

**UNIVERSITY OF PUNE**

**FACULTY OF PHARMACEUTICAL SCIENCES**



**SYLLABUS OF  
SECOND YEAR BACHELOR OF PHARMACY  
(S.Y.B. Pharm.)  
(EFFECTIVE FROM ACADEMIC YEAR 2014-15)**

**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 in vitro 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 into 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.

**B. Skills :**

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

Topic No.	Name of the topic and contents	Hrs.
<b>01</b>	<b>Phase Rule</b> Gibbs phase rule, one component (Water), two components, and three components system.	<b>04</b>
<b>02</b>	<b>Gaseous state of matter</b> Basic gas laws, theory & equation of state for ideal gases, Deviation from gas theory, Compressibility factor, Vander Waal equation for real gases, critical constants, Liquefaction of gases: Linde's process, Claude's process, application of liquefaction to Aerosols i.e. principle of aerosols, 2 phase and 3 phase Systems.	<b>08</b>
<b>03</b>	<b>Solid State</b> Introduction to crystallization, Miers theory, Crystal parameters- crystal forms, habits, lattice angle, Methods of crystal analysis: X-Ray Diffraction, Bragg's equation;	<b>09</b>

	Polymorphism: Definition, Different shape of polymorphs, Example and its application to pharmacy, Mention Detection techniques. Glass transition temperature	
04	<b>Solution of Non-electrolytes and Electrolytes</b> Properties and types of solutions, ideal and real solutions, Raoult's law and its deviations, boiling point diagram & fractional, steam distillation, Colligative properties: relative lowering of vapor pressure, elevation of boiling point, depression of freezing point, and osmotic pressure, problems involving molecular weight determinations, Solution of electrolytes: equivalent and specific conductance, Kohlrauschs law, conductometric titrations, Colligative properties of electrolytes.	12
05	<b>Solubility and Distribution Phenomenon</b> Solute solvent interactions, 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, Distribution phenomenon: Nernst distribution law and its limitations, Effect of ionic dissociation and association, applications in Pharmacy, BCS classification.	12

### 2.3.1 P PHYSICAL PHARMACEUTICS-I (Practical)

(3 hrs / week)

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 (toluene-acetone-water).
4. Construction of ternary phase diagram for three-component system (oil-water-surfactant).
5. Determination of solubility of substance at different temperatures.
6. Determination of solubility of benzoic acid in different solvents.
7. Determination of effect of co solvents on solubility of benzoic acid in water.
8. Determination of molecular weight by Rast's camphor method.
9. Determination of cell constant by conductometry.
10. Determination of unknown concentration by conductometric titration.
11. Verification of Ostwald's dilution law by conductometry.
12. Determination of partition coefficient of iodine.
13. Determination of partition coefficient of benzoic acid between water and benzene.
14. Determination of effect of pH on partition coefficient.
15. Estimation of saturation solubility of given drug in water.

#### **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. Arnika, 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. Marlton, 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 & IMMUNOLOGY (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.

Topic No.	Name of the topic and contents	Hrs.
1	<b>Introduction to Microbiology:</b> 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-	05

	contributions of Anton van Leeuwenhoek, Louis Pasteur, Robert Koch and Paul Ehrlich.	
2	<b>Bacteria:</b> 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	<b>Yeasts and moulds:</b> Introduction and applications of <i>Saccharomyces cerevisiae</i> , <i>Candida albicans</i> and <i>Penicillium</i> .	01
4	<b>Viruses:</b> Introduction, general properties, structure of viruses, Human viruses – multiplication and cultivation, Structure Human Immunodeficiency virus.	03
5	<b>Microbial Limit tests:</b> Viable count, Identification of specific microorganism as per IP	02
6	<b>Sterilization:</b> Introduction to concept of sterilization, Different methods - dry heat, moist heat, gaseous, radiation and filtration.	03
7	<b>Preservation and Disinfection:</b> Chemical classification of different disinfectants with a example, Phenol coefficient test: RW test.	03
8	<b>Fundamentals of Immunology:</b> Microbial virulence, exotoxins, endotoxins Antigens, Types of Immunity, Defense mechanisms of host – specific and nonspecific, Mechanism of CMI and HMI, Antibodies-Classification.	09
9	<b>Antigen - Antibody reactions:</b> 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	<b>Vaccines and sera:</b> Classification of vaccines, General production of Vaccines and sera and their quality control.	05

### 2.3.2 P PHARMACEUTICAL MICROBIOLOGY & IMMUNOLOGY (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:***

1. Anathnarayan R. and Panikar C. K. J., (2000). Textbook of Microbiology, 8/Ed., Orient Longman, 2011.
2. Aulton M. E., Pharmaceutics-The Science of Dosage Form Design, Churchill Livingstone, 1998
3. Baird, R.M., et al. (eds.), Handbook of Microbiological Quality Control – Pharmaceutical and Medical Devices. Taylor and Francis Inc., London, 2000.
4. Carter S. J., Copper and Gunn's Tutorial Pharmacy, CBS Publishers and Distributors, Delhi, 1996.
5. Collee J. G. et al, Mackie and McCartney Practical Medical Microbiology, Fourteenth Edition, Churchill Livingstone Publications, New York, 1996.
6. Hugo W. B. and Russell A. D. Pharmaceutical Microbiology, 6/Ed., Blackwell Science, 1998.
7. Kokare C. R., Pharmaceutical Microbiology-Principles and Applications, 6/Ed., Nirali Prakashan, Pune, India,2008.
8. Indian Pharmacopoeia, Govt. of India, Ministry of Health and Family Welfare. 1996 & 2007.
9. Pelczar M. J. et al., Microbiology, 5/Ed., McGraw Hill, New York, 1986.
10. Rawlins E. A., (eds.), Bentley's Textbook of Pharmaceutics, 8/Ed., Bailliere Tindall, London, 1992.
11. Akers M. J., Parenteral Quality Control, 2/Ed., Marcel Dekker Inc., New York 1994
12. Brooks. G.F, Butel. J. S., Morse. S. A, Jawetz, Metrics, & Adel bergs Medical Microbiology, 21/Ed., Appleton & Lange Publication, United State of America, 1989
13. Maloy. S. R., Cronan. J. E., Microbial Genetics, 2/Ed., Narosa Publishing House, New Delhi, 2006.
14. Ingraham.J. L , Ingraham C. A. , Introduction to Microbiology, 2/Ed., Thomson. Brooks Cole, U.S., 2000
15. Wiley M. Sherwood L. M., Woolverton C. J. Prescott, Harley & Klein's Microbiology, 7/Ed., McGraw Hill International Edition, 2008.
16. Frobisher M, HinsDill. R. D, Crabtree K.T., Good Heart. C. R, Fundamentals of Microbiology, 9/Ed., Saunders Company, Japan, 1974.
17. Casida. L.E., Industrial Microbiology, 7/Ed., New Age International Publication, 2007
18. Richard A. Goldsby, Thomas J. Kindt, "Kuby Immunology", 5<sup>th</sup>, 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, learner should be able to

