SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Engineering & Technology

Structure & syllabus for

B.Pharmacy Part-II

(w.e.f. Academic Year 2015-16)

Solapur University,Solapur

Second Year B Pharmacy

2.3.1 Physical Pharmacy-I (Theory)

1. **Matter and its Properties**
   State of matter, change in the state of matter, latent heats and vapor pressure, sublimation-critical phenomenon, Eutectic mixtures, gases, liquid complexes, liquid crystals, glassy state, solids- crystal, amorphous powders and polymorphism.

2. **Thermodynamics**
   Elementary study of First law of thermodynamics: Energy, Work, Heat, Enthalpy, Thermochemistry, Second law of Thermodynamics: Entropy, Free Energy, Net Work, Gibbs Helmholtz equation, Third law of thermodynamics and Zeroth law.

3. **Solutions**
   Definition and types of solutions: Solutions of electrolytes & non electrolytes, Ideal & real solution, Raoult's law & deviation, Colligative properties, Osmotic pressure, Semipermeable membrane, measurement of osmotic pressure, Van't Hoff & Morse equation for osmotic pressure, mechanism of osmosis through semipermeable membrane, Arrhenius theory and Debye Huckel theory.

4. **Solubility & Distribution Phenomenon**
   General principles and types of solvents; solubility of gases in liquids; solubility of liquids in liquids, solubility of solids, influence of pH, solvents & surfactants, distribution coefficient (Nernst coefficient): True & apparent distribution, preservative action of weak acids, drug action & partition co-efficient; phase rule – one component system (water), co-solvency.

5. **Viscosity and Rheology**
   Newtonian systems, Law of flow, types of viscosity, effect of temperature, non-Newtonian systems, pseudoplastic, dilatant, plastic, thixotropy, thixotropy in formulation, determination of viscosity, capillary, falling ball, rotational viscometers.

Reference books

1. Subhramanyam, C.V.S. Essentials of Physical Pharmacy. Vallabh Prakashan, New Delhi, latest edition.
2. Martin A.A., Bustamante, P., A.H.C. Physical Pharmacy. 4th Edition. B. I. Waverly (P) Ltd., New Delhi, latest edition.
3. Agarwal S. P., Khanna Rajesh; Physical Pharmacy, CBS Publisher, New Delhi, latest edition.
4. A. T. Florence and D. Attwood W: Physiochemical principles of Pharmacy.
5. Shotten E & Ridgaway K; Physical Pharmaceutics, Oxford University Press, London, latest edition.

6. Genaro A. R; Remington's Pharmaceutical Science.19th Ed. Mack Publishing Co., latest edition.
7. H. S. Beans, A. H. Beckett and J. E. Carless: Advances in Pharmaceutical Sciences, Vol. 1-4.
8. S. P. Agarwal, Rajesh Khanna: Physical Pharmacy, CBS Publishers, New Delhi.
9. Tutorial Pharmacy by Cooper & Gunn
10. Liberman H. A., Riogor M. M, & Banker G. Pharmaceutical dosage forms - Disperse systems, Vol.1-3, Marcel Dekker Inc, New York.
11. Liberman H. A, Lachman C. Pharmaceutical Dosage forms, Tablets, Vol.1-3, Marcel Dekker Inc.
12. Physical Pharmaceutics by R. Manavalan and C. Ramasamy.
13. Conores K. A., Amiden G. L. and Stella V. J. Chemical Stability of Pharmaceuticals John Wiley and Sons, New York, latest edition.
14. Bahl and Tuli. Essential of Physical Chemistry. S. Chand Publication.

2.3.7 Physical Pharmacy-I (Practicals)

1. Determination of Density / Specific gravity of given liquids
2. Viscosity determination of various types of liquids by Ostwald's viscometer and Brookfield viscometer.
3. Determination of composition of a binary mixture by viscosity method.
4. Determination of partition coefficient of iodine between carbon tetrachloride and water.
5. Determination of partition coefficient of benzoic acid between water and benzene.
6. Determination of critical solution temperature of phenol water system.
7. Effect of impurities on critical solution temperature.
8. Effect of co-solvency on solubility.
9. Effect of temperature on solubility of solid in liquid.
10. Determination of Molecular weight: Freezing Point Depression Method (Rast camphor)
11. Any other experiment based on theory.

