

SAVITRIBAI PHULE PUNE UNIVERSITY



Faculty of Pharmaceutical Science

Syllabus

**Second Year B. Pharm. Credit System 2015 Course
(With effect from Academic Year 2016 - 17)**

2.3.1 T PHYSICAL PHARMACEUTICS-I (Theory) (3 Hrs/Week)

Learning objectives: On completion of following theory topics & laboratory experiments, learner should be able to

A. Knowledge:

1. Understand the basics of chemical and physical phenomena that govern the in vivo and invitro actions of pharmaceutical products.
2. Describe the principles of pharmaceutical sciences in the field of pharmaceutics.
3. Explain and apply the key physical pharmacy concepts of solubility and dissolution, partitioning phenomena, surface phenomena, etc.
4. Articulate the interrelationships between the physiochemical properties of a drug, its dosage form, route of administration and bioavailability.
5. Acquire knowledge in Physical principles of states of matter and phase rule.
6. Recognize basic rules and equations regarding physical principles essential for pharmaceutical applications.
7. Compare and contrast between one, two & three component system.
8. Explain various laws and theories of gases and correlate them with formation of aerosols.
9. Know about crystallization as well as various parameters of crystal like crystal forms, habits, lattice angle, methods of crystal analysis, polymorphism.
10. Adapt knowledge of Non-electrolytic and Electrolytic solutions regarding their types and properties mostly colligative properties.
11. Illustrate Solubility and Distribution Phenomenon and apply them in the pharmaceutical practices.
12. Know applications of thermodynamics in the pharmacy.

B. Skills:

1. To operate different pharmaceutical laboratory instruments used in determining various physical properties such as surface tension, viscosity, adsorption and solubility.
2. To calculate critical solution temperature & effect of addition of electrolyte on CST of phenol-water system.
3. To construct of ternary phase diagram for three-component system.
4. To predict solubility, molecular weight, cell constant, pKa of given compound.
5. To evaluate unknown concentration by conductometric titration.

Topic No.	Name of the topic and contents	No of Hrs.
SECTION-I		
1	Phase Rule a. Gibbs phase rule, one component (Water), two components, and three components system, Pharmaceutical applications	04
2	Gaseous state of matter a. Basic gas laws, theory & equation of state for ideal gases, Deviation from gas theory, Compressibility factor, Vander Waal equation for real gases, critical constants, b. Liquefaction of gases: Linde's process, Claude's process, application of liquefaction to Aerosols i.e. principle of aerosols, two phase and three phase systems.	07
03	Solution of Non-electrolytes and Electrolyte a. Properties and types of solutions, ideal and real solutions, Raoult's law and its deviations, boiling point diagram, fractional and steam distillation, b. Colligative properties: relative lowering of vapor pressure, elevation of boiling Point, depression of freezing point, and osmotic pressure, problems involving molecular weight determinations. c. Solution of electrolytes: equivalent and specific conductance, Kohlrauschs law, conductometric titrations, Colligative properties of electrolytes.	11
SECTION-II		
4	a. Introduction to crystallization, Crystal parameters- crystal forms, habits, lattice angle, Methods of crystal analysis: X-Ray Diffraction, Bragg's equation. b. Polymorphism: Definition, Different shapes of polymorphs, Example and its Pharmaceutical applications, Brief introduction of Detection techniques. Glass transition temperature	08
5	Solubility and Distribution Phenomenon a. Solute solvent interactions, Definition of solubility, intrinsic and saturation solubility, solubility of gases in liquids, liquid in liquids and solids in liquids, factors affecting solubility, solubility of weak electrolytes, influence of pH, solvents, solubility parameter and combined effect of pH and Solvents. b. Distribution phenomenon: Nernst distribution law and its limitations, Effect of ionic dissociation and association, applications in Pharmacy. c. Brief introduction of BCS classification.	11
6	Thermodynamics a. Definition of enthalpy, entropy, First and second law of thermodynamics (Statement and equation)	04

2.3.1 P PHYSICAL PHARMACEUTICS-I
(Practical) (3 Hrs/Week)

Sr. No	Topic	Experiment
1	Phase Rule	1. Determination of Critical solution temperature of Phenol water system. 2. Determination of effect of addition of electrolyte on CST of phenol water system. 3. Construction of ternary phase diagram for three-component system [oil-water-surfactant].
2	Solutions of non-electrolytes and electrolytes	1. Determination of solubility of substance at different temperatures. 2. Determination of solubility of benzoic acid in different solvents. 3. Determination of effect of co solvents on solubility of benzoic acid in water. 4. Determination of molecular weight by Rast's camphor method. e. Determination of unknown concentration by conductometric titration.
3	Solubility and Distribution phenomena	1. Determination of partition coefficient of benzoic acid between water and benzene. 2. Determination of effect of pH on partition coefficient. 3. Estimation of saturation solubility of given drug in water. 4. Determination of effect of pH on solubility.
4	Thermodynamics	1. Determination of heat of solution of Salicylic/benzoic/oxalic acid

Recommended Books:

1. Martins Physical Pharmacy and Pharmaceutical Sciences, 5/Ed., Patrick J. Sinka, Lippincott Williams and Wilkins.
2. Essentials of Physical Chemistry by B. S. Bahl, G. D. Tuli, Golden Jubilee Ed., S. Chand and Company.
3. Essentials of Physical Chemistry and Pharmacy, H. J. Arnikar, S. S. Kadam, K. N. Gujar, Orient Longman Pvt. Ltd, India
4. Textbook of Physical Pharmacy, Vol. II, 3/Ed., K. L. Kapoor, McMillan India Ltd
5. Principles of Physical Chemistry 4/Ed., Samuel H. Marltan, Carl F. Frultoon, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi
6. Physical Pharmacy by Dr. U.B. Hadkar, NiraliPrakashan, 8/Ed, Mumbai
7. Essentials of Physical Pharmaceutics by C.V. S. Subramanyam, 2/Ed, Vallabh Prakashan, New Delhi.

8. Textbook of Physical Pharmaceutics by C.V. S. Subramanyam, 2/Ed, Vallabh Prakashan, New Delhi
9. Theory and Practice of Industrial Pharmacy by H A Liebermann, Leon Lachman and J B Schwartz
10. Physical Pharmacy, by Martin, Swarbrick and Cammarata Indian Edition, Varghese Publishing House, Mumbai.
11. Handbook of Practical Physical Pharmacy and Physical Pharmaceutics by U. B. Hadkar, NiraliPrakashan, 4/Ed., 2007, Pune
12. Practical Physical Pharmacy by H.N. More and A. A. Hajare, Career Publication. 1/Ed, 2007, Nashik
13. Practical Physical Pharmacy by Gaud and Gupta, NiraliPrakashan
14. Essentials of Physical Pharmacy, by Madan and Tuli, S. Chand & Company, New Delhi
15. Martin's Physical Pharmacy and Pharmaceutical Sciences, 5/Ed. by Patric J. Sinka, Lippincott Williams and Wilkins, 2007.
16. Essentials of Physical Chemistry and Pharmacy. H. J. Arnikar, S. S. Kadam, K. N.Gujar, Orient Longman Pvt. Ltd, India,.
17. Practical Physical Pharmacy, Gurtoo and Kapoor.

2.3.2 T PHARMACEUTICAL MICROBIOLOGY (THEORY) (3 Hrs/Week)

Learning objectives: On successful completion of following theory topics & laboratory experiments, learner should be able to

A. Knowledge:

1. Define microbiology & classify microbes into various categories
2. Aware about historical developments and contributions of scientists in the field of microbiology.
3. Know the recent advances in microbiology.
4. Compare and contrast the various structural features, biology & characteristics of microbes.
5. Know the modes of reproduction in bacteria, growth characteristics, requirements.
6. Describe isolation & counting methods of microorganisms.
7. Explain the mechanism of tumour formation.
8. Illustrate use of microorganism in pharmacy.
9. Identify the causes and basis of microbial spoilage.
10. Know the sources & types of microbial contamination.
11. Explain an importance of microbial limit tests, preservative efficacy test & standardization processes.
12. State mechanism of action and effectiveness of various sterilization processes.
13. Know the Sterility testing as per I.P. and its importance.
14. Classify disinfectants & be able to illustrate mechanism of action & its evaluation.
15. Focus on various basic aspects of immunology.
16. Illustrate types of immunity, basic aspects like antigen, antibody and their various their various reactions.
17. Know the vaccines, its types and preparation methods.
18. Know the basics behind various reactions of antigen and antibody as well as hypersensitivity reactions.
19. Describe vaccine manufacturing process.

B. Skills:

1. Explain the principle, construction and working of various instruments and perform their operations.
2. Handle microscope for observation of microbes.
3. Learn how to prepare and sterilize nutrient broth, nutrient agar, slants, stabs and plates.
4. Adopt the skills required for maintaining strictly aseptic condition & handling inoculating loop, its sterilization and inoculation procedure.
5. Isolate microorganism by streak plate technique & count them by pour plate technique.
6. Observe motility of bacteria by hanging drop technique.

7. Execute morphology bacteria by simple staining, negative staining & gram staining.
8. Do sterility testing of WFI by direct inoculation method.
9. Determine minimum inhibitory concentration by broth dilution.
10. Do Antibiotic Assay of any antibiotic.