**A) Knowledge :**

1. explain the scope of Biochemistry in pharmacy.
2. understand role of biochemical processes, cell metabolism.
3. clarify the enzyme structures, their functions, mechanism for enzymatic activity and applications of enzymes.
4. draw the general metabolism process of proteins, lipids, carbohydrates.
5. understand basics like chemistry, function, classification, biological importance, qualitative tests & applications of various biomolecules. e.g. proteins, carbohydrates and lipids, etc
6. clarify the fundamentals 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. detect and identify proteins, amino acids and carbohydrates by various qualitative as well as quantitative tests.
2. separate, identify and characterize proteins from various samples like egg, milk, etc and understand principle behind the technique.
3. handle and operate gel chromatography, UV spectrophotometer, colorimeter, flame photometer and various instruments used in clinical biochemistry laboratory.
4. isolate starch from potato and understand techniques as well as mechanism involved.
5. estimate quantity of ascorbic acid in a given sample.
6. demonstrate action of salivary amylase on starch.
7. separate proteins by SDS-PAGE.

Topic No.	Name of the topic and contents	Hrs.
1	<b>Introduction to Biochemistry:</b> Scope of the subject in Pharmaceutical Sciences, Biochemical reactions, Highlights of Prokaryotic and eukaryotic cell metabolism.	02
2	<b>Enzymes:</b> 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	<b>Biomolecules:</b> <b>i. Amino acids:</b> Introduction, Classification, Essential and non-essential amino acids, Physicochemical properties, Colour reactions. Structure: Peptide bond, end group analysis (Edman's and Sanger's method), and medically important amino acids. <b>ii. Proteins:</b> Introduction, Functional classification of $\alpha$ Helix, $\beta$ sheet structure. Tertiary, Quaternary structure, Globular (IgG and Haemoglobin) and Fibrous	12



	<p>protein (Keratin and Collagen).</p> <p><b>iii. Carbohydrates:</b> Definition, Classification, Functions and biological role of glucose, fructose, galactose, ribose, lactose, maltose, sucrose, starch, glycogen, hyaluronic acid and heparin.</p> <p><b>iv. Lipids:</b> Definition, Classification, Functions, Types of Lipids and their biological role.</p> <p><b>v. Nucleic acids:</b> Structure, biochemical functions, replication, transcription, translation and genetic code of Eukaryotic cell.</p>	
4	<p><b>Metabolism:</b> (Structures not mandatory) Electron transport chain, Oxidative phosphorylation and correlation of metabolic processes.</p> <p><b>i. Carbohydrate metabolism:</b> Glycolysis, Citric acid cycle and its Amphibolic nature, Gluconeogenesis including Cori's cycle, Glycogenesis, Glycogenolysis, Pentose Phosphate pathway, Metabolism of Galactose &amp; fructose.</p> <p><b>ii. Lipid metabolism:</b> Metabolism of Triglycerides, Beta Oxidation of fatty acids, formation and utilization of ketone bodies and cholesterol.</p> <p><b>iii. Protein metabolism:</b> Transamination, oxidative and non oxidative deamination of amino acids, urea formation, Biosynthesis of glycine and tyrosine</p> <p><b>iv. Nucleic Acids metabolism:</b> Synthesis and breakdown of purines &amp; pyrimidines.</p>	19
6	<p><b>Vitamins:</b> Structure and biochemical function of fat-soluble and water-soluble vitamins.</p>	05

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

- Detection and identification of proteins, amino acids and carbohydrates.  
(Minimum 9 experiments)
- Isolation of milk casein
- Isolation of Starch from Potato
- Estimation of Ascorbic acid (Vitamin C)
- To study action of salivary amylase on Starch
- Separation of Proteins by SDS-PAGE.

#### **Recommended Books:**

- Lehninger's Principles of Biochemistry by Albert Lehninger, 4/Ed., Palgrave Macmillon.
- Biochemistry by Lubert Stryer, W.H., Freeman & Company, New York.
- Harper's Illustrated Biochemistry by R.K. Murray & D.K. Granner, 27/Ed, McGraw Hill.
- An Introduction to Practical Biochemistry by David Plummer, 3/Ed, Tata McGraw-Hill Edition.
- Fundamentals of Biochemistry by Dr. A. C. Deb, New central book agency (P) Ltd., Kolkata.
- Varley's Practical Clinical Biochemistry by Harold Varley, 6/Ed., CBS Publishers, New Delhi.
- Laboratory Medical Technology by Prafulla Godkar.
- Biochemistry by U. Satyanarayana & U. Chakrapani, 3/Ed., Books & Allied (P) Ltd.
- Viva & Practical Biochemistry by A. C. Deb, 3/Ed., New Central Book Agency (P)Ltd

**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 relevance of stereochemistry & its significance in Pharmaceutical Sciences.
2. clarify Isomerism & apply that knowledge in understanding the structure property relationship.
3. explain the stereochemical aspects of the organic compounds.
4. clarify 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 and underlying concepts like isoelectric point.
7. explain the synthesis and reaction of Polycyclic Compounds.

**B. Skills:**

1. make correct use of various equipments & practice safety measures in Pharmaceutical Organic Chemistry laboratory.
2. understand the chromatographic techniques in organic chemistry
3. explain the principle and procedure involved column chromatographic separation techniques and TLC.
4. explain significance of qualitative analysis of organic compounds & synthesis of derivatives.
5. explain and understand the principle behind various qualitative tests and analyze the given unknown binary organic compounds having different functional groups.
6. explain synthesis recrystallisation, filtration and precipitation techniques of organic compounds along with reaction & mechanism.

