Faculty of Pharmaceutical Science

Syllabus

Second Year B. Pharm. Credit System 2015 Course
(With effect from Academic Year 2016 - 17)
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.
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<tr>
<th>Topic No.</th>
<th>Name of the topic and contents</th>
<th>No of Hrs.</th>
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<tr>
<td></td>
<td><strong>SECTION-I</strong></td>
<td></td>
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<tr>
<td>1</td>
<td><strong>Phase Rule</strong>&lt;br&gt;a. Gibbs phase rule, one component (Water), two components, and three components system, Pharmaceutical applications</td>
<td>04</td>
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<td>2</td>
<td><strong>Gaseous state of matter</strong>&lt;br&gt;a. Basic gas laws, theory &amp; equation of state for ideal gases, Deviation from gas theory, Compressibility factor, Vander Waal equation for real gases, critical constants,&lt;br&gt;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.</td>
<td>07</td>
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<td>03</td>
<td><strong>Solution of Non-electrolytes and Electrolyte</strong>&lt;br&gt;a. Properties and types of solutions, ideal and real solutions, Raoult’s law and its deviations, boiling point diagram, fractional and steam distillation,&lt;br&gt;b. Colligative properties: relative lowering of vapor pressure, elevation of boiling Point, depression of freezing point, and osmotic pressure, problems involving molecular weight determinations.&lt;br&gt;c. Solution of electrolytes: equivalent and specific conductance, Kohlrauschs law, conductometric titrations, Colligative properties of electrolytes.</td>
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<td><strong>SECTION-II</strong></td>
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<td>4</td>
<td>a. Introduction to crystallization, Crystal parameters- crystal forms, habits, lattice angle, Methods of crystal analysis: X-Ray Diffraction, Bragg’s equation.&lt;br&gt;b. Polymorphism: Definition, Different shapes of polymorphs, Example and its Pharmaceutical applications, Brief introduction of Detection techniques. Glass transition temperature</td>
<td>08</td>
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<td>5</td>
<td><strong>Solubility and Distribution Phenomenon</strong>&lt;br&gt;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.&lt;br&gt;b. Distribution phenomenon: Nernst distribution law and its limitations, Effect of ionic dissociation and association, applications in Pharmacy.&lt;br&gt;c. Brief introduction of BCS classification.</td>
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<td>6</td>
<td><strong>Thermodynamics</strong>&lt;br&gt;a. Definition of enthalpy, entropy, First and second law of thermodynamics (Statement and equation)</td>
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### 2.3.1 P PHYSICAL PHARMACEUTICS-I
(Practical) (3 Hrs/Week)

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<tr>
<th>Sr. No</th>
<th>Topic</th>
<th>Experiment</th>
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<tr>
<td>1</td>
<td>Phase Rule</td>
<td>1. Determination of Critical solution temperature of Phenol water system.</td>
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<td>2. Determination of effect of addition of electrolyte on CST of phenol water system.</td>
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<td>3. Construction of ternary phase diagram for three-component system [oil-water-surfactant].</td>
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<td>2</td>
<td>Solutions of non-electrolytes and electrolytes</td>
<td>1. Determination of solubility of substance at different temperatures.</td>
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<td>2. Determination of solubility of benzoic acid in different solvents.</td>
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<td>3. Determination of effect of co solvents on solubility of benzoic acid in water.</td>
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<td>3</td>
<td>Solubility and Distribution phenomena</td>
<td>1. Determination of partition coefficient of benzoic acid between water and benzene.</td>
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<td>2. Determination of effect of pH on partition coefficient.</td>
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<td>4. Determination of effect of pH on solubility.</td>
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<tr>
<td>4</td>
<td>Thermodynamics</td>
<td>1. Determination of heat of solution of Salicylic/benzoic/oxalic acid</td>
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</table>

**Recommended Books:**
6. Physical Pharmacy by Dr. U.B. Hadkar, NiraliPrakashan, 8/Ed, Mumbai
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
13. Practical Physical Pharmacy by Gaud and Gupta, NiraliPrakashan
14. Essentials of Physical Pharmacy, by Madan and Tuli, S. Chand & Company, New Delhi
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.
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.

