation Effects in Elimination Reactions, Stereochemistry of E2 Elimination Reactions, Elimination not involving C-H Bonds.

Recommended Books

1. F.A. Carey and R.J. Sundberg, 'Advanced Organic Chemistry'-Part B, Reactions and

Synthesis, Plenum Press, London.
2. E.I. Ernest and H. Samuel, 'Stereochemistry of Organic Compounds', John Wiley and Sons, New York.
3. R.E. Lehr and A.P. Marchand, 'Orbital Symmetry: A Problem Solving Approach', Academic Press, New York.
4. J. March, 'Advanced Organic Chemistry: Reactions, Mechanisms and Structures', John Wiley and Sons, New York.

MODERN ANALYTICAL TECHNIQUES

Subject Code – MPHA7-102 **L T P C** **Duration – 45 Hrs**
3 1 0 4

UNIT-I (9 Hrs)

Infrared Spectroscopy: The Hook's Law and Calculation of Stretching Frequencies for Different Types of Bonds And Their Bond Strengths, Coupled Interactions, Hydrogen Bonding, Examination of Infrared Spectrum, Survey of Important Functional Groups With Examples, Radiation Source, Detectors Used, Sample Handling, Quantitative Applications, Qualitative Applications with Special Reference to Stereo-Chemical Aspects and Hydrogen Bonding, Near-Ir Spectroscopy, Absorption and Reflectance Spectro-Photometry, Instrumentation, Applications, Far Infrared Spectroscopy. Introduction to FTIR and its Applications

UNIT-II (10 Hrs)

Ultraviolet and Visible Spectroscopy: Energy Level and Selection Rules, Effect of Substituents, Effect of Conjugation, Conformation and Geometry, The Woodward-Fisher Rules, the Fisher-Kuhn Rules, Applications of UV with Reference to different Electronic Systems. Derivative Spectroscopy and its Applications. Introduction and Application of Fluorimetry

UNIT-III (12 Hrs)

Nuclear Magnetic Resonance Spectroscopy: ^{1}H-NMR Spectroscopy Magnetic Equivalence, Chemical Shifts, Local Diamagnetic Shielding, Hybridization Effects, Magnetic Anisotropy, Mechanism of Spin-Spin Coupling, The Origin of Spin-Spin Splitting, Pascal's Triangle, The Coupling Constant, Protons on Oxygen, Nitrogen and Sulphur, Diastereom
eric Protons, Chemical Shift Reagents, Long Range Coupling, Spin Decoupling Methods, Nuclear Over Hauser Effect. Introduction and Applications of 2D NMR;

^{13}C-NMR Spectroscopy: Introduction, Peak Assignments, Off Resonance Decoupling, Selective Proton Decoupling; Chemical Shift Equivalence; Chemical Shifts; Spin Coupling.

Electron Spin Resonance Spectroscopy: Introduction of Electron Spin Resonance Spectroscopy and its Applications.

UNIT-IV (17 Hrs)

Mass Spectrometry: Basic Principle and Theory Involved; Instrumentation, Type of Ions; Various Ion Sources, Electron Impact Source, Chemical Ionization Sources, Field Ionization Sources, Desorption Sources, Mass Analysers, Double Focusing, Quadrupole, Time of Flight, Ion Trap Analyser, Ionization, Fragmentation, Rearrangements, Mass Spectra of Representative Compounds, Recognition of Molecular Ion Peak, Metastable Peak, Isotopic Peaks, Applications.

Chromatography

1. General Principle, Classification, Chromatographic Techniques, Normal and Reverse Phase, Column Chromatography.

2. Gas Chromatography: Gas Liquid Chromatography, Gas Solid Chromatography, Instrumentation and Applications (GC-MS and GC-FTIR). Derivatization as a Means of Sampling of Thermo Sensitive Compounds.
3. High Performance Liquid Chromatography: Partition, Adsorption, Ion Exchange, Size Exclusion; Pharmaceutical Applications of HPLC and LC-MS. Introduction to Super Critical Fluid Chromatography and HPTLC.