Topic No.	Name of the topic and contents	Hrs
1	<b>Stereochemistry:</b> Significance of stereochemistry in biological activity. Stereoisomerism, Geometrical isomerism, E & Z nomenclature, optical isomerism, chirality, Fischer representation, R & S nomenclatures, Diastereomerism, Resolution of Racemic modification, Newman and Sawhorse representation, Conformational isomerism, conformational isomerism in ethane and n-butane, conformations of cyclohexane, monoalkyl and dialkyl cyclohexanes, conformation in decalin	15
2	<b>Molecular Rearrangement Reactions:</b> Rearrangement of electron deficient systems, migration to oxygen, nitrogen, and carbon, Mechanism and stereochemistry of Baeyer-Villiger oxidation and Dakin oxidations, Wagner Meerwein rearrangements, Pinacol-Pinacolone rearrangement, Beckmann, Curtius, Lossen, Hofmann and Schmidt rearrangements. 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

<b>3</b>	<b>Chemistry of amino acids:</b> Classification and structures of natural amino acids, Iso electric point, General methods of preparation of amino acids, Peptide bonds.	<b>5</b>
<b>4</b>	<b>Polycyclic Compounds:</b> Synthesis and reaction of naphthalene, phenanthrene and anthracene	<b>5</b>

**2.3.4 P PHARMACEUTICAL ORGANIC CHEMISTRY -III (Practical)**  
(3 hrs / week)

1. Laboratory techniques: Column chromatographic separation techniques and TLC (Demonstration)
2. Separation and qualitative analysis of binary mixtures (Solid-Solid) (Any 7)
3. Organic Synthesis by rearrangements in point 2 of theory syllabus (Any 5) for example, benzilic acid rearrangement, pinacol-pinacolone rearrangement, Beckmann rearrangement, Hofmann reaction, Fries rearrangement etc.
4. Demonstration of Stereomodels.

**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. Advanced Organic Chemistry by E.S. Gould, 4/Ed. Wiley Eastern Edition.
4. Principles of Organic Synthesis by Norman, 3/Ed., Nelson Thorns Publication.
5. Organic Chemistry by Morrison & Boyd, 7/Ed, Pearson Education.
6. Organic Chemistry by Fieser & Fieser, Vol. I-X, 1/Ed. Asia Publishing House.
7. Quantitative organic Analysis by Siggsa & Honna, 4/Ed., A Wiley Interscience Publication. John Wiley & Sons.
8. Combinatorial Chemistry, Principles and techniques, Arpad Furka, published in electronic form by Arpad Furka, Budapest 2007.
9. Vogel's Textbook of Practical Organic Chemistry by A. I. Vogel, 5/Ed., Pearson Education
10. Handbook of Organic Analysis (Qualitative and Quantitative) by H. T. Clarke, 1/Ed., Arnold-Heinemann.
11. Experimental Pharmaceutical Organic Chemistry- A Benchtop manual, K.S. Jain, P.B. Miniyar and T.S. Chitre; Career Publication, second edition, 2006.
12. Indian Pharmacopoeia 1996; Published by ministry of health and family welfare.
13. Stereochemistry Conformation and Mechanism by P.S. Kalsi, 7/Ed 2008, New Age International Publishers, New Delhi.
14. Advanced General Organic Chemistry-A Modern Approach by Sachin Kumar Ghosh, 3/Ed 2009, New Central Book Agency (P) Ltd.
15. Organic Chemistry by Jonathan Clayden, Nick Greeves, Stuart Warren, 2/Ed 2012, Oxford University press
16. Advanced Organic Chemistry-Reactions, Mechanisms & Structures by Jerry March, Wiley India (P) Ltd., New Delhi
17. Organic Chemistry, Volume -2: Stereochemistry and the chemistry of natural products by I.L.Finar, 5/Ed 2007, Pearson Education Ltd.

### 2.3.5 T PHARMACOLOGY – I (Theory)

(3 hrs / week)

**Learning objective:** On successful completion of following theory topics learner should be able to  
**Knowledge :**

1. know basics of pharmacology like history, scope & general principles.
2. define drug and illustrate on types of drugs including their use.
3. compare & contrast various routes of administration with advantages and disadvantages.
4. associate an information regarding new drug discovery and development process.
5. aware about basics of pharmacokinetic and pharmacodynamic parameters.
6. classify receptors and correlate them to various proteins present in the body.
7. know the principles, site, mechanisms and factors modifying drug action.
8. understand the concept of adverse drug reactions and drug toxicity so that it can get minimize.
9. describe synthesis, storage, release, physiological & pathophysiological role of autacoids and pharmacology of their antagonists.
10. give examples of rational drug treatment during pregnancy and lactation, pediatric patients & in geriatric patients

Topic No.	Name of the topic and contents	Hrs.
1.	<b>Basics of Pharmacology</b> Definitions, history, scope & general principles of pharmacology, nature & sources of drug, drug nomenclature, type of drugs, essential drug (medicine) concept, National Drug Policy, rational use of medicine.	02
2.	<b>Routes of Drug Administration</b> Classification, merits and demerits of individual route, factors governing choice of route.	02
3.	<b>New drug Discovery and Development Process</b>	02
4.	<b>Pharmacokinetics:</b> <b>Biological membranes:</b> Structure and function of cell membrane, Transportation of drug across cell membrane. Factor governing transportation of drug. <b>Absorption &amp; Bioavailability of Drug:</b> Definitions, Factors affecting absorption and bioavailability of drug. <b>Distribution:</b> Definitions, volume of distribution, Factors affecting drug distribution- Physiological barriers, Plasma protein binding of drug. <b>Metabolism:</b> Definitions, organs and enzymes involved in drug metabolism, Enzyme induction and inhibition, first pass metabolism of drug, Phases of drug metabolism, Factors affecting drug metabolism. <b>Excretion:</b> Definitions, route of excretion, Factors affecting excretion of drug. <b>Basic concepts of Clinical Pharmacokinetics:</b> Bioavailability & Bioequivalence, Half life of drug, Clearance, Therapeutic drug monitoring (TDM).	15
5.	<b>Pharmacodynamics:</b> Principles of drug action, Site and mechanisms of drug action, factors modifying drug action, structure activity relationship (SAR), Drug receptors: classification and families of receptors, regulation of receptors, Drug receptor interaction, Dose response curve and Therapeutic Index.	09
6.	<b>Principles of Therapeutics:</b> Individualization of drug therapy, Combined effects of drugs, Adverse drug reactions (ADR): Types, intensity of ADR, Reporting of ADRs, Drug Interactions, Drug Toxicity:	05