Sr. No.	Topic	No of Hrs
SECTION-I		
1	Introduction to Microbiology: Scope and applications to pharmaceuticals, Whittaker's five kingdom concept, Classification of microbes into bacteria, rickettsia, actinomycetes, fungi, protozoa, algae and viruses (and their significance related to pharmacy), Historical developments- contributions of Anton van Leeuwenhoek, Louis Pasteur, Robert Koch and Paul Ehrlich.	05
2	Bacteria: Size, shape, structure, cell wall, capsules, spores, flagella, Reproduction- binary fission, Growth, growth curve, Culture media, Counting methods, Preservation of microbial cultures, Significance of Prebiotics and Probiotics.	10
3	Yeasts and moulds: Introduction and applications of <i>Saccharomyces cerevisiae</i> , <i>Candida albicans</i> and <i>Penicillium</i> .	01
4	Viruses: Introduction, general properties, structure of viruses, Human viruses – multiplication and cultivation, Structure Human Immunodeficiency virus.	03
5	Microbial Limit tests: Viable count, Identification of specific microorganism as per IP	02
6	Sterilization: Introduction to concept of sterilization, Different methods - dry heat, moist heat, gaseous, radiation and filtration.	03
SECTION-II		
7	Preservation and Disinfection: Chemical classification of different disinfectants with a example, Phenol coefficient test: RW test.	03
8	Fundamentals of Immunology: Microbial virulence, exotoxins, endotoxins Antigens, Types of Immunity, Defense mechanisms of host – specific and nonspecific, Mechanism of CMI and HMI, Antibodies-Classification.	09
9	Antigen - Antibody reactions: Characteristics of Antigen Antibody reaction, Basics of Precipitation, Agglutination (Slide and Tube), Introduction to complement fixation test, immunofluorescence tests, Radio Immunoassay and ELISA.	04
10	Vaccines and sera: Classification of vaccines, General production of Vaccines and sera and their quality control.	05

2.3.2 P PHARMACEUTICAL MICROBIOLOGY (Practical) (3 Hrs/Week)

1. To study the principle and working of laboratory equipments.(autoclave, hot air oven, colony counter, incubator)
2. Microscopy different parts of compound microscope, resolving power, magnification power, numerical aperture and working distance.
3. Preparation and sterilization of nutrient broth, nutrient agar, slants, stabs and plates.
4. To study different techniques of Inoculation of cultures and aseptic techniques.
5. Isolation of microorganism by streak plate technique.
6. Total Viable Count (TVC) by pour plate technique.
7. Observation of motility of bacteria by hanging drop technique.
8. To study morphology bacteria by simple staining
9. To study morphology bacteria by negative staining.
10. To study morphology bacteria by Gram staining.
11. Sterility testing of WFI by direct inoculation method.
12. MIC (minimum inhibitory concentration) determination by broth dilution.
13. Antibiotic Assay of any one antibiotic as per IP.

Recommended Books for Theory and Practical:

1. Anathnarayan R, Panikar CKJ. Textbook of Microbiology. Eighth Edition, Orient Longman. 2011.
2. Aulton ME. Pharmaceutics-The Science of Dosage Form Design. Churchill Livingstone. 1998.
3. Baird RM, et al. Handbook of Microbiological Quality Control – Pharmaceutical and Medical Devices. Taylor and Francis Inc., London. 2000.
4. Carter SJ. Copper and Gunn's Tutorial Pharmacy. CBS Publishers and Distributors, Delhi. 1996.
5. Collee JG, et al. Mackie and McCartney Practical Medical Microbiology. Fourteenth Edition, Churchill Livingstone Publications, New York. 1996.
6. Hugo WB, Russell AD. Pharmaceutical Microbiology. Sixth Edition, Blackwell Science. 1998.
7. Kokare CR. Pharmaceutical Microbiology-Principles and Applications. Sixth Edition, Nirali Prakashan, Pune, India. 2008.
8. Indian Pharmacopoeia. Govt. of India, Ministry of Health and Family Welfare. 1996 & 2007.
9. Pelczar MJ et al. Microbiology. Fifth Edition, McGraw Hill, New York.
10. Rawlins EA. Bentley's Textbook of Pharmaceutics. Eighth Edition, 1992. Bailliere Tindall, London.1986.

11. Akers MJ. Parenteral Quality Control. Second Edition, Marcel Dekker Inc., New York. 1994.
12. Brooks GF, Butel JS, Morse SA. Jawetz, Metrics & Adel bergs Medical Microbiology. Twenty First Edition, Appleton & Lange Publication, United State of America. 1989.
13. Maloy SR, Cronan JE. Microbial Genetics. Second Edition, Narosa Publishing House, New Delhi. 2006.
14. Ingraham JL, Ingraham CA. Introduction to Microbiology. Second Edition, Thomson. Brooks Cole, US. 2000.
15. Wiley M, Sherwood LM, Woolverton CJ. Prescott Harley & Klein's Microbiology. Seventh Edition, McGraw Hill International Edition. 2008.
16. Frobisher M, HinsDill RD, Crabtree KT, Good Heart CR. Fundamentals of Microbiology. Ninth Edition, Saunders Company, Japan. 1974.
17. Casida LE. Industrial Microbiology. Seventh Edition, New Age International Publication. 2007.
18. Goldsby RA, Kindt TJ. Kuby Immunology. Fifth Edition, W. H. Freeman and company. 2003.

2.3.3 T PHARMACEUTICAL BIOCHEMISTRY (Theory) (3 Hrs/Week)

Learning objectives:

On completion of following theory topics and laboratory experiments, a learner should be able to

A. Knowledge:

1. Know the scope of Biochemistry in Pharmacy.
2. Understand role of biochemical processes in cell metabolism.
3. Know the enzyme structures, their functions, mechanism for enzymatic activity and applications of enzymes.
4. Know the general metabolism process of proteins, lipids, carbohydrates and nucleic acids.
5. Understand chemistry, function, classification, biological importance, qualitative tests & applications of various bio-molecules. e.g. proteins, carbohydrates, lipids, nucleic acids and vitamins
6. Establish the correlation of metabolism, process, steps involved in metabolism of carbohydrates, lipids, protein and nucleic acid
7. Explain types, their structures, biochemical functions & importance of fat-soluble and water-soluble vitamins.

B. Skills:

1. Identify proteins, amino acids and carbohydrates by various qualitative as well as quantitative chemical tests.
2. Separate, identify and characterize proteins from various samples like egg, milk, etc and understand principle behind the technique.
3. Estimate quantity of ascorbic acid in a given sample.
4. Demonstrate action of salivary amylase on starch.

Topic No.	Name of the topic and contents	No of Hrs.
SECTION-I		
1	Introduction to Biochemistry: Scope of the subject in Pharmaceutical Sciences, biochemical reactions, highlights of only eukaryotic cell metabolism.	02
2	Enzymes: Introduction, classification, co-enzymes, co-factor, active sites, mechanism of enzyme actions, Michaelis-Menten equation, double reciprocal plot, factors affecting enzyme activity, enzyme inhibition (reversible, irreversible, allosteric), applications of enzymes.	07
3	Biomolecules: i. Amino acids: Introduction, classification, structures, essential and non-essential amino acids, physicochemical properties, peptide bond, end group analysis (Edman's and Sanger's method), and medically important amino acids. ii. Proteins: Introduction, classification, structural levels of proteins, globular (IgG and haemoglobin) and fibrous protein (keratin and collagen). Acid and enzymatic hydrolysis of proteins. Determination of the amino acid sequence	12

	<p>in polypeptides by end group analysis</p> <p>iii. Carbohydrates: Introduction, classification, structure and biological role of glucose, fructose, galactose, ribose, lactose, maltose, sucrose, starch, glycogen, cellulose, hyaluronic acid and heparin.</p> <p>iv. Lipids: Introduction, classification, structure, types of lipids and their biological role.</p> <p>v. Nucleic acids: Structure, biochemical functions, replication, transcription, translation and genetic code of Eukaryotic cell.</p>	
SECTION-II		
4	<p>Metabolism: Electron transport chain, Oxidative phosphorylation and correlation of metabolic processes.</p> <p>i. Carbohydrate metabolism: Glycolysis, Citric acid cycle and its Amphibolic nature, Gluconeogenesis including Cori's cycle, Glycogenesis, Glycogenolysis, Pentose Phosphate pathway</p> <p>ii. Lipid metabolism: Metabolism of Triglycerides, Beta Oxidation of saturated fatty acids(with odd and even no. of carbons) , formation and utilization of ketone bodies and cholesterol.</p> <p>iii. Protein metabolism: Transamination, oxidative and non oxidative deamination of amino acids, urea formation.</p> <p>iv. Nucleic Acids metabolism: Synthesis and breakdown of purines & pyrimidines.</p>	19
5.	Vitamins: Structure and biochemical function of fat-soluble and water-soluble vitamins.	05

2.3.3 P PHARMACEUTICAL BIOCHEMISTRY (Practical) (3 Hrs/Week)

1. Tests of carbohydrates, proteins and lipids
2. Identification of carbohydrates (minimum three)
3. Identification of proteins (minimum three)
4. Estimation of serum amylase
5. Study of action of salivary amylase on starch.
6. Estimation of vitamin C.
7. Isolation and estimation of DNA
8. Separation of bio-molecules by gel electrophoresis.
9. Analysis of gastric juice.

Recommended Books:

1. Lehninger's Principles of Biochemistry by Albert Lehninger, 4/Ed., Palgrave Macmillon.
2. Biochemistry by Lubert Stryer, W.H., Freeman & Company, New York.
3. Harper's Illustrated Biochemistry by R.K. Murray & D.K. Granner, 27/Ed, McGraw Hill.