Recommended Books

1. R.M. Silverstein and F.X. Webster, 'Spectrometric Identification of Organic Compounds', John Wiley and Sons, New York.
2. L.G. Chatten, 'Pharmaceutical Chemistry', Vol. I & II, Marcel Dekker, New York.
3. W.D. James and H.T. Kenneth, 'Analytical Chemistry by Open Learning: Thermal Methods. John Wiley and Sons, New York.
4. R.J. Abraham, J. Fisher and P. Bftus, 'Introduction to NMR Spectroscopy', John Wiley and Sons, New York.
5. D.L. Pavia, G.M. Lampman and G.S. Kriz, 'Introduction to Spectroscopy', Harcourt College Publishers, Orlando.

MEDICINAL CHEMISTRY

Subject Code – MPHA7-103 **L T P C** **Duration – 45 Hrs**
3 1 0 4

UNIT-I (10 Hrs)

Structure of Cell Membrane: Membrane Lipids, Membrane Proteins, Membrane Carbohydrates, Passage through Membrane and Drug Action that effect the Structure of Cell Membranes (Antifungal, Antibacterial and Local Anaesthetics).

UNIT-II (10 Hrs)

Receptors: Drug Receptor Interaction, G-Protein Coupled Receptors, Ion Channel Linked Receptors. Ligand Gated Ion Channels (Lgics), Ligand-Receptors Theories: Clarks Occupancy Theory, Rate Theory, Induced Fit Theory, Macromolecular Perturbation Theory and Activation Aggregation Theory

UNIT-III (12 Hrs)

Enzymes: Introduction, Kinetics, Enzyme Kinetics in Drug Action, Mechanism of Enzyme Catalysis; Electrostatic Catalysis and Desolvation, Covalent Catalysis, Acid-Base Catalysis, Strain/Distortion in Enzyme Catalysis, Coenzyme Catalysis. Example Based on Haemoglobin, Theories of Enzyme Inhibition and Inactivation, Enzyme Activation of Drugs-Prodrugs.

UNIT- IV (17 Hrs)

Nitric Oxide (Second Messenger): Introduction, Chemical Properties of Nitric Oxide, Reaction of Nitric Oxide with Metals, Interplay between the Reactions of Nitric Oxide in Biological Systems, Nitric Oxide Synthetase Iso-Enzymes, Mechanism of NOS-Mediated Nitric Oxide Biosynthesis, NOS Inhibitors, Cytotoxic Role of Nitric Oxide, Therapeutic Significance of NOS Inhibitors and Nitric Oxide.

Recommended Books

1. M.E. Wolff Burger, 'Medicinal Chemistry and Drug Discovery, Principle and Practice', John Wiley and Sons, New York.
2. W. Alnley and E.F. James, Martindale, 'The Extra Pharmacopoeia', Pharmaceutical Press,

London.
3. T. Nogrady, 'Medicinal Chemistry-A Biochemical Approach', Oxford University Press, New York.
4. Monographs and Relevant Review Articles Appearing in Various Periodicals and Journals.
5. R. Franke, 'Theoretical Drug Design Methods', Vol. VII, Elsevier, New York.
6. R.B. Silverman, 'The Organic Chemistry of Drug Design and Action', Academic Press Inc., San Diego, USA.
7. G. Thomas, 'Medicinal Chemistry', 2nd Edn., Wiley India Pvt. Ltd.
8. H. Singh and V.K. Kapoor, 'Medicinal and Pharmaceutical Chemistry', 3rd Edn., Vallabh Prakashan, Delhi, **2012.**

BASICS OF PHARMACEUTICAL RESEARCH - I

Subject Code – MPHA7-104 **L T P C** **Duration – 45 Hrs**
3 1 0 4

UNIT-I (8 Hrs)

Drug Design and Discovery: Stages of Drug Discovery, Discovery of Lead Compounds, Pharmacophore Identification and Structure Modification, Physicochemical Alterations, Quantitative Structure Activity Relationship, High throuput Screening, Acute, Sub-Acute and Chronic Studies, In-Vivo and In –Vitro Studies, Introduction to Preclinical and Clinical Trials, Toxicological Studies, FDA Review Process and Approval.

UNIT-II (9 Hrs)

Good Laboratory Practice: Scope of GLP, Definitions, Current GLP in Manufacturing, Responsibilities. General Provision, Organization and Personnel, Building and Facilities, Equipment, Control of Components and Drug product, Laboratory and Control of Records and Reports, Non-clinical Testing, Controls on Animal House, Report Preparation and Documentation, Application of Computers in Quality Control Laboratory

Good Clinical Practices: Introduction, Regulatory perspectives, Provisions, Documentation.