	Types and general principles of management of drug toxicity.	
7.	<b>Autacoids:</b> Synthesis, storage, release, physiological & pathophysiological role of following autacoids and pharmacology of their antagonists. i) Histamine and its antagonists. ii) 5-HT and its antagonists. iii) Kinins, Prostaglandins, Leukotrienes, Platelet activating factor, Angiotensin and their antagonists.	05
8.	<b>Clinical Pharmacology:</b> Rational drug treatment during pregnancy and lactation, pediatric patients & in geriatric patients.	05

**Recommended Books:**

1. Goodman and Gillman: The Pharmacological Basis of Therapeutics, *McGraw-Hill, Medical Publishing Division, New York.*
2. Rang H.P. and Dale M.M.: Pharmacology, *Churchill Livingstone, Elsevier.*
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 with clinical application, *Lippincott Williams & Wilkins.*
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, Mumbai.*
17. Vyawahare N.S. and Vora S.: A Textbook of General Pharmacology, *Nirali Prakashan, Pune*
18. Pharmacopoeia of India (1985), *Controller of publication, Delhi.*
19. Tripathi K.D.: Essentials of Medical Pharmacology, *Jaypee Brothers, Medical Publishers, New Delhi.*
20. Vyawahare N.S., Pawar A. T. and Takawale R.V.: Pharmacology-I, *Tech Max Publications, Pune.*

**2.3.6 T PHARMACOGNOSY & PHYTOCHEMISTRY –I (Theory)**  
(03 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 semi-synthetic 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	Hrs.
1	<b>Plant metabolites:</b> Primary & secondary metabolites: Meaning, types, & their functions in plant; Comparative account of primary & secondary metabolism; Role of secondary	3

	metabolites in plants; Rationale behind use of secondary metabolites as medicinal compounds; Overview of historical contribution in development of phytochemistry.	
2	<b>Pharmacognostic scheme for study of crude drugs:</b> Meaning, component, & significance of individual Pharmacognostic parameter	4
3	<p><b>Primary metabolites of Pharmaceutical &amp; industrial utility:</b>  General consideration: Definition, classification, occurrences, properties, nomenclature, chemistry (including general biogenesis, qualitative/quantitative analysis) &amp; pharmaceutical &amp; industrial applications of carbohydrates, lipids &amp; proteins &amp; their derived products.</p> <p><b>A. Carbohydrates:</b>  a) Systematic Pharmacognostic study of: Agar, Guar gum, Acacia, Isabagol, Sterculia, Tragacanth &amp; Okra mucilage.  b) Source, extraction, properties &amp; uses of: Starch, pectin, inulin, chitosan &amp; cyclodextrins.</p> <p><b>B. Lipids:</b>  a) Systematic Pharmacognostic study of: Castor oil, Linseed oil, Neem oil, Hydnocarpus oil, Codliver oil, Shark liver oil, Rice Bran oil, Cocoa butter, Kokum butter, Wool fat, &amp; Bees wax;  b) Source, extraction, properties &amp; uses of: Lecithin, Polyunsaturated fatty acids, &amp; Carotenoids.</p> <p><b>C. Proteins &amp; enzymes:</b> Source, method of preparation, properties &amp; uses of: Thaumatin, Papain, Bromelin, Streptokinase &amp; gelatin.</p> <p><b>D. Natural fibers:</b> Source, method of preparation, properties &amp; applications of Cotton, Wool, Silk &amp; Jute.</p>	17

### 2.3.6 P PHARMACOGNOSY & PHYTOCHEMISTRY –I (Practical) (03 Hrs / Week)

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:**

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.dzumennis.nic.in/Microbes%20and%20Plants%20Growth/pdf/Evolution%20and%20Ocurrent%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. Severian Dumitriu, **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 & Distributors, 1985. ISBN:81-239-0886-5.
  14. Wink M., **Functions and Biotechnology of Plant Secondary Metabolites** (Annual plant reviews, volume 39) 2<sup>nd</sup>ed., Blackwell Publishing Ltd., 2010. ISBN 978-1-4051-8528-8.
  15. Brain K.R. & Turner T.D., **The Practical Evaluation of Phytopharmaceuticals**, Wright-Scientifica, Bristol, 1975.
  16. Khandelwal K. R., **Practical Pharmacognosy**, Pragati Books Pvt. Ltd. ISBN 8185790302.
  17. Kokate C. K., **Practical Pharmacognosy**, Vallabh Prakashan, 1993.
  18. Wallis T. E., **Practical Pharmacognosy**. J.A. Churchill Ltd., London, 1953.
  19. Jeffrey B. Harborne. **Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis**. Springer, 1998. ISBN 0412572702, 9780412572708.
  20. Manual of methods of analysis of foods: Oils & Fats  
(<http://www.fssai.gov.in/Portals/0/Pdf/15Manuals/OILS%20AND%20FATS.pdf>)