2.3.2 Pharmaceutical Engineering (Theory)

1. **Unit Operations**
   Introduction to Pharmaceutical Engineering. Unit Operations, Concept and Requirement, Material and Energy Balances.

2. **Fluid flow**
   Types of flow, Reynold's number, Bernoulli's Theorem, flow meters.

3. **Material Handling Systems**
   Liquid handling: Different types of pumps- reciprocating pumps, positive displacement pumps, rotary pumps- volute and centrifugal pump, peristaltic pump, Air Binding and self-priming pumps.
   Gas handling: Blowers and Compressors.
   Solid handling: Bins, Bunkers, Conveyors (Screw, Belt, Pneumatic and Chain conveyors).

4. **Drying**
   Moisture content and mechanism of drying, rate of drying and time of drying calculations. Types of dryers, dryers used in pharmaceutical industries *viz.* tray dryer, fluid bed dryer, spray dryer and freeze dryer.

5. **Evaporation**
   Basic concept of phase equilibria, factors affecting evaporation
   Evaporators: tube evaporators, film evaporators, single effect and multiple effect evaporators.

6. **Distillation**
   Raoult's law, phase diagrams, volatility, simple, steam and flash distillation, principles of rectification, Mc. Cabe Thiele method for calculation of number of theoretical plates, Azeotropic and extractive distillation.

Reference books

1. Badger W. L. and Banchero J. T. Introduction to Chemical Engineering Mc Graw Hill International Book London, latest edition.
2. Perry R. H.& Clinton C. H. Chemical Engineers Handbook, Mc Graw Kogakush Ltd., latest edition
3. McCabe W. L. and Smith J. C. Unit Operation of Chemical Engineering Mc Graw Hill International Book London, latest edition.
4. Sambhamurthy, Pharmaceutical Engineering, New Age Publishers, latest edition.
5. Gavhane K. A. "Unit Operation-I", Nirali Prakashan, latest edition
6. Pharmaceutical Engineering- Dr. Paradkar
7. Subhramanyam, C.V.S. Pharmaceutical Engineering. Vallabh Prakashan, New Delhi, latest edition.
8. Mrs. B. Jeevana Jyothi. Practical manual of pharmaceutical engineering. Nirali Prakashan Pune.

2.3.8 Pharmaceutical Engineering (Practical)

1. Determination of humidity of air by Dew point method.
2. Determination of humidity of air by using Psychrometric chart.
3. Determination of solubility curve.
4. Study of factors affecting flow of liquids.
5. Demonstration of different dryers.
6. Construction of drying curve.
7. Determination of equilibrium moisture content of various pharmaceutical raw materials.
8. Purification of liquids by simple distillation.
9. Separation of liquids by steam distillation.
10. Determine the efficiency of steam distillation.
11. Study of boiling point diagrams of miscible liquids.
12. Experiments to illustrate the influence of parameters like surface area, temperature on evaporation.
13. Any other experiment based on theory.

2.3.3 Organic Chemistry-II (Theory)

1. **Benzene and aromaticity**
   Huckel rule, resonance in benzene, Mechanism of electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's reaction, orientation and reactivity in electrophilic aromatic substitution. Mechanism of nucleophilic aromatic substitution: unimolecular, bimolecular and elimination-addition (reactions involving benzyne intermediate)

2. **Aldehydes and Ketones (aliphatic & aromatic)**
   Preparations, oxidation, reduction reactions, mechanism of nucleophilic addition: cynide, alcohol, derivatives of ammonia, Grignard reagents and metal hydride, enamine preparation. MPV reduction, Oppenaur oxidation, Aldol Condensation, Cannizzarro's reaction, Reformatsky reaction, Perkin reaction, Knoevenagel reaction, Haloform Reactions & Mannich reaction.