UNIT-III (16 Hrs)

Principles of Experimental Pharmacology: Common Laboratory Animals in Pharmacological Research, Limitations of Animal Tests, Alternatives to Animal Use, Anaesthetics used in Laboratory Animals, Some Standard Techniques used in Laboratory Animals, Euthanasia of Experimental Animals. Regulations for the Care and Use of Laboratory Animals, CPCSEA, OECD Guidelines.

Analytical Method Validation: General Principles, Validation of Analytical and Bio-analytical Method as per ICH Guidelines.

Calibration and Qualification of Analytical Instruments: Electronic Balance, pH Meter, UV-Visible Spectrophotometer, FTIR, GC, HPLC, HPTLC, Disintegration and Dissolution Test Apparatus. **Qualification of Glassware:** Volumetric Flask, Pipette, Beakers and Burette

UNIT-IV (12 Hrs)

Methods in Material Characterization - Particle dimensions: Particle Size and Powder Surface Area, Particle Shape and Surface Morphology.

Characterization of Solid State Structure: Spectroscopy in Pharmaceutical Analysis, X-Ray Diffraction, Solid-State Nuclear Magnetic Resonance, Vibrational Spectroscopy, Calorimetry in Pharmaceutical Analysis, Water Vapour Sorption, Electron and Confocal Microscopy, Density

Measurements.

Thermal Methods of Analysis: Theory, Instrumentation and Applications of Thermo Gravimetric Analysis (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC) and Thermo Mechanical Analysis (TMA)

X-Ray Diffraction Methods: Introduction, Generation of X-Rays, X-Ray Diffraction, Bragg's Law, X-Ray Powder Diffraction, Interpretation of Diffraction Patterns and Applications.

Recommended Books

1. M.E. Wolff, 'Burger's Medicinal Chemistry and Drug Discovery, Principle and Practice'. John Wiley and Sons, New York.
2. R. Franke, 'Theoretical Drug Design Methods', Vol. VII, Elsevier, New York.
3. R.B. Silverman, 'The Organic Chemistry of Drug Design and Action', Academic Press Inc., San Diego, USA.
4. P.I. Good, 'A Managers Guide to Design and Conduct of Clinical Trials', Wiley-Liss, Hobokem, U.S.A., **2002.**
5. A.C. Cartwright and B.R. Matthews (eds.), 'International Pharmaceutical Product Registration', Elis Horwood, New York, U.S.A., **1994.**
6. H.G. Vogel, 'Drug Discovery and Evaluation-Pharmacological Assays', 2nd Edn,, Springer Verlag, Berlin, Germany, **2002**.
7. M.N. Ghosh, 'Fundamentals of Experimental Pharmacology', Scientific Book Agency, Calcutta, India, **1984.**
8. Sandy Weinberg, 'Good Laboratory Practices', Vol. 129, 3rd Edn., Drugs and Pharm. Sci. Series, Marcel Dekker Inc.
9. Robert M. Silverstein, 'Spectrometric Identification of Organic Compounds', 6th Edn., Wiley & Sons Publication.
10. Doglass A. Skoog, Holler, Nieman, 'Principles of Instrumental Analysis', 5th Edn., Thomson & Brooks Cole Publication.
11. Hobert H. Willard, 'Instrumental Methods of Analysis', 7th Edn., CBS Publication.
12. Gary D. Christian, 'Analytical Chemistry', 6th Edn., Wiley & Sons Publication.
13. A.H. Beckett, J.B. Stenlake, 'Practical Pharmaceutical Chemistry', Volume I & II, 4th Edn., CBS Publications.
14. Skoog, West, Holler and Crouch, 'Fundamentals of Analytical Chemistry', 8th Edn., Thomson & Brooks Cole Publication.

PHARMACEUTICAL CHEMISTRY LAB - I

Subject Code – MPHA7-105 **L T P C**
0 0 14 7

Pharmaceutical Chemistry Lab -I

1. Qualitative Analysis of Organic Mixtures.
2. Synthesis Involving Oxidation, Reduction, Nitration, Halogenations.
3. Synthesis Involving Rearrangements and Named Reaction.
4. Workshops on Stereomodel, Spectral Interpretations and Drug Design.