**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 in vitro 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 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 the topic and contents	Hrs.
01	<b>Surface &amp; Interfacial phenomena</b> Surface and interfacial tension, surface free energy, measurement of surface and interfacial tension, spreading coefficient, adsorption at liquid- interfaces, surfactants (Types, HLB scale and its applications including wetting, foaming anti-foaming, and micellar solubilization, Krafft & Cloud point), soluble monolayer and Gibbs equation, insoluble monolayer and film balance, adsorption at solid interfaces, adsorption isotherms, (Langmuir and Freundlich)	10
02	<b>Rheology</b> Fundamentals of rheology, Types of flow, Methods of viscosity measurements, mechanical model to illustrate flow on viscoelasticity, thixotropy, measurement of	08

	thixotropy in formulation, rheology of disperse systems, pharmaceutical applications of rheology.	
<b>03</b>	<b>Chemical Kinetics and Stability</b> Reaction theories, rate, order and molecularity, mathematical treatment of zero, first and second order, complex reactions: reversible, parallel and side reactions (no derivations), determination of order, Effect of temperature, Arrhenius equation and energy of activation, degradation pathways, physical & chemical instability & evaluation methods, Accelerated stability studies. Problems related to half life, shelf life, energy of activation and Arrhenius factor.	<b>10</b>
<b>04</b>	<b>Micromeritics</b> Introduction and pharmaceutical importance, particle size and distribution, particle shape, particle volume, particle number, surface area, methods for determining particle size, particle volume measurement, specific surface, method for determining surface area, derived properties of powder: porosity, packing arrangement, densities, bulkiness, flow properties of powder, angle of repose, factors affecting flow of powder.	<b>08</b>
<b>05</b>	<b>Colloids</b> Introduction and types, optical, kinetic and electrical properties of colloids, electrical double layer, Nernst & Zeta potential, Donnan membrane equilibrium, Protective colloids, stabilization of colloidal system, DLVO theory, Schulz Hardy rule, Hoffmeister series, Applications in pharmacy.	<b>09</b>

#### 2.4.1 P PHYSICAL PHARMACEUTICS-II (Practical)

(3 hrs / week)

1. Determination of surface tension of given liquid.
2. Determination of Krafft point of given surfactant.
3. Determination of Cloud point of given surfactant.
4. Determination of critical micelle concentration of a surfactant by surface tension method.
5. Determination of relative strength of two acids.
6. Determination of order of reaction by equal fraction method.
7. Determination of energy of activation of acid hydrolysis of methyl acetate.
8. Kinetics of inversion of cane sugar by polarimetry.
9. Determination of viscosity of given liquid by Ostwald's viscometer and demonstration of Brookfield viscometer.
10. Determination of composition of binary mixture by viscosity method.
11. Determination of Specific Surface area of charcoal by adsorption method.
12. Determination of particle size distribution of any material by Microscopy.
13. Determination of particle size distribution of any material Sieve analysis.
14. Determination of derived properties of given powder.
15. Determination of effect of salts on stability of hydrophobic sols

#### **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. Marlton, 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. Handbook of Practical Physical Pharmacy and Physical Pharmaceutics by U. B. Hadkar, NiraliPrakashan, 4/Ed., 2007, Pune
11. Practical Physical Pharmacy by H.N. More and A. A. Hajare, Career Publication. 1/Ed, 2007, Nashik
12. Practical Physical Pharmacy by Gaud and Gupta, NiraliPrakashan
13. Practical Physical Pharmacy, Gurtoo and Kapoor.

## 2.4.2 T PATHOPHYSIOLOGY AND CLINICAL BIOCHEMISTRY (Theory)

(03 hrs / Week)

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

### **A. Knowledge:**

1. explain the biochemical mechanisms and pathophysiological processes responsible for common biochemical disorders
2. explain the rationale and theoretical basis for methods used in the diagnosis of common biochemical disorders.
3. compare and contrast the different patterns of biochemistry test results observed in various disease states.
4. demonstrate competency in performing common analytical techniques used in clinical chemistry
5. demonstrate an understanding of quality management in and its relevance to patient management.
6. understand the role of clinical biochemistry in clinical diagnosis.
7. discuss the biochemistry and pathophysiology associated with tests performed in a clinical biochemistry laboratory.
8. describe the principals of the analytical instruments in use in the routine clinical laboratory.
9. have an understanding of the importance of quality control and assurance to diagnostic work.
10. demonstrate knowledge of the physiology and pathophysiology of the major organ systems under investigation in clinical biochemistry.
11. discuss the role of clinical biochemistry investigations in diagnosis, monitoring and treatment of disease.
12. demonstrate an integrated understanding of the principles of some analytical investigations performed in clinical biochemistry laboratories and their clinical significance.
13. demonstrate an ability to follow experimental procedures for the laboratory investigation of disease with interpretation and discussion.
14. ability to read and use literature with critical understanding, give a clear and accurate account of the subject matter, think independently, formulate arguments and engage in debate.

### **B. Skills:**

1. develop primary laboratory skills and excel them in to regular clinical biochemistry practicals.
2. isolate and identify DNA.
3. handle and know the correct use of the instrument /equipment.
4. operate colorimeter, centrifuge, microscope, flame photometer & various instruments used in pathology laboratory.
5. distinguish the colours while performing various chemical tests.
6. perform qualitative tests for determination of abnormal constituents, liver function test, cardiac Profile Tests as well as kidney function test for given samples.
7. describe the principle involved in the measurement of analytes in the clinical biochemistry laboratory.
8. outline how biochemical analysis can be employed to differentiate between normal and diseased conditions.
9. perform practical biochemical analysis of clinical samples.
10. proficient in the interpretation of results of routine clinical biochemistry investigations.
11. recommend safe and accurate specimen collection and processing techniques;
12. have developed problem-solving skills relevant to the practice of clinical biochemistry.

13. familiar with the literature in Clinical Biochemistry and able to extract and present relevant information.
14. recognising and applying subject-specific concepts and principles. analysing, summarising and integrating information critically from a variety of media.
15. accommodate skills necessary for self-managed and lifelong learning (working independently, time management, organisation).