3. **Carboxylic acids and its derivatives (aliphatic & aromatic)**
   Preparations and reactions of carboxylic acids, acid halides, anhydrides, esters and amides

4. **Amines (aliphatic & aromatic)**
   Preparations and reactions. Hinsberg method for separation of mixture of amines. Use of diazonium salts in synthesis.

5. **Phenol**
   Preparation and reactions

6. **Polycyclic compound**
   Preparation, reactions and structure elucidation* of naphthalene*, anthracene and phenanthrene.

7. **Heterocyclic compound**
   Nomenclature, Preparation and reactions of pyrrole, thiophene, imidazole, thiazole, oxazole, pyridine, pyrimidine, indole, quinoline, isoquinoline.

Reference books

1. Advanced Organic Chemistry by Jerry March, John Wiley & Sons.
2. Fundamentals of Organic Chemistry by I. L. Finar (Vol. 1&2), ELBS.
3. Advanced Organic Chemistry by Bahl & Bahl, S.Chand & Company Ltd, New Delhi.
4. Advanced Organic Chemistry by Solomans
5. Reactions, Mechanisms and Reagents by G. R. Chatwal
6. Organic Chemistry by M. K. Jain
7. A guide book to reaction mechanisms in Organic Chemistry by Peter Sykes
8. Organic Chemistry by Pine
9. Organic Chemistry by Morrison and Boyd, LPE.
10. Advanced general organic chemistry, A Modern approach, Part I & II by S. K. Gosh, NCBA.

2.3.9 Organic Chemistry-II (Practicals)

A. Synthesis based on

1. Benzoylation
2. Bromination
3. Nitration
4. Sulphonation
5. Oxidation
6. Reduction
7. Claisen Schmidt reaction
8. Esterification
9. Amide Synthesis
10. Cannizzaro reaction
11. Synthesis of two heterocyclic rings

B. Building molecules using molecular model set or virtual molecular modeling kit and determining of the bond angle, bond length, dipole moment, pi molecular orbitals in case of Benzene and effect of substituents on the molecular orbitals of Benzene.

Reference books

1. Vogel's text book of practical organic chemistry by B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell
2. Elementary Practical Organic Chemistry, small scale preparations, 6th edition, Arthur I. Vogel
3. Practical Organic Chemistry by F. G. Mann & B. C. Saunders
4. Practical in Organic & Medicinal Chemistry by Dr. Ramesh Goyal, Hardik Bhatt, Bhoomika R. Goyal.
5. A laboratory handbook of organic qualitative analysis and separation by V. S. Kulkarni & S. P. Pathak, Dastane Ramchandra & Co., Pune.
6. A handbook of organic analysis, qualitative & quantitative by H. T. Clarke, 5th edition, Arnold publishers.
7. Handbook of practical chemistry (Inorganic & organic) by Dr. K. R. Mahadik, S. H. Bhosale, Nirali prakashan.

2.3.4 Pharmaceutical Analysis-I (Theory)

1. **Introduction**
   Definition and scope of Pharmaceutical analysis,
   Introduction to analytical techniques: volumetric, gravimetric and instrumental analysis.
   Definition of solute, solvent, solution, molarity, molality, equivalent weight, normality, formality, mole fraction, parts per million, parts per billion, stoichiometry, titration, titrant, titrate, primary and secondary standard.

2. **Errors**
   Absolute and relative errors, precision, accuracy and relative precision, significant figures. types of errors: determinate and indeterminate errors.

3. **Acid base titrations**
   Law of mass action, Neutralization curve, endpoint detection, theory of neutralization indicators. (no chemical structures). Preparation and standardization of 1M HCl, 1M H_2SO_4, 1M NaOH and 1M Na_2CO_3, assay of Aspirin powder IP, Ibuprofen powder IP & Ephedrine powder IP.
4. **Oxidation- Reduction Titrations**
   Theory**,** oxidation reduction indicators (self indicator, internal indicator, external indicator). Preparations and standardization of potassium permanganate solution, assay of hydrogen peroxide, preparation and standardization of 0.05 M cerric ammonium sulphate, assay of ferrous sulphate powder IP. Preparation and standardization of iodine solution by sodium thiosulphate, assay of sodium thiosulphate powder IP, Preparation and standardization of 0.0167 M potassium bromate solution, assay of isoniazid powder IP, sodium methyl paraben IP.