Recommended Books

1. Indian Pharmacopoeia, Central Indian Pharmacopoeia Laboratory, Govt. of India, Ministry of Health & Family Welfare, Ghaziabad.
2. U.S. Pharmacopoeia – NF, The United States Pharmacopoeial Convention, Rockville, USA.
3. European Pharmacopoeia, Directorate for the Quality of Medicines of the Council of Europe (EDQM), Strasbourg, Europe.
4. British Pharmacopoeia, The Stationary Office on behalf of the Medicine Health Care Product Regulatory Agency (MHRA), London.
5. J. Mendham, R.C. Denney, J.D. Barnes and M. Thomas, 'Vogel's Textbook of Quantitative Chemical Analysis', Pearson Education Limited, Singapore.
6. R.M. Silverstein and F.X. Webster, 'Spectrometric Identification of Organic Compounds', John Wiley and Sons, New York.
7. Eliel and H. Samuel, 'Stereochemistry of Organic Compounds', John Wiley & Sons, New York.

SEMINAR

Subject Code – MPHA7-106 **L T P C** **Duration – 45 Hrs**
0 0 4 2

1. Introduction, Information and Retrieval Systems.
2. Writing Assignments and Term Papers.
3. Reading Research Papers.
4. Organization and Presentation of Scientific Material, Research Work, Dissertations, Patents etc.
5. Skills in Oral and Technical Presentations.

Each student has to present at least three seminars during the semester.

CHEMISTRY OF NATURAL PRODUCTS

Subject Code – MPHA7-207 **L T P C** **Duration – 50 Hrs**
4 0 0 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

UNIT-I (12 Hrs)

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)

UNIT-II (12 Hrs)

Alkaloids

- 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.

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 cardiacglycosides. Stereochemistry and nomenclature of steroids, chemistry of contraceptive agents male & female sex hormones (Testosterone, Estradiol, Progesterone), adreno-corticoids (Cortisone), contraceptive agents and steroids (Vit – D).

UNIT-III (12 Hrs)

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 triterpenoids (squalene, ginsenoside) carotinoids (β carotene).

Vitamins

- Chemistry and Physiological significance of Vitamin A, B1, B2, B12, C, E, Folic acid andNiacin.

UNIT-IV (14 Hrs)

- 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
- Active constituent of certain crude drugs used in Indigenous system Diabetic therapy – *Gymnema sylvestre, Salacia reticulate, Pterocarpus marsupiam, Swertia chirata, Trigonella foenum graccum; Liver dysfunction – Phyllanthus niruri; Antitumor – Curcuma longa Linn.*
- Structural Characterization of natural compounds, Structural characterization of natural compounds using IR, ^{1}HNMR, ^{13}CNMR and MS Spectroscopy of specific drugs e.g., Penicillin, Morphine, Camphor, Vit-D, Quercetin and Digitalis glycosides.

Recommended Books

1. Peech and M.V. Tracey, 'Modern Methods of Plant Analysis', Springer – Verlag, Berlin, Heidelberg.

2. Miller, 'Phytochemistry', Vol. I and II, 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. Nakanishi Gggolo, 'Natural Product Chemistry', University Science Books, California.
6. Rapheal Khan, 'Natural Product Chemistry, A laboratory guide'.
7. R.H.F. Manske, 'The Alkaloid Chemistry and Physiology', Academic Press.
8. C.H.J. Wells, 'Introduction to Molecular Phytochemistry', Chapmannstall.
9. Gurdeep and Chatwall, 'Organic Chemistry of Natural Products', Vol I and II, Himalaya Publishing House.
10. O.P. Agarwal, 'Organic Chemistry of Natural Products', Vol I and II, Krishan Prakashan.
11. I.L. Finar, 'Organic Chemistry', Vol I and II, Pearson Education.
12. P.K. Gupta, 'Elements of Biotechnology', Rastogi Publishers.
13. S.P. Vyas and V.K. Dixit, 'Pharmaceutical Biotechnology', CBS Publishers.
14. Purohit and Mathur, 'Biotechnology', 13th Edn., Agro-Bios, Phytochemical methods of Harborne, Springer, Netherlands.
15. 'Burger's Medicinal Chemistry'.

ADVANCED ORGANIC CHEMISTRY - II

Subject Code – MPHA7-208 **L T P C** **Duration – 50 Hrs**
4 0 0 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.