Topic No.	Name of the topic and contents	Hrs.
	<b>Pathophysiology (Definition, types, epidemiology, etiology, pathogenesis, clinical manifestations, complications, diagnosis &amp; brief plan of treatment for following diseases / disorders)</b>	
1.	<b>Introduction to Pathophysiology</b>	01
2.	<b>Cell Injury and Inflammation</b>	02
3.	<b>Cardiovascular System:</b> Hypertension, Low Blood Pressure, Coronary Artery Diseases , Heart Failure, Arrhythmias, Shock, Peripheral Vascular Diseases (Buerger's Disease, Raynauds Diseases, Deep Vein Thrombosis, Varicose Vein)	08
4.	<b>Hematological:</b> Anemia, Leukemia	02
5.	<b>Respiratory System:</b> Chronic Obstructive Pulmonary Disorder (COPD), Pneumonia.	02
6.	<b>Digestive System:-</b> Peptic Ulcer, Diarrhea, Constipation, Gastroenteritis, Pancreatitis, Inflammatory Bowl Disorder (IBD), Hemorrhoids	05
7.	<b>Liver and Gall bladder:</b> Jaundice, Fatty Liver, Alcoholic Liver Disease, Cirrhosis, Hepatitis, Gall Stone	03
8.	<b>Central Nervous System:</b> Pain, Epilepsy, Parkinson's Disease, Alzheimer's Disease, Schizophrenia, Depression, Sleep Disorders.	07
9.	<b>Urinary System:</b> Urinary Calculi, Nephritis, Urinary Tract Infections, Renal Failure	02
10.	<b>Endocrine System:</b> Hyperthyroidism, Hypothyridism, Diabetes Mellitus, Hypoglycemia	02
11.	<b>Reproductive System:</b> Endometeriosis, Dysmenorrhoea, Infertility	02
12.	<b>Immune System:</b> Myasthenia Gravis, Rheumatoid Arthritis	02
13.	<b>Musculoskeletal System :</b> Osteoarthritis, Gout.	02
14.	<b>Malignancy</b>	01
15.	<b>Infection &amp; Parasitic diseases:</b> Malaria, Leprosy, Tuberculosis, Sexual Transmitted Diseases (Syphilis,Gonorrhea,AIDS)	04

**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: Principles and Practice of Medicine, *Churchill Livingstone, New York*
4. Kumar V., Abbas A. K., Fausto N., Robbins and Crotan Pathologic Basis of Disease, *Elsevier*
5. Dr. Bodhankar S.L, Dr. Vyawahare N.S.: Pathophysiology. *Nirali Prakashan, Pune*

6. Herfindal Eric T., Gourley Dick R., Textbook of Therapeutics, Drug and Disease Management, *Lippincott Williams & Wilkins*
7. Rang H.P. and Dale M.M.: Pharmacology, *Churchill Livingstone, Elsevier*
8. Goodman and Gillman: The Pharmacological Basis of Therapeutics, *McGraw-Hill, Medical Publishing Division, New York.*
9. Katzung B.G.: Basic and Clinical Pharmacology, *The McGraw-Hill companies*
10. Tripathi K.D.: Essentials of Medical Pharmacology, Jaypee Brothers, Medical Publishers, *New Delhi*
11. Deodhare S. G., General Pathology & Pathology of Systems, *Popular Prakashan, Mumbai*
12. Berkow Robert, Beers M. H., Fletcher A. J., The Merck Manual of Medical Information Home Edition, *Pocket Books, New York*
13. Stobo J. D., Hellmann B. D., Ladenson P. W., Petty B. G., Traill T. A., The Principles and Practice of Medicine, *Appleton & Lange*
14. Stethen J. Mcthee, Lingappa Vishwanath R., Wiliam F. Gang, Jack D. Lange, Pathophysiology of Disease and Introduction to Clinical Medicine, *Prentice Hall International, UK, London*

#### **2.4.2 P PATHOPHYSIOLOGY AND CLINICAL BIOCHEMISTRY (Practical)**

**(03 hrs / Week)**

1. Common instruments of clinical laboratory, Laboratory management and maintenance of records
2. Collection and recording of biochemical specimen of serum / plasma, preservation and disposal of biological material.
3. 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:
  - a. Determination of Serum Creatinine
  - b. Determination of Blood Urea
  - c. Determination of Serum Sodium, Potassium, Chloride
  - d. Determination of Serum Uric Acid
6. Liver Function Test:
  - a. Determination of Serum Total Bilirubin, Direct Bilirubin, Indirect Bilirubin
  - b. Determination of Serum SGOT, SGPT, Alk. Phosphatase
  - c. Determination of Serum Proteins, Globulin, Albumin, A/G Ratio
7. Cardiac Profile Tests:
  - a. Determination of Serum Cholesterol, Triglycerides, HDL, VLDL
  - b. Determination of Serum Total / HDL chol., HDL:LDL chol, Troponin I
8. Determination of C-Reactive Protein (CRP)
9. Determination of Serum Erythrocyte Sedimentation Rate (ESR)
10. Recording of Electro Cardiogram (ECG) and its interpretation.
11. Determination of blood glucose level
12. Day one of ICU tests
13. Basics of histopathology
14. Detection of malaria parasite

15. Case studies minimum 5
16. Visit to Hospital, Pathology Laboratory & Blood Bank ( To demonstrate the practicals which may not be conducted at College level)

***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 & Cotran Pathologic Basis Disease by Robbins, Cotran, Kumar, 7/Ed, Elsevier.
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 learner should be able to

**A. Knowledge:**

1. sketch the structure with numbering & illustrate chemistry, methods of preparation & chemical reactions of five membered, six membered and fused heterocyclic rings.
2. draw synthesis and reactions of pharmaceutically important heterocyclic rings.
3. explain the application of combinatorial chemistry in the speedy synthesis of organic compounds and peptides.
4. Construct retro-synthesis of pharmaceutical important compounds.
5. draw reactions related to C<sub>5</sub> and C<sub>6</sub> sugars.
6. understand uses of nanochemistry and microwave assisted synthesis of compounds.

**B. Skills:**

1. make correct use of various equipments & safety measures in Pharmaceutical Organic chemistry laboratory.
2. perform qualitative analysis of solid-liquid and liquid-liquid organic binary mixtures & synthesis of derivatives.
3. separate and purify of binary mixtures of organic compounds.
4. synthesize heterocycles & draw mechanisms of the reaction.
5. do recrystallisation, filtration and precipitation techniques.
6. determine quantitative determination of different reactive groups.