5. **Precipitation Titration**
   Theory (Mohr's method, Volhard's method, Fajan's Method and Gay-Lussac method), Solubility product, Common Ion effect, Indicators, Preparation and standardization of 0.1 M $AgNO_3$, assay of sodium chloride injection IP and potassium chloride powder IP.

Reference Books

1. Pharmaceutical analysis, Volume I by Dr. A. V. Kasture & S. G. Wadodkar- Nirali Prakashan.
2. Vogel's Text book of Practical organic chemistry- 6th edition.
3. Practical Pharmaceutical Chemistry, part I & II by Beckett & Stenlake.
4. Pharmaceutical analysis Volume I & II by Ashutosh Kar.
5. Pharmaceutical analysis by P. C. Kamboj.
6. Inorganic Pharmaceutical chemistry by Tipnis & Dhake.
7. Indian Pharmacopoeia
8. Analytical Chemistry by Gary Christian
9. Pharmaceutical Analysis by David G. Watson.
10. Basic concepts of Analytical Chemistry S. M. Khopkar.

2.3.10 Pharmaceutical Analysis-I (Practicals)

1. Introduction to lab equipments & basic techniques: use & care of laboratory glass wares, techniques of measurement of volume, weight, safety in analytical laboratory.
2. Calibration of volumetric apparatus: burette, pipette, volumetric flask.
3. Preparation & standardization of 0.1 M NaOH, 0.1M HCl.
4. Assay of aspirin powder or ibuprofen powder or benzoic acid IP
5. Preparation & standardization of 0.1 M $KMnO_4$
6. Assay of ferrous sulphate powder by $KMnO_4$
7. Preparation & standardization of 0.05M Cerric ammonium sulphate
8. Assay of Isoniazid powder IP.
9. Preparation & standardization of 0.1M Iodine.
10. Assay of Ascorbic acid & sodium thiosulphate.
11. Preparation & standardization of 0.1N $AgNO_3$
12. Assay of Sodium chloride injection IP and potassium chloride powder IP.

Reference books

1. Indian Pharmacopoeia.
2. Practical pharmaceutical chemistry Part-I, A. H. Beckett, J. B. Stenlake, CBS publications.
3. Pharmaceutical analysis –I (practical) by Mrs. Sonali Sheorey, Ms. Meera Honrao, Nirali prakashan
4. Vogel's Textbook of quantitative chemical analysis by G.H. Jeffery, J. Bassett, J. Mendham, R. C. Denney.
5. Vogel's Textbook of quantitative analysis by G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney.

2.3.5 Pathophysiology & Clinical Biochemistry-I (Theory)

1. **Introduction to Pathophysiology**

2. **Basic principles of cell injury and adaptation**
   Causes, pathogenesis and morphology of cell injury, Apoptosis-causes and mechanism, Cellular adaptations-Atrophy, hypertrophy, metaplasia and hyperplasia.

3. **Water, Electrolytes and Acid-Base balance**
   Water compartments, water balance, electrolyte distribution, physiological mechanisms which maintain fluid volume, normal pH range. Types of acid base derangements, the H_2CO_3-HCO_3 buffer system, dehydration, hypovolemia, hypo & hypernatremia, hypo & hyperkalemia. hypo & hyperlcaemia. Disorders of Acid-base balance, Respiratory acidosis, respiratory alkalosis, metabolic acidosis, metabolic alkalosis.

4. **Pain and Inflammation**
   Pain: Types of pain, degenerative joint disease, osteoarthritis.
   Osteoarthritis - causes & abnormalities, assessment subjective, objective.
   Gout - Hyper uricemeia, chronic gout, maintenance of the acute attack.