UNIT-I (12 Hrs)

Green Chemistry:

- Introduction, principles of green chemistry
- 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
- Ultrasound assisted reactions: Types of reactions, homogenous, heterogeneous liquid-liquid and liquid-solid reactions, synthetic applications
- Continuous flow reactors: Working principle, advantages and synthetic applications**.**

UNIT-II (14 Hrs)

Chemistry of Peptides

- Coupling reactions in peptide synthesis
- 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
- Segment and sequential strategies for solution phase peptide synthesis with any two case studies
- Side reactions in peptide synthesis: Deletion peptides, side reactions initiated by proton abstraction, protonation, over-activation and side reactions of individual amino acids.

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

UNIT-III (12 Hrs)

Catalysis:

- Types of catalysis, heterogeneous and homogenous catalysis, advantages and disadvantages
- Heterogeneous catalysis – preparation, characterization, kinetics, supported catalysts, catalyst deactivation and regeneration, some examples of heterogeneous catalysis used in synthesis of drugs.
- 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
- Transition-metal and Organo-catalysis in organic synthesis: Metal-catalyzed reactions
- Biocatalysis: Use of enzymes in organic immobilized enzymes/cells in organic reaction.
- Phase transfer catalysis - theory and applications

UNIT-IV (12 Hrs)

Stereochemistry & Asymmetric Synthesis

- 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.
- Methods of asymmetric synthesis using chiral pool, chiral auxiliaries and catalytic asymmetric synthesis, enantiopure separation and Stereo selective synthesis with examples.

Recommended Books

1. J. March, 'Advanced Organic Chemistry, Reaction, Mechanisms and Structure', John Wiley and sons, New York.
2. E.S. Gould, Hold Rinchart and Winston, 'Mechanism and Structure in Organic Chemistry', New York.
3. Clayden, Greeves, Warren and Woihers., 'Organic Chemistry', Oxford University Press, **2001**.
4. I.L. Finar, 'Organic Chemistry'. Vol I and II. ELBS, 6th Edn., **1995**.

5. Carey, 'Organic chemistry', 5th Edn., Viva Books Pvt. Ltd.
6. S. Warren, 'Organic Synthesis-the Disconnection Approach', Wily India.
7. R.O.C. Norman and J.M. Coxan, Nelson Thorns 'Principles of Organic Synthesis'.
8. V.K. Ahluwalia and R. Aggarwal, 'Organic Synthesis- Special Techniques', Narosa Publishers.
9. V.K. Ahluwalia and R.K. Parashar, 'Organic Reaction Mechanisms', 4th Edn., Narosa Publishers.

COMPUTER AIDED DRUG DESIGN

Subject Code – MPHA7-209 **L T P C** **Duration – 50 Hrs**
4 0 0 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 modeling software to design new drug molecules
- The in silico virtual screening protocols

UNIT-I (12 Hrs)

- **Introduction to Computer Aided Drug Design (CADD):** 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.

UNIT-II (12 Hrs)

- **Quantitative Structure Activity Relationships**: Applications Hansch analysis, Free Wilson analysis and relationship between them, Advantages and disadvantages; Deriving 2D-QSARequations.
- 3D-QSAR approaches and contour map analysis.
- Statistical methods used in QSAR analysis and importance of statistical parameters.

UNIT-III (14 Hrs)

Molecular Modelling and Docking

- Molecular and Quantum Mechanics in drug design.
- Energy Minimization Methods: comparison between global minimum conformation and bioactive conformation
- 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)

Molecular Properties and Drug Design

- Prediction and analysis of ADMET properties of new molecules and its importance in drug design.
- 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.
- Homology modeling and generation of 3D-structure of protein.

UNIT- IV (12 Hrs)

Pharmacophore Mapping and Virtual Screening

- Concept of pharmacophore, pharmacophore mapping, identification of Pharmacophore features and Pharmacophore modeling; 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.

Recommended Books

1. Robert M. Stroud and Janet. F Moore, 'Computational and Structural Approaches to Drug Discovery', R.C.S. Publishers.
2. Y.C. Martin, 'Introduction to Quantitative Drug Design', C.R.C. Press, Taylor & Francis Group.
3. Ariens, 'Drug Design', Volume 1 to 10, Academic Press, Elsevier Publishers, **1975**,
4. Smith and Williams, 'Principles of Drug Design', CRC Press, Taylor & Francis.
5. Richard B. Silverman, 'The Organic Chemistry of the Drug Design and Drug Action', Elsevier Publishers.
6. Burger, 'Medicinal Chemistry', Wiley Publishing Co.
7. Graham L. Patrick, 'An Introduction to Medicinal Chemistry', Oxford University Press.
8. 'Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry', Ippincott Williams & Wilkins.
9. Corwin and Hansch, 'Comprehensive Medicinal Chemistry', Pergamon Publishers.
10. 'Computational and Structural Approaches to Drug Design', edited by Robert M. Stroud and Janet. F. Moore.