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<th>Sr. No.</th>
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<tr>
<td><strong>SECTION-I</strong></td>
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<tr>
<td>1</td>
<td><strong>Introduction to Microbiology:</strong> 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.</td>
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<td><strong>Bacteria:</strong> 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.</td>
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<td>3</td>
<td><strong>Yeast and moulds:</strong> Introduction and applications of <em>Saccharomyces cerevisiae</em>, <em>Candida albicans</em> and <em>Penicillium</em>.</td>
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<td><strong>Viruses:</strong> Introduction, general properties, structure of viruses, Human viruses – multiplication and cultivation, Structure Human Immunodeficiency virus.</td>
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<td><strong>Microbial Limit tests:</strong> Viable count, Identification of specific microorganism as per IP</td>
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<td>6</td>
<td><strong>Sterilization:</strong> Introduction to concept of sterilization, Different methods - dry heat, moist heat, gaseous, radiation and filtration.</td>
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<td><strong>SECTION-II</strong></td>
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<td>7</td>
<td><strong>Preservation and Disinfection:</strong> Chemical classification of different disinfectants with a example, Phenol coefficient test: RW test.</td>
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<td>8</td>
<td><strong>Fundamentals of Immunology:</strong> Microbial virulence, exotoxins, endotoxins Antigens, Types of Immunity, Defense mechanisms of host – specific and nonspecific, Mechanism of CMI and HMI, Antibodies-Classification.</td>
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<td>9</td>
<td><strong>Antigen - Antibody reactions:</strong> Characteristics of Antigen Antibody reaction, Basics of Precipitation, Agglutination (Slide and Tube), Introduction to complement fixation test, immunofluorescence tests, Radio Immunoaassay and ELISA.</td>
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<td>10</td>
<td><strong>Vaccines and sera:</strong> Classification of vaccines, General production of Vaccines and sera and their quality control.</td>
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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:

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

Learning objectives:
On completion of following theory topics and laboratory experiments, a learner should 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.

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<td>SECTION-I</td>
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<tr>
<td>1</td>
<td><strong>Introduction to Biochemistry</strong>: Scope of the subject in Pharmaceutical Sciences, biochemical reactions, highlights of only eukaryotic cell metabolism.</td>
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<td>2</td>
<td><strong>Enzymes</strong>: 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.</td>
<td>07</td>
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| 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 medicinally 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         |
iii. Carbohydrates: Introduction, classification, structure and biological role of glucose, fructose, galactose, ribose, lactose, maltose, sucrose, starch, glycogen, cellulose, hyaluronic acid and heparin.


SECTION-II

4. Metabolism:
   Electron transport chain, Oxidative phosphorylation and correlation of metabolic processes.
   i. Carbohydrate metabolism: Glycolysis, Citric acid cycle and its Amphibolic nature, Gluconeogenesis including Cori’s cycle, Glycogenesis, Glycogenolysis, Pentose Phosphate pathway
   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.
   iii. Protein metabolism: Transamination, oxidative and non oxidative deamination of amino acids, urea formation.


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:

5. Fundamentals of Biochemistry by Dr. A. C. Deb, New central book agency (P) Ltd., Kolkata.
7. Laboratory Medical Technology by Prafulla Godkar.
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.

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<tr>
<td>SECTION-I</td>
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<tr>
<td>1</td>
<td><strong>Stereochemistry:</strong> Molecular representations: Wedge, Fischer, Newman and Saw-horse formulae, their description and interconversions. Stereoisomerism, Significance of Stereochemistry in biological activity. Geometrical isomerism, E &amp; Z nomenclature, optical isomerism, chirality, R &amp; 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</td>
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<td>2</td>
<td><strong>Chemistry of carbohydrates:</strong> Introduction, Significance and medicinal importance of carbohydrates. Classification, Method of synthesis (Kliiani fischer and ruff degradation) and reactions of C₅ (Arabinose) and C₆ (Glucose and</td>
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(fructose) sugars, Mutarotation, Establishment of structures of Glucose and Fructose.