5. **Pathophysiology of GIT**
   Disorders of Esophagus: Diffuse spasm of esophagus, Achalasia.
   Disorders of Stomach: Ulcer and types of ulcers, peptic ulcer, emesis.
   Disorders of small intestine: Crohn's disease, chronic ulcerative colitis, tuberculosis of intestine.
   Disorders of liver: Infectious hepatitis, Types of hepatitis, liver changes in viral, alcoholic hepatitis cirrhosis.
   Disorders of the gall bladder: Gall stone formation- types of gall stones, Assessment & management.
   Disorders of exocrine pancreas: Acute pancreatitis- alcohol induced acute pancreatitis resulting gall bladder and billary tract disease, chronic pancreatitis- Cause, abnormalities, assessment and management.

6. **Renal Disorders**
   Glomerular disease: Types of glomerulonephritis and nephrotic syndrome
   Renal failure - Obstructive, pre, acute and chronic renal failures.
   Acute Tubular Necrosis.
   Urinary tract infections & pyelonephritis- Acute pyelonephritis, chronic pyelonephritis.

7. **Malignancy -** Pathophysiology of Benign and Malignant tumors**.**

Reference books

1. Textbook of Pathology by Harsh Mohan, Jaypee brothers, Medical Publishers (P) Ltd, New Delhi.
2. Pathologic Basis of disease by Robbins and Cotran, Elsevier, Philadelphia.
3. Textbook of medical Physiology by Guyton and Hall, Elsevier, Philadelphia.

4. Pathophysiology by Carol Mattson Porth, Lippincott, New York.
5. Physiology : V.D. Joshi
6. Human Physiology by C. C Chatterjee, Medical allied Agencies, Kolkata.

2.3.11 Pathophysiology & Clinical Biochemistry-I (Practicals)

1. Procedure for collection and preservation of blood, plasma, serum, cerebrospinal fluid, urine, faeces, pleural fluid, peritoneal fluid and serum.
2. Discussion of normal and abnormal ranges of constituents of blood, serum and urine samples in various diseases and disorders.
3. Hematology
   i) Specimen collection of blood and storage using different anticoagulants. Preparation of serum.
   ii) Eosinophil count and its clinical significance
   iii) Platelet Count and its clinical significance
   iv) Coagulation test, determination of prothrombin time and its clinical significance.
   v) ESR by westergreen method and wintrobe method
   vi) Sputum Analysis.
5. Study of Histopathological slides of inflammation, GIT & renal disorders and cancer.
6. Qualitative, Quantitative and microscopic examination of urine.
7. Visit to the Blood Bank.

Reference books

1. Manual of clinical Lab procedure for non-Routine problems: S. Winsten
2. Clinical lab methods: John D
3. T.B of clinical Medical biochemistry and immunology: Dr. S. Ramakrishnan, Dr. Raji Swami
4. Handbook of Medical laboratory Technology by V. H. Talib, CBS Publishers and Distributors, New Delhi.
5. Handbook of Experimental Physiology and biochemistry: Dr P. V. Chadha
6. Medical Laboratory Technoloy: Kinari L. Mukherjee
7. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi.
8. Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers,Ludhiana .
9. Practical biochemistry, R. C. Guptha, S. Bhargava, CBS publishers, New Delhi.
10. Biochemical Methods by Sadasivam & Manickam (1996) New Age International (P) Ltd.
11. A Handbook of Practical and Clinical Immunology, 2nd Ed, G. P. Talwar and S. K. Gupta (eds) (2005) Publishers: CBS Publishers and distributors.

2.3.6 Computer Applications (Theory)

1. **Computer fundamentals**
   Definition, history, characteristics of computer organization input & output devices, storage devices (including latest devices), classifications of computers, introduction to computer virus, application of computers in pharmacy.

2. **Operating Systems**
   Definition, functions of an operating system, types of operating systems and their characteristics.