Topic No.	Name of the topic and contents	Hrs
1	<b>Heterocyclic Chemistry:</b> 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.	20
2	<b>Introduction to Combinatorial Chemistry:</b> History, Introduction to linkers and solid supports. Various techniques used in combinatorial synthesis (Mix and split, Parallel synthesis). Applications	05
3	<b>Retro-synthesis:</b> 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.	07
4	<b>Chemistry of carbohydrates:</b> Introduction, Significance and medicinal importance of carbohydrates. Classification, Method of synthesis(Killiani fischer and ruff degradation) and reactions of C <sub>5</sub> (Arabinose) and C <sub>6</sub> (Glucose and fructose) sugars., Mutarotation., Establishment of structures of Glucose and Fructose	10
5	<b>Nanochemistry &amp; Microwave assisted Synthesis:</b> Basics and application of Nanochemistry and Microwave assisted synthesis in pharmaceutical organic chemistry.	03



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

1. Separation of Binary Mixtures ( Solid-liquid, liquid-liquid) (**Any 3**)
2. Organic Synthesis of Heterocycles/in point 1 of the theory (**Any 5**).  
For e.g.: 7-Hydroxycoumarin (Coumarin derivative), Amino Pyridine (Pyridine derivative), 2,3-Diphenylquinoxaline (quinoxaline), Benzotriazole, Benzimidazole, Benzthiazole, etc.
3. Microwave assisted reaction (**Any 1**)
4. Quantitative determination of reactive groups (**Any 6**)-Quantitative determination of, Phenolic hydroxyl, esters, carboxyl, carbonyl, primary amines, amides and nitro group.

***Recommended Books:***

1. Advanced Organic Chemistry by E.S. Gould, 4/Ed. Wiley Eastern Edition.
2. Principles of Organic Synthesis by Norman, 3/Ed., Nelson Thorns Publication.
3. Organic Chemistry by Morrison & Boyd, 7/Ed, Pearson Education.
4. Heterocyclic Chemistry by Joule and Mill, 4/Ed., Blackwell Publishing Oxford.
5. Organic Chemistry by Fieser & Fieser, Vol. I-X, 1/Ed. Asia Publishing House.
6. Modern Heterocyclic Chemistry by Leao Payrettee.
7. Organic Synthesis- The disconnection approach by Stuart Warren, John Wiley & Sons
8. Vogel's Textbook of Practical Organic Chemistry by A. I. Vogel, 5/Ed., Pearson Education
9. Handbook of Organic Analysis (Qualitative and Quantitative) by H. T. Clarke, 1/Ed., Arnold-Heinemann.
10. Synthesis of Drugs-Synthone approach Vol. 1, by Radhakrishnan Ayer, J. R. Rao, M. S. Degani, S. A. Ghone, K. Mohanraj, 2/Ed, 2008, Sevak Publication Pvt. Ltd.
11. Quantitative organic Analysis by Siggsa & Honna, 4/Ed., A Wiley Interscience Publication. John Wiley & Sons.
12. Organic Synthesis, Vol. I to X, John Wiley & Sons Ins. New York.
13. Organic Chemistry by Jonathan Clayden, Nick Greeves, Stuart Warren, 2/Ed 2012, Oxford University press
14. Advanced Organic Chemistry-Reactions, Mechanisms & Structures by Jerry March, Wiley India (P) Ltd., New Delhi
15. Organic Chemistry, Volume -2: Stereochemistry and the chemistry of natural products by I.L.Finar, 5/Ed 2007, Pearson Education Ltd.
16. Heterocyclic Chemistry by Raj K. Bansal, New Age International Publishers
17. Organic Chemistry, Volume -1: The Fundamental Principles by I.L.Finar, 5/Ed 2007, Pearson Education Ltd.

## 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 of analytical techniques
2. apply the analytical techniques to study bulk-drug pharmaceuticals, quality control.
3. develop an in-depth knowledge and critical awareness of the application of modern methods of instrumental analysis
4. know preparation and standardization of various concentrations of acids and bases.
5. understand the basic concepts involved in electro-analytical techniques and its types.
6. explain types, apparatus used and applications of potentiometric titration.
7. define and compare the terms used in pharmaceutical analysis like potentiometry, conductometry, amperometry, etc.
8. discuss conductometric titrations, conductometric curves and their applications.
9. illustrate principle, instrumentation and applications of polarography
10. recognize and apply the fundamental concepts of various techniques used in pharmaceutical analysis and apply the concepts to problem solving.
11. apply and assess concepts of availability and evaluation of analytical standards.
12. assess sources of error in instrumental analysis and account for errors in data analysis.
13. understand & apply the theory and operational principles of analytical instruments.
14. associate all information regarding amperometric titration.
15. understand theory, principle, types and techniques of coulometric titration and compare between amperostatic and potentiostatic coulometry.
16. know instrumentation and applications of refractometry and calculate RI.
17. understand the basic concepts and applications of Polarimetry
18. compare and contrast various techniques used in analysis of moisture, halogens and nitrogen etc.

### B. *Skills:*

1. clarify and understand the correct use of laboratory equipments like pH meter, Conductometer, Refractometer, Polarimeter with calibration of various instruments used in analytical chemistry laboratory together with safety measures to be followed.
2. develop practical hand in analytical methods by estimation of analyte concentration in pure form and in formulation with thorough understanding of principle and procedures used in different analytical techniques.
3. determine RI and pKa of various compounds for examining quality of a product.
4. demonstrate Karl Fischer Titration.
5. perform potentiometric as well as conductometric titrations.
6. extend and deepen their practical skills so as to be capable of solving practical problems associated with the design and maintenance of analytical protocols within a professional or workplace context.
7. demonstrate the required level of professional competence in the planning, conduct, evaluation and reporting of the results of investigations, including the appropriate use of literature and secondary data.

<b>Topic No.</b>	<b>Name of the topic and contents</b>	<b>Hrs</b>
1.	<b>Electro-Analytical Techniques</b> 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.	4
2.	<b>Potentiometry</b> 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	6
3.	<b>Conductometry</b> 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	5
4.	<b>Polarography</b> Introduction, theory& principle of polarography, polarogram, half wave potential,Ilkovic equation, Dropping Mercury Electrode ,types of polarography ( Linear Scan & Differential Pulse), applications	6
5.	<b>Amperometry</b> Introduction, theory & principle of amperometry, types of electrodes,amperometric titration, general procedure, advantages, disadvantages and applications of amperometry, Biamperometric titration	5
6.	<b>Coulometry</b> Introduction, theory & principle of Coulometry, types of Coulometry, general characteristics of Coulometric techniques, Coulometry at controlled potential (potentiostatic), constant current Coulometry (Amperostatic), applications	5
7.	<b>Refractometry</b> 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.	5
8.	<b>Polarimetry</b> 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)	6
9.	<b>Miscellaneous techniques</b> Karl Fischer Titration, determination of organically bound nitrogen (Kjeldahl's method), Oxygen combustion flask techniques	3

#### 2.4.4 P PHARMACEUTICAL ANALYSIS-II (Practical)

(3 Hrs / week)

1. Calibration of pH meter / Conductometer / Refractometer / Polarimeter.

2. Potentiometric titrations.

(Strong acid Vs. Strong base, Weak acid Vs. Strong base, Assay: any one API / formulation)

3. Determination of pKa. (monobasic / dibasic / tribasic acids)
4. Conductometric titrations.  
(Strong acid Vs. Strong base, Weak acid Vs. Strong base, mixture of acids)
5. Measurement of RI and molar refraction.  
(oil samples, glycerin-water mixture, organic solvents)
6. Measurement of Optical rotation and Specific Optical rotation, Assay of Dextrose injection.
7. Karl Fischer Titration (Demo).