### SECTION-II

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<th>2</th>
<th>Molecular Rearrangement Reactions:</th>
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<td>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, Sommlet, Favorskii, Neber and Benzilic acid rearrangement. Rearrangement to aromatic nucleus including mechanism of Fries &amp; Claisen rearrangement. Pericyclic Reactions: Electro cyclic, Cycloaddition and Sigmatropic reactions (Cope rearrangement)</td>
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<th>3</th>
<th>Chemistry of amino acids:</th>
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<td>Classification and structures of natural amino acids, Isoelectric point, General methods of preparation of amino acids, Peptide bonds</td>
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### 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:

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.

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<td><strong>SECTION - I</strong></td>
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<tr>
<td>1.</td>
<td><strong>Basics of Pharmacology</strong></td>
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<td>➢ Definitions, History, Scope &amp; General Principles of Pharmacology</td>
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<td>➢ Nature &amp; Sources of Drug, Drug nomenclature</td>
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<td>➢ Essential drug (Medicine) concept, National Drug Policy</td>
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<td>2.</td>
<td><strong>Routes of Drug Administration</strong></td>
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<td>➢ Detail discussion, Merits and Demerits of various routes of drug administration</td>
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<td><strong>New drug Discovery and Development Process</strong></td>
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<td>➢ Introduction to drug discovery and drug development process with detail emphasis on new approaches in preclinical drug development</td>
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<td>➢ Clinical trials</td>
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<td><strong>Pharmacokinetics:</strong></td>
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<td>➢ <strong>Biological membranes:</strong> Structure and function of cell membrane, Physicochemical factors and processes involved in transportation of drug across cell membrane</td>
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<td>➢ <strong>Absorption &amp; Bioavailability of Drug:</strong> Definitions, Factors affecting absorption and bioavailability of drug</td>
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<td>➢ <strong>Distribution:</strong> Definitions, Volume of distribution, Factors affecting drug distribution- Physiological barriers, Plasma protein binding of drug, disease state of patients etc.</td>
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<td>➢ <strong>Metabolism (Biotransformation):</strong> Definitions, Organs and enzymes involved in drug metabolism, first pass metabolism of drug, Phases of drug metabolism, Factors affecting drug metabolism</td>
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<td>➢ <strong>Excretion(Elimination):</strong> Definitions, Factors affecting excretion of drug</td>
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<td>➢ <strong>Basic concepts of Clinical Pharmacokinetics:</strong></td>
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<td></td>
<td>i) Bioavailability &amp; Bioequivalence</td>
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<td>ii) Volume of distribution</td>
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<td>iii) Half life of drug</td>
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<td>iv) Clearance</td>
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v) Basic discussion on nonlinear pharmacokinetics and therapeutic drug monitoring (TDM)

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<th>SECTION - II</th>
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<td>5. <strong>Pharmacodynamics:</strong></td>
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<td>➢ Site and mechanisms of drug action, factors modifying drug action, Structure activity relationship (SAR)</td>
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<td>➢ Drug Receptors, Basic discussion about receptors, Classification and families of receptors, Regulation of receptors</td>
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<tr>
<td>➢ Drug receptor interaction: Concept of agonist, antagonist, mixed agonist-antagonist, partial agonist, inverse agonist, Drug receptor interaction theories</td>
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<td>➢ Dose response curve and Therapeutic Index</td>
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<td>6. <strong>Principles of Therapeutics:</strong></td>
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<td>➢ Basic discussion on Individualization of drug therapy</td>
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<td>➢ Concept of drug synergism and antagonism with its types</td>
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<td>➢ Adverse drug reactions (Hypersensitivity, Photosensitivity, Mutagenicity, Carcinogenicity, Teratogenicity)</td>
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<tr>
<td>➢ Basics of Drug Interactions</td>
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<td>➢ Drug Induced Diseases (Iatrogenic Diseases)</td>
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<tr>
<td>➢ Drug Toxicity: Types of drug toxicity and general principles of management of drug toxicity</td>
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<tr>
<td>7. <strong>Autocoids:</strong> Synthesis, Storage, Release, Physiological &amp; Pathophysiological actions of autocoids and Pharmacology of their antagonists</td>
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<td>i) Histamine and its antagonists</td>
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<td>ii) 5-HT and its antagonists</td>
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<td>iii) Arachidonic acid metabolites</td>
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<td>8. <strong>Clinical Pharmacology:</strong> Developmental changes in physiological factors that influence pharmacokinetics and pharmacodynamics in pediatric, geriatric, pregnancy and Lactation.</td>
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<tr>
<td>➢ Rational drug treatment in pediatric patients</td>
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<td>➢ Rational drug treatment in geriatric patients</td>
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<tr>
<td>➢ Rational drug treatment during pregnancy and lactation</td>
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**Recommended Books**