3. **MS Word**
   Word Essentials, the word workplace, Parts of MS Word screen, Typing and Editing, Finding and Replacing, Autocorrect and Autotext, Reusing Text and Graphics, use of spellcheck & grammer, thesaurus and scientific symbols, viewing of document by various ways Editing Tools, Formatting Text Formatting Text Character, Formatting Paragraphs, Formatting and Sorting Lists, Page Design and Layout, Page Setup : Margins, Page Numbers, and Other Items, Newspaper -style Columns, Working with Tables Creating and formatting of tables and sorting, merging etc. of data in tables. Inserting, deleting and sizing of rows and columns in tables, Opening, Saving and Protecting Documents, Locating and Managing Documents Printing, Assembling Documents with Mail Merge,

4. **MS Excel**
   Introduction to EXCEL worksheet, calculations in EXCEL, preparation of templates for application in pharmaceutical chemistry, pharmaceutical technology, pharmacology and pharmacognosy (statistical treatment of data for Beers Lamberts curve, solution of problems based on physical pharmacy, pharmaceutical engineering, stability study, area under the curve, bio-assay, bioequivalence study, extraction, Rf value, etc.) Special attention must be given to arithmetic expressions. Hierarchy of operation, library functions such as logarithm, squareroot, standard deviation, sum, average, t-test, ANOVA etc. Drawing graphs in EXCEL line graph, histogram, pie-chart- At least one graph for each discipline of chemistry, pharmaceutical technology, pharmacology and pharmacognosy –Editing chart features such as annotation, labeling of axis, changing legends etc.

5. **MS Powerpoint**
   Creating and viewing a presentation, adding animations and managing slide shows etc.

6. **Introduction to MS Access and Outlook**

7. **Paint, Adobe Acrobat reader**

8. **Networking & Internet**
   Computer networks, networking technology, components of network. Internet – Basic terms, software and hardware requirement for internet, process of internet working,

internet tools, Email- components and working, study of pharmaceutical web sites and search engines, searching through pharmaceutical data bases, study of patent websites.

2.3.12 Computer Applications (Practicals)

Practical exercises based on theoretical topics. Exercise to familiarize students with the use of various DOS commands and WINDOWS environment. Exercises on word processing to execute various commands in preparing and editing documents, preparation of important documents and practical tables of pharmacognosy, pharmaceutical chemistry, pharmaceutics and pharmacology in MS Word. Preparing and editing worksheets in MS EXCEL, drawing graphs, inserting formulas etc. Preparation of slides, adding animations and managing slide show in MS PowerpointDemonstration of softwares for viewing .pdf documents (ADOBE reader, ACROBAT), drawing simple chemical structures (CHEMDRAW, etc.), working with diagrams in paint.
Demonstration of pharmaceutical web sites including educational, government, commercial & search engines working with E-mail & e-mail software, patent Web-site.

2.4.1 Physical Pharmacy-II (Theory)

1. **Micromeretics and Powder Rheology**
   Particle size and distribution, average particle size, number and weight distribution, particle number, methods for determining particle volume, methods of determining particle size- optical microscopy, sieving, sedimentation; measurements of particle shape, specific surface area; methods for determining surface area; permeability, adsorption, derived properties of powders, porosity, packing arrangement, densities, bulkiness & flow properties.

2. **Surface and Interfacial Phenomenon**
   Liquid interface, surface and interfacial tensions, surface free energy, measurement of surface and interfacial tensions, spreading coefficient, adsorption at liquid interfaces, surface active agents, HLB classification, solubilization, detergency, adsorption at solid interfaces, solid-gas and solid-liquid interfaces, complex films, electrical properties of interface.

3. **Dispersion systems**
   Colloidal dispersions: Definition, types, properties, preparation & purification of colloids, protective colloids, applications of colloids in Suspensions and Emulsions: Interfacial properties of suspended particles, settling in suspensions, theory of sedimentation, effect of Brownian movement, sedimentation of flocculated particles, sedimentation parameters, wetting of particles, controlled flocculation, flocculation in structured vehicles, rheological considerations; Emulsions-types, theories, physical stability.

4. **Kinetics and Drug stability**
   General considerations & concepts of chemical kinetics, half-life determination, modes of degradation & their correction. Influence of temperature, light, solvent, catalytic species and other factors, Accelerated stability study, expiration dating.

5. **Complexation**
   Classification of complexes, methods of preparation, analysis and applications.