4. An Introduction to Practical Biochemistry by David Plummer, 3/Ed, Tata McGraw-Hill Edition.
5. Fundamentals of Biochemistry by Dr. A. C. Deb, New central book agency (P) Ltd., Kolkata.
6. Varley's Practical Clinical Biochemistry by Harold Varley, 6/Ed., CBS Publishers, New Delhi.
7. Laboratory Medical Technology by Prafulla Godkar.
8. Biochemistry by U. Satyanarayana & U. Chakrapani, 3/Ed., Books & Allied (P) Ltd.
9. Viva & Practical Biochemistry by A. C. Deb, 3/Ed., New Central Book Agency (P) Ltd
10. Textbook of Biochemistry with clinical correlations by Thomas and Devlin, A Wiley Medical Publication.

2.3.4 T PHARMACEUTICAL ORGANIC CHEMISTRY-III
(Theory) (3 Hrs/Week)

Learning objectives: On successful completion of following theory topics & laboratory experiments, learner should be able to

A. Knowledge:

1. Understand various molecular representations and their interconversions
2. Understand relevance of stereochemistry & its significance in Pharmaceutical Sciences.
3. Explain conformational Analysis and draw various conformational structures for different molecules.
4. Explain mechanism and applications of rearrangement of electron deficient & electron rich systems.
5. Comprehend & explain basic concepts in pericyclic reactions.
6. Explain the chemistry of amino acids, methods of preparation and underlying concepts like isoelectric point.
7. Know what are polypeptides and explain synthesis of di-tri polypeptides.

B. Skills:

1. Synthesize & recrystallize the organic compounds based on rearrangement reactions and should be able to demonstrate techniques such as filtration, precipitation, etc
2. Understand the chromatographic techniques in organic chemistry
3. Explain the principle and procedure involved in column chromatographic separation techniques and TLC.
4. Explain and understand the principle behind various qualitative tests and analyze the given unknown binary organic compounds having different functional groups.

Topic No.	Name of the topic and contents	No of hrs.
SECTION-I		
1	<p>Stereochemistry: Molecular representations: Wedge, Fischer, Newman and Saw-horse formulae, their description and interconversions. Stereoisomerism, Significance of Stereochemistry in biological activity. Geometrical isomerism, E & Z nomenclature, optical isomerism, chirality, R & S nomenclatures, Diastereomerism, Relative and absolute configuration, Resolution of Racemic modification, Conformational isomerism, Use of Physical and Spectral methods in conformational analysis, conformational isomerism in ethane and n-butane, conformations of cyclohexane, monoalkyl and dialkyl cyclohexanes, conformation in decalin</p>	15
2	<p>Chemistry of carbohydrates: Introduction, Significance and medicinal importance of carbohydrates. Classification, Method of synthesis (Killiani fischer and r uff de gradation) and reactions of C₅ (Arabinose) and C₆ (Glucose and</p>	06

	fructose) sugars, Mutarotation, Establishment of structures of Glucose and Fructose.	
SECTION-II		
2	Molecular Rearrangement Reactions: Definition and classification. Molecular rearrangements involving Rearrangement of electron deficient systems, migration to oxygen, nitrogen, and carbon. Mechanism and stereochemistry of Wagner- Meerwein, Pinacol-Pinacolone, Wolf rearrangement, Hofmann, Lossen, Curtius, Schmidt and Beckmann rearrangements, Baeyer-Villiger oxidation and Dakin oxidations. Rearrangements of electron rich system inclusive of Stevens, Sommet, Favorskii, Neber and Benzilic acid rearrangement. Rearrangement to aromatic nucleus including mechanism of Fries & Claisen rearrangement. Pericyclic Reactions: Electrocyclic, Cycloaddition and Sigmatropic reactions (Cope rearrangement)	20
3	Chemistry of amino acids: Classification and structures of natural amino acids, Isoelectric point, General methods of preparation of amino acids, Peptide bonds	04

2.3.4 P PHARMACEUTICAL ORGANIC CHEMISTRY -III (Practical) (3 Hrs/Week)

1. Synthesis of organic compounds by rearrangement reactions mentioned in theory (Any five) e.g.: Benzilic acid rearrangement, pinacol-pinacolone rearrangement, Beckmann rearrangement, Hofmann reaction, Fries rearrangement etc.
2. Demonstration of techniques such as column chromatographic separation and TLC
3. Separation and qualitative analysis of binary mixtures (Any six solid-solid mixtures)
4. Demonstration of Stereo models

Recommended Books:

1. Stereochemistry of Carbon Compounds by E. L. Eliel, 32 reprint 2005, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
2. Stereochemistry of Organic Compound Principles and Applications by Nasipuri, Revised Edition, New Age International Publishers.
3. Stereochemistry Conformation and Mechanism by P.S. Kalsi, 7/Ed 2008, New Age International Publishers, New Delhi.
4. Advanced Organic Chemistry by E.S. Gould, 4/Ed. Wiley Eastern Edition.
5. Principles of Organic Synthesis by Norman, 3/Ed., Nelson Thorns Publication.
6. Organic Chemistry by Morrison & Boyd, 7/Ed, Pearson Education.
7. Advanced General Organic Chemistry-A Modern Approach by Sachin Kumar Ghosh, 3/Ed 2009, New Central Book Agency (P) Ltd.
8. Organic Chemistry by Jonathan Clayden, Nick Greeves, Stuart Warren, 2/Ed 2012, Oxford University press

9. Advanced Organic Chemistry-Reactions, Mechanisms & Structures by Jerry March, Wiley India (P) Ltd., New Delhi
10. Organic Chemistry by Fieser & Fieser, Vol. I-X, 1/Ed. Asia Publishing House.
11. Quantitative organic Analysis by Siggsa & Honna, 4/Ed., A Wiley Inter Science Publication. John Wiley & Sons
12. Vogel's Textbook of Practical Organic Chemistry by A. I. Vogel, 5/Ed., Pearson Education
13. Handbook of Organic Analysis (Qualitative and Quantitative) by H. T. Clarke, 1/Ed., Arnold-Heinemann.
14. Reactions, Rearrangements and Reagents by S N Sanyal.

2.3.5 T PHARMACOLOGY – I
(Theory) (3 Hrs/Week)

Learning objectives:

1. Understand the basic pharmacology along with its scope. The nature and sources of drugs and route of drug administration.
2. Know the process of drug discovery and development.
3. Understand pharmacokinetic and pharmacodynamics of drugs.
4. Understand receptor, drug receptor interaction, drug toxicity, drug interaction and adverse drug reactions.
5. Rational drug treatment in pediatric and geriatric patients and in pregnancy.

Sr. No.	Topics	Hours
SECTION - I		
1.	Basics of Pharmacology <ul style="list-style-type: none"> ➤ Definitions, History, Scope & General Principles of Pharmacology ➤ Nature & Sources of Drug, Drug nomenclature ➤ Essential drug (Medicine) concept, National Drug Policy 	02
2.	Routes of Drug Administration <ul style="list-style-type: none"> ➤ Detail discussion, Merits and Demerits of various routes of drug administration 	02
3.	New drug Discovery and Development Process <ul style="list-style-type: none"> ➤ Introduction to drug discovery and drug development process with detail emphasis on new approaches in preclinical drug development ➤ Clinical trials 	02
4.	Pharmacokinetics: <ul style="list-style-type: none"> ➤ Biological membranes: Structure and function of cell membrane, Physicochemical factors and processes involved in transportation of drug across cell membrane ➤ Absorption & Bioavailability of Drug: Definitions, Factors affecting absorption and bioavailability of drug ➤ Distribution: Definitions, Volume of distribution, Factors affecting drug distribution- Physiological barriers, Plasma protein binding of drug, disease state of patients etc. ➤ Metabolism (Biotransformation): Definitions, Organs and enzymes involved in drug metabolism, first pass metabolism of drug, Phases of drug metabolism, Factors affecting drug metabolism ➤ Excretion(Elimination): Definitions, Factors affecting excretion of drug ➤ Basic concepts of Clinical Pharmacokinetics: <ol style="list-style-type: none"> i) Bioavailability & Bioequivalence ii) Volume of distribution iii) Half life of drug iv) Clearance 	15

	v) Basic discussion on nonlinear pharmacokinetics and therapeutic drug monitoring (TDM)	
SECTION - II		
5.	Pharmacodynamics: <ul style="list-style-type: none"> ➤ Site and mechanisms of drug action, factors modifying drug action, Structure activity relationship (SAR) ➤ Drug Receptors, Basic discussion about receptors, Classification and families of receptors, Regulation of receptors ➤ Drug receptor interaction: Concept of agonist, antagonist, mixed agonist-antagonist, partial agonist, inverse agonist, Drug receptor interaction theories ➤ Dose response curve and Therapeutic Index 	09
6.	Principles of Therapeutics: <ul style="list-style-type: none"> ➤ Basic discussion on Individualization of drug therapy ➤ Concept of drug synergism and antagonism with its types ➤ Adverse drug reactions (Hypersensitivity, Photosensitivity, Mutagenicity, Carcinogenicity, Teratogenicity) ➤ Basics of Drug Interactions ➤ Drug Induced Diseases (Iatrogenic Diseases) ➤ Drug Toxicity: Types of drug toxicity and general principles of management of drug toxicity 	06
7.	Autocoids: Synthesis, Storage, Release, Physiological & Pathophysiological actions of autocoids and Pharmacology of their antagonists <ul style="list-style-type: none"> i) Histamine and its antagonists ii) 5-HT and its antagonists iii) Arachidonic acid metabolites 	06
8.	Clinical Pharmacology: Developmental changes in physiological factors that influence pharmacokinetics and pharmacodynamics in pediatric, geriatric, pregnancy and Lactation. <ul style="list-style-type: none"> ➤ Rational drug treatment in pediatric patients ➤ Rational drug treatment in geriatric patients ➤ Rational drug treatment during pregnancy and lactation 	03
		45 Hrs