17. Pharmacopoeia of India (1985), *Controller of publication, Delhi.*
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.
<table>
<thead>
<tr>
<th>Topic No.</th>
<th>Name of the Topic and Contents</th>
<th>No of Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SECTION-I</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td><strong>Plant metabolites:</strong> Primary &amp; secondary metabolites: Meaning, types, &amp; their functions in plant; Comparative account of primary &amp; 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.</td>
<td>03</td>
</tr>
<tr>
<td>2</td>
<td><strong>Pharmacognostic scheme for study of crude drugs:</strong> Meaning, component, &amp; significance of individual Pharmacognostic parameter</td>
<td>04</td>
</tr>
</tbody>
</table>
| 3        | **Primary metabolites of Pharmaceutical & industrial utility:**  
  *General consideration:* Definition, classification, occurrences, properties, nomenclature, chemistry (including general biogenesis, qualitative/quantitative analysis) & pharmaceutical & industrial applications of carbohydrates, lipids & proteins & their derived products.  
  **Carbohydrates:**  
  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:**  
  **Natural fibers:** Source, method of preparation, properties & applications of Cotton, Wool, Silk & Jute. | 17       |
| **SECTION-II**                                                                                                           |                                                     |          |
| 4        | **Secondary metabolites for medicinal utility:**  
  **A] Glycosides:**  
  *General consideration:* Definition, classification, occurrences, properties, nomenclature, & chemistry (including general biogenesis, qualitative/quantitative analysis) of glycoside containing drugs.  
  **Systematic Pharmacognostic study:**  
  A] Saponin glycosides: Liquorice, ginseng, & dioscorea  
  B] Cardioactive glycosides: Digitalis, squill, & strophanthus  
  C] Anthraquinone glycosides: Aloe, senna, rhubarb, cascara  
  D] Others: 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. *Systematic Pharmacognostic study:* Gambier, black catechu, Amla, Beleric & Chebulic Myrobalan.

**Recommended Books:**


   


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 (Isappol 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.).
10. Systematic approach for identification of powdered crude drugs

**Recommended Books (Practical's):**

ENVIRONMENTAL SCIENCES
(2hrs / week)

Learning objectives:

On successful completion of following theory topics learner should be able to

Knowledge:
1. Know basics of environment like ecology, ecosystem, food chain, food web and ecological pyramids.
2. Know the different natural sources and their conservation to save the environment.
3. Know the current problems of environment and how to solve them.
4. Understand the different factors of environmental pollution and measures to minimize it.
5. Aware about hazards of disposal wastes from hospitals and pharmaceutical industries.
6. Role of individual in conservation of natural resources.
7. Know the Disaster management.
8. Role of individual to save the environment.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Name of the topic and contents</th>
<th>No of Hrs</th>
</tr>
</thead>
</table>
| 1.     | **The Multi-disciplinary Nature of Environmental Studies.**
          Definition, scope and importance. Need for public awareness.                            | 2         |
| 2.     | **Ecology and Ecosystems.**
          • Definition of ecology
          • Structure and function of an ecosystem
          • Producers, consumers and decomposers
          • Energy flow in the ecosystem
          • Food chains, food webs and ecological pyramids.
          • Introduction, types, characteristic features, structure and function of the following ecosystems:
            • Forest ecosystem
            • Grassland ecosystem
            • Desert Ecosystem
            • Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries) | 4         |
| 3. | **Biodiversity and its conservation. (General account)**  
• Introduction – Definition: genetic, species and ecosystem diversity.  
• Value of biodiversity: consumptive use, productive use, social, ethical, and esthetic and option values.  
• Biodiversity at global, National and local levels.  
• India as a mega – diversity nation.  
• Hot Spots of biodiversity.  
• Threats to biodiversity: habitat, poaching of wildlife, man wildlife conflicts.  
• Endangered and endemic species of India. | 3 |