**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 Garrat 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) (03 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	Hrs.
1	<i>Alkaloids</i>	
	A. General consideration: Definition, classification, occurrences, properties, nomenclature, & chemistry (including general biogenesis, qualitative / quantitative analysis) of alkaloids.	<b>03</b>
	B. Systematic pharmacognostic study including history & contribution to modern medicine: a. Pyridine-piperidine: Tobacco b. Tropane: Belladonna, datura, coca c. Quinoline and Isoquinoline: Cinchona, ipecac, opium. d. Indole: Ergot, rauwolfia, catharanthus and nux-vomica e. Imidazole: Pilocarpus f. Steroidal: Veratrum and kurchi g. Alkaloidal Amine: Ephedra and colchicum h. Glycoalkaloid: Solanum i. Purines: Coffee and tea	<b>24</b>
2	<i>Terpenoids &amp; Resins</i>	
	A. General consideration: Definition, classification, occurrences, properties, nomenclature, & chemistry (including general biogenesis, qualitative/quantitative analysis) of terpenoids / resins.	<b>03</b>
	B. Systematic Pharmacognostic study (including history & contribution to modern medicine of followings): a. Lower terpenoids: Clove, Cinnamon, Coriander, Lavender, Sandal wood, Artemisia b. Diterpenoids: Taxus, Coleus c. Triterpenoids: Ginseng d. Tetraterpenoids: Annato & Saffron e. Resins: Podophyllum, Guggul, Boswellia & Cannabis	<b>15</b>

#### 2.4.5 P PHARMACOGNOSY & PHYTOCHEMISTRY –II (Practical)

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:***

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

**2.4.6. T PHARMACEUTICAL ENGINEERING (Theory)**  
(2hrs / week)

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

**A) Knowledge:**

1. know various heat transfer techniques including their mechanism and applications in pharmacy.
2. define crystallization and illustrate types of crystallizers.
3. know about evaporation and describe the types of evaporator with their mechanism, instrumentation and applications.
4. develop an understanding of pharmaceutical engineering by studying advance modules that are relevant to the changing priorities and requirements of the modern pharmaceutical industries.
5. foster the knowledge of product manufacturing.
6. study the principle, theory, mechanism, working and construction of equipments of different unit operations. (Filtration, centrifugation, drying, heat transfer.)
7. focus on graphical representation of various equipment for unit operations.
8. study the different materials used in the pharmaceutical plant constructions.
9. emphasize principles, mechanisms and theories of different unit operations.
10. illustrate fundamentals and facts about flow of fluids.
11. describe types of distillation, their mechanisms with appropriate diagrams.
12. define drying and classify different types of dryers.

Topic no.	Name of the topic and contents	Hrs.
1	<b>Heat Transfer:</b> Mechanisms-conduction, convection, radiation, Fourier's law, Stefan Boltzman's constant, Kirchoff's law, heat transfer- between fluid & solid boundary, boiling liquids, condensing vapor's, heat exchangers-heat transfer in parallel flow & counter flow, tubular heat exchangers, Plate heat exchangers, applications, Steam traps-mechanical & thermostatic.	7
2	<b>Crystallization:</b> Theories of supersaturation, nucleation, crystal growth, classification of crystallizers, tank, Swenson walker, vacuum, circulating magma, DTB and growth type crystallizers, caking of crystals.	5
3	<b>Evaporation:</b> Theory, evaporator capacity - heat & material balances, factors influencing hear transfer coefficients, Evaporators- pan, tubular (horizontal, vertical-short, long & their subtypes), wipe film, centrifugal rotary, multiple evaporator- economy, capacity, methods of feeding etc, Evaporator accessories- condensers, vacuum pump, removal of condensate, entrainment separators, foam.	8
4	<b>Flow of fluids:</b> Fluid statics- pressure, pressure measurement- manometers & pressure gauge, fluid dynamics, mechanism of fluid flow, material & energy balance, pressure differential flow meter- principal, orifice meter, pitot tube, Variable area flow meter- principal, rotameter orifice & plug meter, quantity flow meters..	7
5	<b>Mass transfer:</b> Molecular diffusion in gases & liquids, theories of interphase mass transfer.	2
6	<b>Distillation:</b> Vapour liquid equilibrium, distillation of miscible systems, boiling point diagram, equilibrium distillation, differential distillation, rectification, fractionating column, heat & material balance, factors affecting plate efficiency, molecular distillation, separation of azeotropes, and distillation of immiscible system.	6



<b>7</b>	<b>Drying:</b> Mechanism, theory, factors affecting, Dryer- tray dryer, fluidized bed dryer, spray dryer, freeze dryer, flash dryer, drum dryer.	<b>6</b>
<b>8</b>	<b>Corrosion:</b> Mechanisms, factors influencing corrosion process, method of combating it.	<b>4</b>

***Recommended Books***

1. W. McCabe, J. C. Smith, P. Harriot; Unit Operation of Chemical Engineering; McGraw Hill, (1993)
2. W.I. Badger and J.T. Banchero, Introduction to Chemical engineering; McGraw Hill, (1988)
3. M.S. Peters, K. D. Timmerhaus; Plant design and economics for to Chemical Engineering; McGraw Hill.
4. E. Ganderton; Pharmaceutical unit Operation; Academic press.
5. Perry's Handbook of Chemical engineering; McGraw Hill;(1984)
6. A. R. Paradkar, Introduction to Pharmaceutical Engineering, Nirali Prakashan, 10<sup>th</sup> Ed. 2007.