Recommended Books

1. Goodman and Gillman: Pharmacological Basis of Therapeutics, *McGraw-Hill, Medical Publishing Division, New York.*
2. Rang H.P. and Dale M.M.: Pharmacology, *Churchill Livingstone, Edinbergh.*
3. Katzung B.G.: Basic and Clinical Pharmacology, *Lange Medical Publications, California.*
4. Bowman W.C. and Rand M.J.: Textbook of Pharmacology, *Blackwell Scientific Publications, Oxford.*
5. Pradhan S.N., Maickel R.P. and Dutta S.N.: Pharmacology in Medicine-Principles and Practice, *S.P. Press International Inc., Maryland.*
6. Craig C.R. and Stitzel R.E.: Modern Pharmacology, *Little Brown and Co., Boston.*
7. Melman K.I. and Morelli H.F.: Clinical Pharmacology: Basic Principles in Therapeutics, *Macmillan Press, New York.*

8. Laurence D.R. and Bennett P.N.: Clinical Pharmacology, *Churchill Livingstone, Edinburgh.*
9. Bevan J.A. and Thompson J.H.: Essentials of Pharmacology, *Harper and Row Publishers, Philadelphia.*
10. Drill V.A.: Pharmacology in Medicine, *McGraw Hill Co., New York.*
11. Grollman A.: Pharmacology & Therapeutics, *Lea & Fabiger, Philadelphia.*
12. Avery G.S.: Drug Treatment, *Adiss Press, Sydney.*
13. Das M.M. and Dutta S.K.: Ghosh's Modern Concepts on Pharmacology & Therapeutics, *Hilton & Co., Calcutta.*
14. Barar F.S.K.: Essentials of Pharmacotherapeutics, *S. Chand & Co., New Delhi.*
15. Krantz and Carr: Pharmacology Principles of Medical Practice, *Williams & Wilkins Co, Baltimore.*
16. Satoskar R.S. and Bhandarkar S.D.: Pharmacology & Pharmacotherapeutics, *Popular Prakashan, Bombay.*
17. Pharmacopoeia of India (1985), *Controller of publication, Delhi.*
18. Tripathi K.D.: Essentials of Medical Pharmacology, *Jaypee Brothers, Medical Publishers, New Delhi.*

2.3.6 T PHARMACOGNOSY & PHYTOCHEMISTRY-I

(Theory) (3 Hrs/Week)

Learning objectives: on successful completion of theory and laboratory experiments, learner should be able to,

A. Knowledge:

1. Explain meaning & significance of Pharmacognostic parameters & Pharmacognostic study of crude drugs.
2. Comprehend & explain underlying reason of evolutionary significance of secondary metabolites production in plants & other organisms & deduce their significance as medicinal molecules. Learner should be able to explain evolution of Phytochemistry to current phase.
3. Comprehend & explain primary metabolites comprehensively from source to their Pharmaceutical & industrial applications. In relation with primary metabolites, learner should be able to define, classify, explain source, name & draw chemical structures, identify from the structure, organize the biosynthetic sequence, describe methods of extraction & underlying rationale of qualitative & quantitative analysis, explain general processes of preparation of semisynthetic products, explain their properties.
4. Define, classify, explain source, name & draw chemical structures, identify from the structure, organize the biosynthetic sequence, and describe methods of extraction & underlying rationale of qualitative & quantitative analysis of glycosides & tannin compounds of plant origin.

B. Skills:

1. Able to prepare permanent slides & explain the significance of reference material such as herbarium specimen, permanent slides etc. in plant authentication.
2. Demonstrate skill of plant material sectioning, staining, mounting & focusing.
3. Decide on staining reagents required for specific part of plant.
4. Identify the parts of plants from its morphological & microscopical features by applying experimental & theoretical knowledge of morphology & anatomy obtained in theory classes.
5. Draw morphological & microscopical diagrams & able to label component/parts.
6. Able to conduct extractions/isolations & explain significance of use of various chemicals & physical conditions.
7. Able to identify unorganized crude drugs & samples of powders of organized & unorganized crude drugs using morphological, chemical, physical & microscopical characteristics.
8. Able to handle various equipments as per SOPs (such as spectrophotometer, Tintometer, simple / compound / digital microscope, Abbe's Refractometer, Melting point apparatus) & judge the quality of material.
9. Explain significance of how laboratory experiments are linked with social needs.
10. Able to judge the quality of crude drugs by different means & explain the significance of same in commerce & industry.

Topic No.	Name of the Topic and Contents	No of Hrs
	SECTION-I	
1	Plant metabolites: Primary & secondary metabolites: Meaning, types, & their functions in plant; Comparative account of primary & secondary metabolism; Role of secondary metabolites in plants; Rationale behind use of secondary metabolites as medicinal compounds; Overview of historical contribution in development of phytochemistry.	03
2	Pharmacognostic scheme for study of crude drugs: Meaning, component, & significance of individual Pharmacognostic parameter	04
3	Primary metabolites of Pharmaceutical & industrial utility: <i>General consideration:</i> Definition, classification, occurrences, properties, nomenclature, chemistry (including general biogenesis, qualitative/quantitative analysis) & pharmaceutical & industrial applications of carbohydrates, lipids & proteins & their derived products. Carbohydrates: A] Systematic Pharmacognostic study of: Agar, Guar gum, Acacia, Isabgol, Sterculia, Tragacanth & Okra mucilage. B] Source, extraction, properties & uses of: Starch, pectin, inulin, chitosan & cyclodextrins. Lipids: A] Systematic Pharmacognostic study of: Castor oil, Linseed oil, Neem oil, Hydnocarpus oil, Cod liver oil, Shark liver oil, Rice Bran oil, Cocoa butter, Kokum butter, Wool fat, & Bees wax; B] Source, extraction, properties & uses of: Lecithin, Polyunsaturated fatty acids, & Carotenoids. Proteins & enzymes: A] Source, method of preparation, properties & uses of: Thaumatin, Papain, Bromelin, Streptokinase & gelatin. Natural fibers: Source, method of preparation, properties & applications of Cotton, Wool, Silk & Jute.	17
	SECTION-II	
4	4. Secondary metabolites for medicinal utility: A] Glycosides: <i>General consideration:</i> Definition, classification, occurrences, properties, nomenclature, & chemistry (including general biogenesis, qualitative/quantitative analysis) of glycoside containing drugs. <i>Systematic Pharmacognostic study:</i> A] <i>Saponin glycosides:</i> Liquorice, ginseng, & dioscorea B] <i>Cardioactive glycosides:</i> Digitalis, squill, & strophanthus C] <i>Anthraquinone glycosides:</i> Aloe, senna, rhubarb, cascara D] <i>Others:</i> Kalmegh, gentian, Citrus peels, Artemisia, Visnaga	15

	B] Tannins: General consideration: Definition, classification, occurrences, properties, nomenclature, & chemistry (including general extraction, qualitative/quantitative analysis) of tannin containing drugs. <i>Systematic Pharmacognostic study:</i> Gambier, black catechu, Amla, Beleric & Chebulic Myrobalan.	06
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Recommended Books:

1. Evans W. C., Trease G. E., **Trease and Evan's Pharmacognosy.** W.B. Saunders, 2002. 16th Ed. ISBN-10: 0702029335.
2. Francisco A. Macias, Jose L.G. Galindo, Juan C.G. Galindo, **Evolution and current status of ecological Phytochemistry**, *Phytochemistry* 68 (2007) 2917–2936.
<http://www.dzumervis.nic.in/Microbes%20and%20Plants%20Growth/pdf/Evolution%20and%20current%20status%20of%20ecological.pdf>
3. Jean Bruneton, Caroline K. Hatton, **Pharmacognosy, phytochemistry, medicinal plants.** Lavoisier, 1999. ISBN 1898298637.
4. Kokate C. K., Gokhale S.B. and Purohit A.P., **Textbook of Pharmacognosy**, Nirali Prakashan, Pune, 2008, ISBN: 8185790094.
5. Mukherjee Pulok K., **Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals.** Business Horizons, 2002. ISBN 8190078844.
6. **Quality control methods for medicinal plant materials**, World Health Organization, Geneva, 1998. ISBN 9241545100.
7. Rangari V.D., **Pharmacognosy & Phytochemistry (Vol I)**, Career Pub., Nashik, 2009, ISBN: 978-81-88739-45-5.
8. Rangari V.D., **Pharmacognosy & Phytochemistry (Vol II)**, Career Pub., Nashik, 2009, ISBN: 978-81-88739-65-3.
9. Roy Lester Whistler, James N. BeMiller, **Industrial gums: polysaccharides and their derivatives**, Academic Press, 1993. ISBN 0127462538.
10. Seigler David S., **Plant Secondary Metabolism**, Kluwer Academic Publishers, Dordrecht, the Netherlands. 1995. ISBN 0-412-01981-7.
11. SeverianDumitriu, **Polysaccharides: Structural Diversity and Functional Versatility.** CRC Press, 2004. ISBN 0824754808.
12. Thomas Hartmann, **From waste products to ecochemicals: Fifty years research of plant secondary metabolism**, *Phytochemistry*, Volume 68, Issues 22–24, 2007.

(<http://www.sciencedirect.com/science/article/pii/S0031942207005730>)

13. Wallis T. E., **Textbook of Pharmacognosy**. CBS Publisher, 1985. ISBN:81- 239-0886-5.

14. Wink M., **Functions and Biotechnology of Plant Secondary Metabolites** (Annual plant reviews, volume 39) 2nd ed., Blackwell Publishing Ltd., 2010. ISBN 978-1-4051-8528-8.