| 4. | **Natural Resources and their conservation**  
• Air resources: Features, composition, structure, air quality management.  
• Forest resources: Use and over/exploitation, deforestation, case studies, timber extraction, mining, dams and their effect on forests and tribal people.  
• Water resources: Use and over utilization of surface and ground water, flood, drought, conflicts over water, dams –benefits and problems; water quality management: management of water resources. E.g. Rivers, lakes, ground water, etc: Fluorosis and arsenic problems.  
• Mineral resource: Draw on and exploitation, environmental effects of extracting and using mineral resources, case studies.  
• Food resources: World food problems, changes caused by agricultural and overgrazing, effects of modern agriculture, fertilizer-pesticide Problems, water logging, salinity, case studies.  
• Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources, Case studies.  
• Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources and prevention of pollution. Equitable use of resources for sustainable lifestyles.  
Disaster management: Floods, earthquakes, cyclone and slides. | 5 |

| 5. | **Environmental issues related to the specific discipline for Pharmacy Course.**  
• Maintenance of healthy environment in Pharmaceutical industry  
• Disposal of wastes,  
• Hospital waste, Pharmaceutical industrial waste.  
• Air sampling and air handling in Pharma. Industries. | 4 |

| 6. | **Environmental Pollution.**  
• Definition  
• Air pollution: Definition, causes, effects and control measures: Air Quality Management, Air Pollution Case Studies.  
• Water pollution: Definition, causes, effects and control measures: case studies: Water  
• Quality Management: Definition, causes, effects and control measures.  
• Marine Pollution  
• Thermal pollution.  
• Soil pollution: Definition, causes and control measures: case studies | 7 |

**SECTION-II**
- Noise pollution.
- Nuclear hazards: Waste Management:
  - Waste minimization through cleaner technologies; reuse and recycling of wastes.
  - Solid waste management Causes, effects and control measures of urban and industrial wastes: hazardous waste: bio medical waste.
- Role of an individual in prevention of pollution.
- Pollution case studies.
- Disaster management: floods, earthquake, cyclone and landslide

<table>
<thead>
<tr>
<th>7</th>
<th><strong>Human Population and the Environment.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Population growth, variation among nation.</td>
</tr>
<tr>
<td></td>
<td>- Population explosion- Family Welfare Programme</td>
</tr>
<tr>
<td></td>
<td>- Environment and human health.</td>
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<td>- Human Rights</td>
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<td>- Value Education.</td>
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<td>- HIV / AIDS.</td>
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<td>- Women and Child Welfare.</td>
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<td>- Role of Information Technology in Environment and human health.</td>
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<td></td>
<td>- Case Studies.</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>8</th>
<th><strong>Field Work (any two of the following)</strong></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>- Visit to local area to document environmental assets-river/ forest/ Grasslands/ Hill/ Mountain</td>
</tr>
<tr>
<td></td>
<td>- Visit to a local pollution site –Urban/Rural/Industrial/Agricultures/etc.</td>
</tr>
<tr>
<td></td>
<td>- Study of common plants, insects, birds.</td>
</tr>
<tr>
<td></td>
<td>- Study of simple ecosystems- pond, river, hill slopes, etc.</td>
</tr>
<tr>
<td></td>
<td>- Or Any other field work fulfilling the demand of subject</td>
</tr>
</tbody>
</table>