PHARMACEUTICAL PROCESS CHEMISTRY

Subject Code – MPHA7-210 **L T P C** **Duration – 50 Hrs**
4 0 0 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

UNIT-I (10 Hrs)

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

UNIT-II (12 Hrs)

Unit Operations

- Extraction: Liquid equilibria, extraction with reflux, extraction with agitation, counter current extraction.
- Filtration: Theory of filtration, pressure and vacuum filtration, centrifugal filtration,
- Distillation: azeotropic and steam distillation
- Evaporation: Types of evaporators, factors affecting evaporation.
- Crystallization: Crystallization from aqueous, non-aqueous solutions factors affecting crystallization, nucleation. Principle and general methods of Preparation of polymorphs, hydrates, solvates and amorphous APIs.

UNIT-III (16 Hrs)

Unit Processes - I

- Nitration: Nitrating agents, Aromatic nitration, kinetics and mechanism of aromatic nitration, process equipment for technical nitration, mixed acid for nitration,
- Halogenation: Kinetics of halogenations, types of halogenations, catalytic halogenations. Case study on industrial halogenation process.
- 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.

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.

UNIT-IV (12 Hrs)

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

Recommended Books

1. K. Gadamasetti, 'Process Chemistry in the Pharmaceutical Industry: Challenges in an Ever-Changing Climate-An Overview', CRC Press.
2. 'Pharmaceutical Manufacturing Encyclopedia', 3rd Edn., Volume 2.
3. Burger, 'Medicinal Chemistry', 6th Edn., Volume 1-8.
4. W.L. McCabe, J.C Smith, Peter Harriott, 'Unit Operations of Chemical Engineering', 7th Edn., 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', W.E.P. 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', Mc Graw Hill.
16. B.K. Sharma, 'Industrial Chemistry', Goel Publishing House.
17. ICH Guidelines.
18. United States Food and Drug Administration official website www.fda.gov.

PHARMACEUTICAL CHEMISTRY LAB - I

Subject Code – MPHA7-211 **L T P C**
0 0 12 6

- Synthesis of organic compounds by adapting different approaches involving (3 experiments)
  - Oxidation
  - Reduction/hydrogenation
  - Nitration
- Comparative study of synthesis of APIs/intermediates by different synthetic routes (2 experiments)
- Assignments on regulatory requirements in API (2 experiments)
- Comparison 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-iodotolene 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 modeling
- 2D-QSAR based experiments
- 3D-QSAR based experiments
- Docking study based experiment
- Virtual screening based experiment

Recommended Books

1. 'Indian Pharmacopoeia', Central Indian Pharmacopoeia Laboratory, Govt. of India, Ministry of Health & Family Welfare, Ghaziabad.
2. 'U.S. Pharmacopoeia – NF', The United States Pharmacopoeial Convention, Rockville, USA.
3. 'European Pharmacopoeia', Directorate for the Quality of Medicines of the Council of Europe (EDQM), Strasbourg, Europe.
4. 'British Pharmacopoeia', The Stationary Office on behalf of the Medicine Health Care Product Regulatory Agency (MHRA), London.
5. J. Mendham, R.C. Denney, J.D. Barnes and M. Thomas, 'Vogel's Textbook of Quantitative Chemical Analysis'. Pearson Education Limited, Singapore.
6. R.M. Silverstein and F.X. Webster, 'Spectrometric Identification of Organic Compounds', John Wiley and Sons, New York.
7. Eliel and H. Samuel, 'Stereochemistry of Organic Compounds', John Wiley & Sons, New York.

SEMINAR/ASSIGNMENTS

Subject Code – MPHA7-212 **L T P C**
0 4 0 4

- Introduction, Information and Retrieval Systems.
- Writing Assignments and Term Papers
- Reading Research Papers
- Organization and Presentation of Scientific Material, Research Work, Dissertations, Patents Etc.
- Skills in Oral and Technical Presentations
- Tutorials related to subject taught

Each student has to present atleast three seminars during the semester.