2.3.6 P PHARMACOGNOSY & PHYTOCHEMISTRY-I

(Practical) (3 Hrs/Week)

Practical's:

1. Preparation of permanent slides.
2. Study of morphology, microscopy, & powdered characteristics (drugs mentioned in theory syllabus). (Min 3 Exp.)
3. Qualitative analysis of unorganized crude drugs/fibers (drugs mentioned in theory syllabus) (Min 3 Exp.)
4. Determination of swelling index of mucilage/pectin containing crude drugs.
5. Extraction & isolation of mucilage (Isapgol seeds/Okra fruits)
6. Extraction & isolation of pectin from citrus peels.
7. Characterization of starches by microscopical technique.
8. Determination of specific gravity/ refractive index/ colour/ acid value/ saponification value/ unsaponifiable matters of fixed oils/ determination of melting point of fat (Min. 4 Exp.).
9. Estimation of tannins by Spectrophotometer/hide powder assay.
10. Systematic approach for identification of powdered crude drugs

Recommended Books (Practical's):

1. Brain K.R. & Turner T.D., **The Practical Evaluation of Phytopharmaceuticals**, Wright-Scientifica, Bristol, 1975.
2. Khandelwal K. R., **Practical Pharmacognosy**, Pragati Books Pvt. Ltd. ISBN 8185790302.
3. Kokate C. K., **Practical Pharmacognosy**, VallabhPrakashan, 1993.
4. Wallis T E., **Practical Pharmacognosy**. J.A. Churchill Ltd., London, 1953.
5. Jeffrey B. Harborne. **Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis**. Springer, 1998. ISBN 0412572702, 9780412572708.
6. Manual of methods of analysis of foods: Oils & Fats
(<http://www.fssai.gov.in/Portals/0/Pdf/15Manuals/OILS%20AND%20FATS.pdf>)

SAVITRIBAI PHULE PUNE UNIVERSITY



Faculty of Pharmaceutical Science

Syllabus

**Second Year B. Pharm. Credit System 2015 Course
(With effect from Academic Year 2016 - 17)**

2.4.1 T PHYSICAL PHARMACEUTICS-II (Theory) (3 Hrs/Week)

Learning objectives: On successful completion of following theory topics & laboratory experiments, learner should be able to

A. Knowledge:

1. Chemical and physical phenomena that govern the in vivo and invitro actions of pharmaceutical products.
2. Acquire sufficient knowledge of surface and interfacial tension between the surfaces.
3. Acquire skills and understanding of the principles, concepts of surface tension and its measurement.
4. Understand the different types of flow in order to identify and choose suitable flow characteristics for the formulation.
5. Define reaction kinetics, reaction order, and discuss factors affecting the rate of the reaction.
6. Describe the degradation and stabilization of medicinal agents as well as accelerated stability testing.
7. Mention the physicochemical properties of drugs and assessment of physical stability; routes of degradation of drugs & principle methods of stabilization of Drugs, etc.
8. Know types, properties and applications of colloids in the formulations.
9. Understand the properties of particles and pharmaceutical powders, their significance in formulating pharmaceutical products, and the common methods for characterizing these properties.
10. Illustrate fundamentals and pharmaceutical applications of rheology.

B. Skills:

1. Predict surface tension of given liquid.
2. Calculate Krafft point, Cloud point, critical micelle concentration and HLB value of given surfactant.
3. Understand working of Brookfield viscometer.
4. Execute relative strength of two acids.
5. Calculate energy of activation of acid hydrolysis.
6. Determine order of any reaction.
7. Find out composition of binary mixture by viscosity method.
8. Evaluate viscosity, specific surface area, particle size distribution & derived properties of any material.

Topic No.	Name of topic and contents	No of Hrs.
01	<p>Surface & Interfacial phenomena</p> <p>1. Introduction to Surface and interfacial tension, surface free energy, Measurement of surface and interfacial tension, spreading coefficient, adsorption at liquid-interfaces.</p> <p>2. Surfactant classification and HLB scale, Micellar solubilization, Krafft & Cloud point, soluble monolayer & Gibbs equation, insoluble monolayer and film balance, adsorption at solid interfaces, adsorption isotherms, (Langmuir and Freundlich)</p>	10
02	<p>Rheology</p> <p>1. Fundamentals of rheology, Types of flow, Viscometers mechanical model to illustrate viscoelasticity, creep curve.</p> <p>2. Thixotropy, measurement of thixotropy, rheology of disperse system, pharmaceutical application of rheology.</p>	08
03	<p>Chemical Kinetics and Stability</p> <p>1. Reaction theories, rate, order and molecularity, mathematical treatment of zero, first and second order, (complex reaction: reversible, parallel and side reactions (no derivations),</p> <p>2. Determination of order, Effect of temperature, Arrhenius equation and energy of activation, degradation pathways, physical & chemical instability Accelerated stability studies.</p> <p>3. Problems related to half life, shelf life, and energy of activation and Arrhenius factor.</p>	10
04	<p>Micromeritics</p> <p>1. Introduction and pharmaceutical importance, particle size and distribution, particle shape, particle volume, particle number, surface area, methods for determining particle size, particle volume measurement.</p> <p>2. Specific surface, method for determining surface area.</p> <p>3. Derived properties of powder: porosity, packing arrangement, densities, bulkiness, flow properties of powder, angle of repose, factors affecting flow of powder.</p>	08
05	<p>Colloids</p> <p>1. Introduction & types, optical, kinetic & electrical properties of colloids, electrical double layer, Nernst & Zeta potential, Donnan membrane equilibrium.</p> <p>2. Protective colloids, stabilization of colloidal system, DLVO theory, Schulz Hardy rule, Hoffmeister series, Applications in pharmacy.</p>	09

2.4.1 P PHYSICAL PHARMACEUTICS-II
(Practical) (3 Hrs/Week)

Sr. No	Topic	Experiment
01	Interfacial phenomena	1. Determination of surface tension of given liquid. 2. Determination of Cloud point and Krafft point of given surfactant. 3. Determination of critical micelle concentration of a surfactant by surface tension method. d. Determination of HLB of glyceryl monostearate.
02	Chemical Kinetics	1. Determination of relative strength of two acids. 2. Determination of order of reaction by equal fraction method 3. Determination of energy of activation of acid hydrolysis of methyl acetate.
03	Viscosity	1. Determination of viscosity of given liquid by Ostwald's viscometer and demonstration of Brookfield viscometer. 2. Determination of composition of binary mixture by viscosity method.
04	Micromeritics	1. Determination of Specific Surface area of charcoal by adsorption method. 2. Determination of particle size distribution of any material by Microscopy 3. Determination of particle size distribution of any material Sieve analysis.
05	Colloids	1. Determination of effect of salts on stability of hydrophobic sols.

Recommended Books:

1. Sinko PJ. Martins Physical Pharmacy and Pharmaceutical Sciences. 6th ed. Noida: Lippincott Williams and Wilkins; Reprint 2010.
2. Bahl BS, Tuli GD. Essentials of Physical Chemistry. 1st ed. New Delhi: S. Chand and Co. Ltd; Reprint 2010.
3. Arnikar HJ, Kadam SS, Gujar KN. Essentials of Physical Chemistry and Pharmacy. 1st ed. Chennai: Orient Longman Pvt. Ltd. Reprint 2007.
4. Kapoor KL. Textbook of Physical Pharmacy. Vol. II, 3rd ed. McMillan India Ltd.
5. Marlton SH, Frultoon CF. Principles of Physical Chemistry. 4th ed. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
6. Hadkar UB. A Textbook of Physical Pharmacy. 4th ed. Pune: Nirali Prakashan; 2007.
7. Subrahmanyam CVS. Essentials of Physical Pharmacy. 1st ed. New Delhi: Vallabh Prakashan; Reprint 2006.
8. Subrahmanyam CVS. Textbook of Physical Pharmaceutics. 1st ed. New Delhi: Vallabh Prakashan; 2003.

9. Liebermann HA, Lachman L, Schwartz JB. Theory and Practice of Industrial Pharmacy. Special Indian ed. Noida, UP: CBS Publishers & Distributors Pvt.Ltd; 2009.
10. Hadkar UB. Handbook of Practical Physical Pharmacy and Physical Pharmaceutics. 4th ed. Pune: Nirali Prakashan; 2007.
11. More HN, Hajare AA. Practical Physical Pharmacy. 2nd ed. Nasik: Career Publication; 2007.
12. Gaud RS and Gupta GD .Practical Pharmaceutics. 1st ed. New Delhi: CBS Publishers & Distributors; Reprint 2010.
13. Madan and Tuli S. Essentials of Physical Pharmacy. Chand & Company, New Delhi.

2.4.2 T PATHOPHYSIOLOGY AND CLINICAL BIOCHEMISTRY (Theory) (3 Hrs/Week)

Learning objectives:

On completion of following theory topics and laboratory experiments, a learner should be able to Understand the definition, epidemiology, etiology, clinical manifestations, pathophysiology, complications, diagnosis & plan of treatment for various diseases and disorders.

Skill:

1. Explain the application, maintenance and uses of various instruments in clinical biochemistry.
2. Know the techniques of biological fluid collection and separation.
3. Understand the importance and estimation of various markers for liver, kidney and heart diseases.
4. Understand different techniques for the estimation blood glucose, CRP, HbA1c etc and its clinical importance.