**Recommended Books:**
1. Environmental Studies by Erach Bharucha.
SAVITRIBAI PHULE PUNE UNIVERSITY

Faculty of Pharmaceutical Science

Syllabus

Second Year B. Pharm. Credit System 2015 Course
(With effect from Academic Year 2016 - 17)
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.
<table>
<thead>
<tr>
<th>Topic No.</th>
<th>Name of topic and contents</th>
<th>No of Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Surface &amp; Interfacial phenomena</strong>&lt;br&gt;1. Introduction to Surface and interfacial tension, surface free energy, Measurement of surface and interfacial tension, spreading coefficient, adsorption at liquid-interfaces.&lt;br&gt;2. Surfactant classification and HLB scale, Micellar solubilization, Krafft &amp; Cloud point, soluble monolayer &amp; Gibbs equation, insoluble monolayer and film balance, adsorption at solid interfaces, adsorption isotherms, (Langmuir and Freundlich)</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td><strong>Rheology</strong>&lt;br&gt;1. Fundamentals of rheology, Types of flow, Viscometers mechanical model to illustrate viscoelastisity, creep curve.&lt;br&gt;2. Thixotropy, measurement of thixotropy, rheology of disperse system, pharmaceutical application of rheology.</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td><strong>Chemical Kinetics and Stability</strong>&lt;br&gt;1. Reaction theories, rate, order and molecularity, mathematical treatment of zero, first and second order, (complex reaction: reversible, parallel and side reactions (no derivations)),&lt;br&gt;2. Determination of order, Effect of temperature, Arrhenius equation and energy of activation, degradation pathways, physical &amp; chemical instability Accelerated stability studies.&lt;br&gt;3. Problems related to half life, shelf life, and energy of activation and Arrhenius factor.</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td><strong>Micromeritics</strong>&lt;br&gt;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.&lt;br&gt;2. Specific surface, method for determining surface area.&lt;br&gt;3. Derived properties of powder: porosity, packing arrangement, densities, bulkiness, flow properties of powder, angle of repose, factors affecting flow of powder.</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td><strong>Colloids</strong>&lt;br&gt;1. Introduction &amp; types, optical, kinetic &amp; electrical properties of colloids, electrical double layer, Nernst &amp; Zeta potential, Donnan membrane equilibrium.&lt;br&gt;2. Protective colloids, stabilization of colloidal system, DLVO theory, Schulz Hardy rule, Hoffmeister series, Applications in pharmacy.</td>
<td>09</td>
</tr>
</tbody>
</table>
## 2.4.1 P PHYSICAL PHARMACEUTICS-II
(Practical) (3 Hrs/Week)

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

**Recommended Books:**
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.

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

**Recommended Books**

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

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

**Recommended Books:**
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.
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 C\textsubscript{5} and C\textsubscript{6} 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:

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.

<table>
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<tr>
<th>Sr. No.</th>
<th>Topics</th>
<th>No. of hrs.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>SECTION-I</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td><strong>Heterocyclic Chemistry</strong>: Structures, numbering and corresponding drugs of the following Heterocyclic compounds: furan, thiophene, pyrrole, pyrazole, thiazole, imidazole, oxazole, isoxazole, hydantoin, pyridine, pyridazine, pyrimidine, indole, benzofuran, benzthiazole, benzimidazole, benzoazolate, quinoline, isoquinoline, quinazoline, cinnoline, purine, xanthine, pteridine &amp; Coumarin. Synthesis and Reaction of following compounds: furan, pyrrole, indole, imidazole, pyridine and quinoline, isoquinoline and thiophene</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td><strong>Polycyclic compounds</strong>: Synthesis and reactions of naphthalene, Anthracene and Phenanthrene.</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>SECTION-II</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Reagents used in organic synthesis</strong>: Methods of preparation, reaction and uses of aluminium isopropoxide, NBS, DDQ, DCC, diazomethane, organoboranes, metal</td>
<td></td>
</tr>
</tbody>
</table>
hydrides, LTA, manganese oxide, organosilicon compounds, osmium trioxide, Wittig reagent, oxidizing, reducing, nitrating, halogenating, sulfonating agents and reactions thereof, coupling reagents.