Topic No.	Topics	Hours
SECTION - I		
1.	Introduction to pathophysiology Definitions and Terminologies of pathophysiology,	01
2.	Cell injury and origin of diseases Etiology of cell injury Genetic, Acquired, idiopathic, Pathogenesis of hypoxic and ischemic cell injury (reversible and irreversible) Cellular deficiencies Cellular intoxications (intracellular accumulations), fats, proteins, glycogen. Endogenous toxins, exogenous toxins.	02
Definition, types, epidemiology, etiology, clinical manifestations, pathophysiology, Morphological changes, complications, diagnosis & plan of treatment for following disorders		
3.	Pain & Inflammation	03
4.	Cardiovascular disorder: Hypertension, Angina Pectoris, Myocardial infarction, Congestive Heart Failure (CHF), Cardiac arrhythmias, Shock, Peripheral arterial diseases (Buerger's disease, Raynauds diseases),	07
5.	Respiratory system disorders: Chronic obstructive pulmonary disorder (COPD), Tuberculosis, Pneumonia.	04
6.	Digestive system disorders:-	04

	Peptic ulcer, diarrhea & dysentery, constipation, Hepatic and biliary disorders- Hepatitis, Jaundice, Cirrhosis, gall stone.	
Section - II		
7.	CNS disorders: Epilepsy, Parkinson disease, Alzheimer's disease, schizophrenia, depression.	05
8.	Urinary system disorders: Renal failure, Urinary Calculi, urinary tract infections.	03
9.	Endocrine system disorders: Cretinism, hyperthyroidism, diabetes mellitus.	03
10.	Reproductive system disorders: Endometriosis, dysmenorrhoea, Polyovaries cyst.	03
11.	Immunological disorders: Autoimmune disorders: Myasthenia gravis, Rheumatoid arthritis.	02
12.	Musculoskeletal and connective tissue disorders: Osteoarthritis, gout.	02
13.	Malignancy	02
14.	Hematological disorders: Anemia and leukemia	02
15.	Infection & Parasitic diseases: Malaria, Leprosy, sexual transmitted disease (syphilis, Gonorrhoea, AIDS)	02
		45

Recommended Books

1. Harsh Mohan: Textbook of Pathology, *Jaypee Brothers, Medical Publishers, New Delhi.*
2. Harisons Internal Medicine, *Tata Mc-Graw Hill Publications, Singapore.*
3. Davidsons: Textbook of Medicine. *Tata Mc-Graw Hill Publications, Singapore.*
4. Robins: Textbook of Pathology.
5. Bodhankar S.L, Vyavahare N.S.: Pathophysiology. *Nirali Publications, Pune.*
6. Herfindal Eric T., Gourley Dick R., Textbook of Therapeutics, Drug and Disease Management
7. Rang H.P. and Dale M.M.: Pharmacology, *Churchill Livingstone, Edinbergh*
8. Goodman and Gillman: Pharmacological Basis of Therapeutics, *McGraw-Hill, Medical Publishing Division, NewYork.*
9. Katzung B.G.: Basic and Clinical Pharmacology, *Lange Medical Publications, California.*
10. Tripathi K.D.: Essentials of Medical Pharmacology, *Jaypee Brothers, Medical Publishers, New Delhi.*

**2.4.2 P PATHOPHYSIOLOGY AND CLINICAL BIOCHEMISTRY
(Practical) (3 Hrs/Week)**

1	Study of commonly used instruments, equipments and accessories in clinical biochemistry laboratory, its management and maintenance of records.
2	Study of general techniques of collection and recording of specimens of serum/plasma etc. Preservation techniques and their disposal.
3	Study of qualitative determination of abnormal constituents of urine - sugar, protein, bile salt, bile pigment, ketones bodies.
4	Chemical examination of stool: occult blood
5	Kidney function test: To determine creatinine, urea, uric acid and electrolytes such as sodium, potassium, chloride from suitable body fluid
6	Liver function test: To determine total bilirubin, direct bilirubin, indirect bilirubin, SGOT, SGPT, Alkaline Phosphatase, proteins, globulin, albumin, from suitable body fluid
7	Cardiac profile tests: To determine Cholesterol, Triglycerides, HDL., VLDL, LDL, Troponin I from the suitable body fluid.
8	To determine C-Reactive protein (CRP) from the suitable body fluid.
9	Determination of serum Erythrocyte Sedimentation Rate (ESR)
10	Determination of blood glucose level and HbA1c
11	Determination of arterial blood gas.
12	Basics of histopathology
13	Detection of malaria parasite.
14	Visit to pathology laboratory or blood bank

Recommended Books:

1. Lehninger's Principles of Biochemistry by Albert Lehninger, 4/Ed., Palgrave Macmillon.
2. Biochemistry by Lubert Stryer, W.H., Freeman & Company, New York.
3. Harper's Illustrated Biochemistry by R.K. Murray & D.K. Granner, 27/Ed, McGraw Hill.
4. An Introduction to Practical Biochemistry by David Plummer, 3/Ed, Tata McGraw-Hill Edition.

5. Varley's Practical Clinical Biochemistry by Harold Varley, 6/Ed., CBS Publishers, New Delhi.
6. Molecular Biology by J.D. Watson, The Benjamin/Cummings Company Inc.
7. Pocket Comparison to Robbins & Cortran Pathologic Basis Disease by Robbins, Cortran, Kumar, 7/Ed, Elseveir.
8. Clinical Biochemistry by Herold Varley, CBS Publishers, New Delhi.
9. Text Book of Biochemistry with Clinical Correlations by Thomas & Devlin, A Wiley Medical Publication.
10. Clinical Chemistry Interpretation and Techniques by Alex Kaplan Lavernel L. & Szebo Kent E. Opheim Published Lea and Febiger.
11. Laboratory Medical Technology by Prafulla Godkar.
12. Text Book of Pathology by Harsh Mohan, 5/Ed., Jaypee Brothers Medical Publishers (P) Ltd.
13. Clinical Biochemistry by S. P. Dandekar 2/Ed
14. Pathophysiology of Disease by Mephee & Lingappa, 2/Ed., Appleton & Lane.
15. Pharmaceutical Biochemistry by Sharma P.K & Dandiya P.C, Vallabh Prakashan.
16. Human Biochemistry by Jamam, Orten.
17. Methods in Enzymology, Academic Press.

2.4.3 T PHARMACEUTICAL ORGANIC CHEMISTRY-IV (Theory) (3 Hrs/Week)

Learning objectives: On successful completion of following theory topics and laboratory experiments, a learner should be able to

A. Knowledge:

1. Know the structures with numbering of heterocyclic compounds, chemistry, methods of preparation and chemical reactions of five, six membered and fused heterocyclic rings.
2. Know schemes of synthesis and reactions of drugs containing heterocyclic rings.
3. Classify carbohydrates and understand reactions related to C₅ and C₆ sugars.
4. Explain various techniques of combinatorial chemistry and understand applications of combinatorial chemistry in the speedy synthesis of organic compounds and peptides.
5. Understand general rules and guidelines involved in retro-synthesis and construct retro-synthesis of pharmaceutically important compounds.
6. Comprehend the techniques of microwave assisted synthesis and explain applications of microwave assisted synthesis in pharmaceutical research.

B. Skills:

1. Perform qualitative analysis of solid-liquid and liquid-liquid organic binary mixtures, separate and purify of binary mixtures of organic compounds.
2. Synthesize heterocyclic compounds and know reaction mechanisms.
3. Demonstrate techniques such as Recrystallisation, filtration and precipitation.
4. Perform quantitative determination of different reactive groups.

Sr. No.	Topics	No. of hrs.
SECTION-I		
1	Heterocyclic Chemistry: Structures, numbering and corresponding drugs of the following Heterocyclic compounds: furan, thiophene, pyrrole, pyrazole, thiazole, imidazole, oxazole, isoxazole, hydantoin, pyridine, pyridazine, pyrimidine, indole, benzfuran, benzthiazole, benzimidazole, benzoxazole, quinoline, isoquinoline, quinazoline, cinnoline, purine, xanthine, pteridine & Coumarin. Synthesis and Reaction of following compounds: furan, pyrrole, indole, imidazole, pyridine and quinoline, isoquinoline and thiophene	20
2	Polycyclic compounds: Synthesis and reactions of naphthalene, Anthracene and Phenanthrene.	4
SECTION-II		
2.	Reagents used in organic synthesis: Methods of preparation, reaction and uses of aluminium isopropoxide, NBS, DDQ, DCC, diazomethane, organoboranes, metal	

	hydrides, LTA, manganese oxide, organosilicon compounds, osmium trioxide, Wittig reagent, oxidizing, reducing, nitrating, halogenating, sulfonating agents and reactions thereof, coupling reagents.	6
3	Introduction to Combinatorial Chemistry: History, Introduction to linkers and solid supports. Various techniques used in combinatorial synthesis (Mix and split, Parallel synthesis). Applications	5
4	Retro-synthesis: Introduction to common terms, General Rules and Guidelines involved in retro-synthesis, Disconnections involving one and two functional groups. The retro-synthesis of following drugs to be covered: Ibuprofen, Propranolol, Ciprofloxacin and Sulfamethoxazole.	7
5	Microwave assisted Synthesis: Basics, Principle, Techniques of microwave assisted synthesis and Applications of Microwave assisted synthesis in pharmaceutical organic chemistry	3

2.4.3 P PHARMACEUTICAL ORGANIC CHEMISTRY -IV (Practical) (3 Hrs/Week)

1. Separation and qualitative analysis of binary mixtures (Any three solid-liquid & liquid-liquid mixtures)
2. Organic Synthesis of drugs & drug intermediates containing heterocyclic rings mentioned in theory (Any five).
e.g.: 4-Methyl 7-hydroxy coumarin (Coumarin derivative), Amino Pyridine (Pyridine derivative), 2, 3 -Diphenylquinoxaline (quinoxaline), Benzotriazole, Benzimidazole, Benzthiazole, etc.
3. Demonstration of microwave assisted reaction of organic compounds (Any one)
4. Quantitative determination of reactive groups (Any five) e.g. Phenolic hydroxyl, ester, carboxyl, carbonyl, primary amine, amide and nitro groups.

Recommended Books:

1. Stereochemistry of Carbon Compounds by E. L. Eliel, 32 reprint 2005, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
2. Stereochemistry of Organic Compound Principles and Applications by Nasipuri, Revised Edition, New Age International Publishers.
3. Stereochemistry Conformation and Mechanism by P.S. Kalsi, 7/Ed 2008, New Age International Publishers, New Delhi.
4. Advanced Organic Chemistry by E.S. Gould, 4/Ed. Wiley Eastern Edition.
5. Principles of Organic Synthesis by Norman, 3/Ed., Nelson Thorns Publication.
6. Organic Chemistry by Morrison & Boyd, 7/Ed, Pearson Education.
7. Advanced General Organic Chemistry-A Modern Approach by Sachin Kumar Ghosh, 3/Ed 2009, New Central Book Agency (P) Ltd.

8. Organic Chemistry by Jonathan Clayden, Nick Greeves, Stuart Warren, 2nd Ed 2012, Oxford University press
9. Advanced Organic Chemistry-Reactions, Mechanisms & Structures by Jerry March, Wiley India (P) Ltd., New Delhi
10. Organic Chemistry by Fieser & Fieser, Vol. I-X, 1st Ed. Asia Publishing House.
11. Quantitative organic Analysis by Siggsa & Honna, 4th Ed., A Wiley Inter Science Publication. John Wiley & Sons
12. Vogel's Textbook of Practical Organic Chemistry by A. I. Vogel, 5th Ed., Pearson Education
13. Handbook of Organic Analysis (Qualitative and Quantitative) by H. T. Clarke, 1st Ed., Arnold-Heinemann.
14. Reactions, Rearrangements and Reagents by S N Sanyal,

2.4.4 T PHARMACEUTICAL ANALYSIS-II (Theory) (3 Hrs/Week)

Learning objectives: On successful completion of following theory topics & laboratory experiments, learner should be able to

A. Knowledge:

1. Understand the basic principles, instrumentation and applications of various analytical techniques mentioned below which are used in Pharmaceutical industry for quality control of chemicals, drug intermediates, APIs, excipients, Pharmaceutical formulations and cosmetic products.

B. Skills:

1. Independently operate and calibrate various analytical instruments for the separation/isolation and assay of various chemicals, drug intermediates, APIs and formulations as per Pharmacopoeial standards.
2. Independently process, interpret the data obtained through experimentation and report the results as per regulatory requirements.
3. Take appropriate safety measures while handling instruments, chemicals and apparatus.
4. Demonstrate the required level of professional competence in the planning, conducting, evaluation and reporting of the results of investigations, including the appropriate use of literature and secondary data.

Topic No.	Name of the topic and contents	Hrs
SECTION-I		
1.	Electro - Analytical Techniques Introduction & types of Electro-Analytical Techniques, Electrochemical cell, potentials in electro -analytical cell& its measurement (Nernst Equation) ,current-potential relationships, mass transfer by migration, convection and diffusion.	03
2.	Potentiometry Introduction, theory & principle of potentiometry, types of electrodes, Reference electrode(Normal hydrogen electrode, calomel electrode, quinhydrone electrode, silver- silver chloride electrode), indicator electrode (Glass, ion sensitive – solid, liquid and gas membrane), measurement of electrode potential and pH, pH meter& its calibration, potentiometric titrations and applications.	07
3.	Conductometry Introduction, theory & principle of Conductometry, measurement of conductance, (specific, molecular and equivalence conductance), effect of dilution, cell constant, conductivity meter, conductometric titrations & high frequency titrations.	05
4.	Polarography Introduction, theory& principle of polarography, polarogram, half wave potential,	06

	Ilkovic equation, Dropping Mercury Electrode ,types of polarography (Linear Scan & Differential Pulse), applications.	
SECTION-II		
5.	Amperometry Introduction, theory & principle of amperometry, types of electrodes, amperometric titration, general procedure, advantages, disadvantages and applications of amperometry, Biamperometric titration.	05
6.	Coulometry Introduction, theory & principle of Coulometry, types of Coulometry, general characteristics of Coulometric techniques, Coulometry at controlled potential (potentiostatic), constant current Coulometry (Amperostatic), applications	05
7.	Refractometry Introduction, Refractive index, Specific and molar refraction, Measurement of RI (angle of refraction), Instrumentation (Abey's, Dipping/Immersion, Pulfrich and Image displacement refractometer) and applications.	05
8.	Polarimetry Introduction, Polarization of light, types of plane polarized light(Linear, Circular and elliptically polarized light), optical activity, factors affecting angle of rotation, measurement of polarized light, specific & molecular rotation, instrumentation and applications of Polarimeter, Optical Rotatory Dispersion (ORD), Circular Dichroism (CD), Cotton Effect (CE)	06
9.	Miscellaneous techniques: Karl Fischer Titration	02

2.4.4 P PHARMACEUTICAL ANALYSIS -II (Practical) (3 Hrs/Week)

1. Calibration of pH meter, Conductometer, Refractometer and Polarimeter.
2. To determine purity of Pharmaceutical substances by potentiometric titrations. (e.g. SA v/s SB, WA v/s SB, WB v/s SA)
3. To determine pKa of some monobasic, dibasic or tribasic acids of pharmaceutical importance.
4. To determine purity of some pharmaceutical substances by conductometric titrations. (e.g. SA v/s SB, WA v/s SB, WB v/s SA)
5. To measure Refractive Index (RI) and Molar Refraction of pharmaceutically important vegetable oils, glycerin-water mixture and organic solvents
6. To measure optical rotation and specific optical rotation of some sugars

Reference books:

1. Vogel's Text Book of Quantitative Chemical Analysis, 6/Ed., Pearson Education.
2. Quantitative analysis by V. Alexyev, Student Edition, CBS Publisher & Distributors.
3. Fundamentals of Analytical Chemistry by Skoog, West, Holler, Harvest, 8/ Ed., Thomson Brookscole.
4. Pharmaceutical Analysis by Higuchi, Reprint 2004, CBS Publisher & Distributors.

5. The quantitative analysis of drugs by Garratt DC, 3/Ed., CBS Publisher & Distributors.
6. Quantitative Analysis by Day R A & Underwood A L. 5/Ed., Prentice Hall of India Pvt. Ltd. New Delhi.
7. Analytical Chemistry by Christian G D, 6/Ed., John Wiley & Sons.
8. A Textbook of Pharmaceutical Analysis by Connors KA, 4/ed., John Wiley & Sons.
9. Practical Pharmaceutical Chemistry Part -I & II by Beckett A H & Stanlake J B , 4/ Ed., CBS Publisher & Distributors.
10. Handbook of Instrumental Techniques for Analytical Chemistry by Frank Settle, First Indian Reprint 2004, Pearson Education
11. Pharmaceutical Analysis Vol. I &II K. R. Mahadik, S.G. Wadodkar, H. N, More,Dr. A. V. Kasture, Nirali Prakashan.
12. Instrumental Methods of Analysis by Willard Merit, Dean Settle, 7th edition, CBS Publisher & Distributor
13. Instrumental Methods of Chemical Analysis by BK Sharma, Goel Publishing House.
14. Instrumental Methods of Chemical Analysis by GW Ewing, McGraw-Hill Book Company
15. A Practical Approach to Pharmaceutical Analysis(Instrumental & Manual), Rajesh kumar Nema, Mahesh Verma, CBS Publishers & Distributors
16. Laboratory Handbook of Instrumental Drug Analysis, B.G. Nagavi, Vallabh Prakashan.

2.4.5 T PHARMACOGNOSY & PHYTOCHEMISTRY-II

(Theory) (3 Hrs/Week)

Learning objectives: on successful completion of theory and laboratory experiments, learner should be able to,

A. Knowledge:

1. Comprehend & explain underlying reason of evolutionary significance of alkaloids formation in plants & other organisms & deduce their significance as medicinal molecules.
2. Explain & draw basic heterocyclic system present in alkaloids, define & classify alkaloids, explain source, name & draw chemical structures, identify from the structure, organize the biosynthetic sequence in formation of major group of alkaloids; describe methods of their extraction & explain underlying rationale of qualitative & quantitative analysis of alkaloids.
3. Explain historical significance & contribution of alkaloids in modern drug discovery, & their currently marketed semisynthetic derivatives/ analogues.
4. Define, classify, explain source, name & draw chemical structures, identify from the structure, organize the biosynthetic sequence, and describe methods of extraction & underlying rationale of qualitative & quantitative analysis of terpenoids & resins. Explain historical significance & contribution of terpenoids / resins in modern drug discovery, & their currently marketed semisynthetic derivatives/ analogues.

B. Skills:

1. Demonstrate skill of plant material sectioning, staining, mounting & focusing; decide on staining reagents required for specific part of plant.
2. Identify the parts of plants from its morphological & microscopical features by applying experimental & theoretical knowledge of morphology & anatomy obtained in theory classes.
3. Draw morphological & microscopical diagrams & be able to label component / parts.
4. Conduct extractions/isolations & explain significance of use of various chemicals & physical conditions.
5. Identify unorganized crude drugs using morphological, chemical, physical & microscopical characteristics.
6. Conduct various analytical parameters of volatile oils & judge the quality of volatile oils.