3 Introduction to Combinatorial Chemistry: History, Introduction to linkers and solid supports. Various techniques used in combinatorial synthesis (Mix and split, Parallel synthesis). Applications

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.

5 Microwave assisted Synthesis: Basics, Principle, Techniques of microwave assisted synthesis and Applications of Microwave assisted synthesis in pharmaceutical organic chemistry

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)
   e.g.: 4-Methyl 7-hydroxy coumarin (Coumarin derivative), Amino Pyridine (Pyridine derivative), 2, 3-Diphenylquinoxaline (Quinoxaline), Benztriazole, 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:

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.

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<tr>
<th>Topic No.</th>
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<tr>
<td>SECTION-I</td>
<td></td>
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<tr>
<td>1.</td>
<td><strong>Electro-Analytical Techniques</strong></td>
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<td>Introduction &amp; types of Electro-Analytical Techniques, Electrochemical cell, potentials in electro-analytical cell &amp; its measurement (Nernst Equation), current-potential relationships, mass transfer by migration, convection and diffusion.</td>
<td>03</td>
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<td>2.</td>
<td><strong>Potentiometry</strong></td>
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<td>Introduction, theory &amp; 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 &amp; its calibration, potentiometric titrations and applications.</td>
<td>07</td>
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<td>3.</td>
<td><strong>Conductometry</strong></td>
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<td>Introduction, theory &amp; principle of Conductometry, measurement of conductance, (specific, molecular and equivalence conductance), effect of dilution, cell constant, conductivity meter, conductometric titrations &amp; high frequency titrations.</td>
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<td>4.</td>
<td><strong>Polarography</strong></td>
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<td></td>
<td>Introduction, theory &amp; principle of polarography, polarogram, half wave potential,</td>
<td>06</td>
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</table>
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, Bi-amperometric 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

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**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:**

4. Pharmaceutical Analysis by Higuchi, Reprint 2004, CBS Publisher & Distributors.
5. The quantitative analysis of drugs by Garratt DC, 3/Ed., CBS Publisher & Distributors.
12. Instrumental Methods of Analysis by Willard Merit, Dean Settle, 7th edition, CBS Publisher & Distributor
16. Laboratory Handbook of Instrumental Drug Analysis, B.G. Nagavi, Vallabh Prakashan.
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.

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<tr>
<td><strong>SECTION-I</strong></td>
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<tr>
<td>1</td>
<td><strong>Alkaloids</strong></td>
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<td></td>
<td>A] General consideration: Definition, classification, occurrences, properties, nomenclature, &amp; chemistry (including general biogenesis, qualitative/quantitative analysis) of alkaloids.</td>
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<td><strong>SECTION-II</strong></td>
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<tr>
<td>2</td>
<td><strong>Terpenoids &amp; Resins</strong></td>
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<td></td>
<td>A] General consideration: Definition, classification, occurrences, properties, nomenclature, &amp; chemistry (including general biogenesis, qualitative/quantitative analysis) of terpenoids/resins.</td>
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</table>
Recommended Books:


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):
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.

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<tr>
<td>1</td>
<td><strong>Mass Transfer:</strong> Molecular diffusion in gases &amp; liquids, theories of interphase mass transfer.</td>
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<td>2</td>
<td><strong>Drying:</strong> Mechanism, theory, factors affecting, Driers- tray drier, fluidized bed drier, spray drier, freeze drier, drum drier.</td>
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<td>3</td>
<td><strong>Heat Transfer:</strong> Mechanisms – conduction, convection, radiation, Fourier’s law, Stefan-Boltzmann’s constant, Kirchoff’s law, Heat exchangers- heat transfer in parallel flow &amp; counter flow, tubular heat exchangers, plate heat exchangers and applications.</td>
<td>07</td>
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<td>4</td>
<td><strong>Evaporation:</strong> Theory, evaporator capacity-heat &amp; material balances, factors</td>
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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.

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**Recommended Books:**