7. Handle various equipments as per SOPs (such as spectrophotometer, simple / compound / digital microscope, Polarimeter, Abbe's Refractometer, hydrodistillation / microwave distillation assembly).

8. Judge the quality of crude drugs by different means & explain the significance of same in commerce & industry.

9. Listen carefully, raise logical query, draw information, understand rationale during field visits & prepare brief report for evaluation.

Topic No.	Name of the Topic and Contents	No of Hrs
	SECTION-I	
	<i>Alkaloids</i>	
	A] <i>General consideration:</i> Definition, classification, occurrences, properties, nomenclature, & chemistry (including general biogenesis, qualitative/quantitative analysis) of alkaloids.	03
1	B] <i>Systematic Pharmacognostic study including history & contribution to modern medicine:</i> <i>Pyridine-piperidine:</i> Tobacco <i>Tropane:</i> Belladonna, datura, coca <i>Quinoline and Isoquinoline:</i> Cinchona, ipecac, opium. <i>Indole:</i> Ergot, rauwolfia, catharanthus and nux-vomica <i>Imidazole:</i> Pilocarpus <i>Steroidal:</i> Veratrum and kurchi <i>Alkaloidal Amine:</i> Ephedra and colchicum <i>Glycoalkaloid:</i> Solanum <i>Purines:</i> Coffee and tea	24
	SECTION-II	
	<i>Terpenoids & Resins</i>	
	A] <i>General consideration:</i> Definition, classification, occurrences, properties, nomenclature, & chemistry (including general biogenesis, qualitative/quantitative analysis) of terpenoids/resins.	03
2	B] <i>Systematic Pharmacognostic study</i> (including history & contribution to modern medicine of followings): <i>Lower terpenoids:</i> Clove, Cinnamon, Coriander, Lavender, Sandal wood, Artemisia <i>Diterpenoids:</i> Taxus, Coleus <i>Triterpenoids:</i> Ginseng <i>Tetraterpenoids:</i> Annato & Saffron <i>Resins:</i> Podophyllum, Guggul, Boswellia & Cannabis	15

Recommended Books:

1. Evans W. C., Trease G. E., **Trease and Evan's Pharmacognosy**. W.B. Saunders, 2002. 16th Ed. ISBN-10: 0702029335.
2. Jean Bruneton, Caroline K. Hatton, **Pharmacognosy, Phytochemistry, Medicinal plants**. Lavoisier, 1999. ISBN 1898298637.
3. Kokate C. K., Gokhale S.B. and Purohit A.P., **Textbook of Pharmacognosy**, Nirali Prakashan, Pune, 2008, ISBN: 8185790094.
4. Mukherjee Pulok K., **Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals**. Business Horizons, 2002. ISBN 8190078844.
5. **Quality control methods for medicinal plant materials**, World Health Organization, Geneva, 1998. ISBN 9241545100.
6. Rangari V.D., **Pharmacognosy & Phytochemistry (Vol I)**, Career Pub., Nashik, 2009, ISBN: 978-81-88739-45-5.
7. Rangari V.D., **Pharmacognosy & Phytochemistry (Vol II)**, Career Pub., Nashik, 2009, ISBN: 978-81-88739-65-3.
8. Wallis T. E., **Textbook of Pharmacognosy**. CBS Publisher & Distributors, 1985. ISBN: 81-239-0886-5.
9. Ernesto F. & Orazio Tagliatela-Scafati, **Modern Alkaloids: Structure, Isolation, Synthesis and Biology**, 2008, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim. ISBN: 978-3-527-31521-5.
10. Roberts, Margaret F., **Alkaloids: Biochemistry, Ecology, and Medicinal Applications**. Springer, 1998, ISBN 978-1-4419-3263-1.
11. Ernest Guenther, **The Essential Oils: History - Origin In Plants - Production - Analysis- Vol 1**, Jepson Press, 2008, ISBN-10: 1443721050.

2.4.5 P PHARMACOGNOSY & PHYTOCHEMISTRY –II

(Practicals) (3 Hrs/Week)

Practical's:

1. Study of morphology, microscopy, & powdered characteristics (drugs mentioned in theory syllabus). Conduct at least one experiment on comparative study of closely related species/varieties (Min 5 Exp.).
2. Determination of solubility, specific gravity, optical rotation & refractive index of volatile oils. (Min 3 Exp.).
3. Determination of total alkaloidal content of Nux vomica seeds
4. Determination Reserpine in Rauwolfia by photometric method
5. Extraction caffeine from tea leaves.
6. Estimation of total tropane alkaloids by UV-visible Spectrophotometer
7. Extraction of volatile oil by hydrodistillation/microwave distillation of any crude drug.
8. Estimation of eugenol from Clove oil.
9. Identification of unorganized drugs (Resins)
10. Field visits: Visit to industry/ cultivation farm/ processing unit & submission of report thereof.

Recommended Books (Practical's):

1. Brain K.R. & Turner T.D., **The Practical Evaluation of Phytopharmaceuticals**, Wright-Scientifica, Bristol, 1975.
2. Jeffrey B. Harborne. **Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis**. Springer, 1998. ISBN 0412572702, 9780412572708.
3. Kadbadi S.S., Deore S.L. & Baviskar B.A., **Experimental Phytopharmacognosy**, Nirali Publication, Pune, 2011. ISBN 9381237131.
4. Khandelwal K. R., **Practical Pharmacognosy**, Pragati Books Pvt. Ltd. ISBN 8185790302.
5. Kokate C. K., **Practical Pharmacognosy**, VallabhPrakashan, 1993.
6. Wallis T. E., **Practical Pharmacognosy**. J.A. Churchill Ltd., London, 1953.

2.4.6 T PHARMACEUTICAL ENGINEERING (THEORY) (3 Hrs/Week)

Learning objectives: On successful completion of following theory topics, learner should be able to

A) Knowledge:

1. Understand molecular diffusion in gases and liquids.
2. Define drying and know the mechanism, theory & factors affecting it.
3. Classify & compare various dryers with respect to their applications in pharmacy.
4. Know various heat transfer techniques including their mechanism and applications in pharmacy.
5. Define crystallization and illustrate types of crystallizers.
6. Know about evaporation and describe the types of evaporator with their mechanism, instrumentation and applications.
7. Develop an understanding of pharmaceutical engineering by studying advance modules that are relevant to the changing priorities and requirements of the modern pharmaceutical industries.
8. Foster the knowledge of product manufacturing.
9. Study the principle, theory, mechanism, working and construction of equipments of different unit operations. (Filtration, centrifugation, drying, heat transfer.)
10. Focus on graphical representation of various equipment for unit operations.
11. Study the different materials used in the pharmaceutical plant constructions.
12. Emphasize principles, mechanisms and theories of different unit operations.
13. Illustrate fundamentals and facts about flow of fluids.
14. Describe types of distillation, their mechanisms with appropriate diagrams.
15. Define drying and classify different types of dryers.

Sr. No.	Topic	No of Hrs
SECTION-I		
1	Mass Transfer: Molecular diffusion in gases & liquids, theories of interphase mass transfer.	02
2	Drying: Mechanism, theory, factors affecting, Driers- tray drier, fluidized bed drier, spray drier, freeze drier, drum drier.	06
3	Heat Transfer: Mechanisms – conduction, convection, radiation, Fourier’s law, Stefan-Boltzmann’s constant, Kirchoff’s law, Heat exchangers- heat transfer in parallel flow & counter flow, tubular heat exchangers, plate heat exchangers and applications.	07
4	Evaporation: Theory, evaporator capacity-heat & material balances, factors	08

	influencing heat transfer coefficients. Evaporators- pan, tubular (horizontal, vertical-short, long & their subtypes), wipe film, centrifugal rotary, multiple effect evaporator-economy, capacity, methods of feeding, etc. Evaporator accessories- condensers, vacuum pump, removal of condensate, entrainment separators, foam.	
	SECTION-II	
5	Crystallization: Miers' theory of supersaturation, nucleation, crystal growth, classification of crystallizers, tank, Swenson walker crystallizer, caking of crystals.	05
6	Flow of Fluids: Fluid statics- pressure, pressure measurement-manometers & pressure guage, fluid dynamics, mechanism of fluid flow, material & energy balance, pressure differential flow meter-principle, orifice meter, pitot tube; Variable area flow meter-principle, rotameter orifice & plug meter, quantity flow meters.	07
7	Distillation: Vapour liquid equilibrium, distillation of miscible systems, boiling point diagram, equilibrium, distillation, differential distillation, rectification, fractionating column, heat & material balance, factors affecting plate theory efficiency, molecular distillation, separation of azeotropes and distillation of immiscible system.	06
8	Corrosion: Mechanisms, factors influencing corrosion process, method of combating it.	04

Recommended Books:

1. Paradkar A. Introduction to Pharmaceutical Engineering. Eleventh Edition, Nirali Prakashan, Pune. 2007.
2. Badger WL, Banchero JT. Introduction to Chemical Engineering. International Edition, McGraw Hill Book Company. 1955.
3. Subrahmanyam CVS, Thimma Setty J, Sarasija Suresh, Kusum Devi V. Pharmaceutical Engineering Unit Operations-II. Second Edition, Vallabh Prakashan, Delhi. 2011.
4. Tekade AR, Pande VV, Shastri KV. Pharmaceutical Engineering. First Edition, Tech-Max Publications, Pune. 2015.
5. Sambamurthy K. Pharmaceutical Engineering. First Edition, New Age International Publishers, New Delhi. 1998.