Reference books

1. Subhramanyam C.V.S., Text Book of Physical Pharmaceutics. Vallabh Prakashan, New Delhi, latest edition.
2. Martin A. A., Bustamante P., A.H.C. Physical Pharmacy. 4th Edition. B. I. Waverly (P) Ltd., New Delhi, latest edition.
3. Agarwal S. P., Khanna Rajesh; Physical Pharmacy, CBS Publisher, New Delhi, latest edition.
4. A. T. Florence and D. Attwood W: Physiochemical principles of Pharmacy.
5. Shotten E & Ridgaway K; Physical Pharmaceutics, Oxford University Press, London, latest edition.
6. Genaro, A.R; Remington's Pharmaceutical Science. 19th Ed. Mack Publishing Co., latest edition.

7. H.S. Beans, A.H. Beckett and J.E. Carless: Advances in Pharmaceutical Sciences, Vol. 1 to 4.
8. S. P. Agarwal, Rajesh Khanna: Physical Pharmacy, CBS Publishers, New Delhi.
9. Tutorial Pharmacy by Cooper & Gunn
10. Liberman H. A., Riogor M. M, & Banker G. Pharmaceutical dosage forms - Disperse systems, Vol.1, 2 and 3 Marcel Dekker Inc, New York.
11. Liberman H.A, Lachman C. Pharmaceutical Dosage forms, Tablets, Vol.1-3, Marcel Dekker Inc.
12. Physical Pharmaceutics by R. Manavalan and C. Ramasamy.
13. Conores K. A., Amiden G. L. and Stella V. J. Chemical Stability of Pharmaceuticals John Wiley and Sons, New York, latest edition.

2.4.7 Physical Pharmacy-II (Practicals)

1. Determination of Surface and Interfacial tension using Stalagmometer.
2. Determination of CMC of a surfactant.
3. Determination of HLB value of surfactant by saponification method.
4. Study of Adsorption Isotherm.
5. Determination of derived properties of powders like density, porosity, compressibility, angle of repose etc.
6. Study of effect of particle size and glidants on angle of repose.
7. Determination of particle size by optical method.
8. Determination of particle size, Particle size distribution and surface area by sieve analysis.
9. Determination of particle size by sedimentation method using Andresen pipette.
10. Determination of Order of reaction - First order, Second order reaction (Any one)
11. Any other experiment based on theory.

2.4.2 Microbiology (Theory)

1. **Introduction to Microbiology**
   Historical developments- contributions of Antony Van Leeuwenhoek, Louis Pasteur, Robert Koch and Paul Ehrlich. Applications to pharmaceuticals.

2. **Microscopy**
   Basic Principle and applications of compound, Dark- field, phase contrast, fluorescence and electron microscopy.

3. **Classification of microorganisms**
   Bacteria, Actinomycets, Fungi, Rickettsia, Protozoa and Viruses
   Bacteria: Size and shape, Classification of bacteria, structure of single bacteria and structure of cell wall, cytoplasm, capsules. Spores properties, formation and germination, locomotion, reproduction by binary fission, reproduction involving genetic exchange transformation, conjugation and transduction.
   Growth requirements, various culture media, growth curve, measurement of bacterial growth and mean generation time. Counting methods- total count and viable count. Identification by various biochemical tests. Detail about endotoxins and exotoxins. Characteristics of disease causing bacteria like Staphylococcus, Streptococcus Clostridium, Mycobacterium, Vibrio and Shigella.
   Fungi: Yeast and moulds, characteristics and uses of *Saccharomyces cervisae, Candida albicans, Penicillium and Aspergillus*.
   Viruses: Introduction and classifications, viral structure and structural symmetry, lytic and lysogeny growth cycle, cultivation of viruses, Introduction to tumor and Human Immunodeficiency virus.
   Rickettsia: Introduction, characteristics and diseases caused by rickettsia

4. **Sterilization, Disinfection, Sanitization and Infection control**
   Sterilization: Definition, classification into thermal and non-thermal methods, hot air sterilization, autoclaving, gaseous, radiation, sterilization by filtration (method of packaging and equipment to be used should also be covered)
   Bio-burden and microbial spoilage of pharmaceutical products: sterilization Monitors (physical, chemical and biological indicators), sensitivity of microorganisms, survivor curves, expression of resistance (D-values and Z-values), sterility test. Applications of autoclaving in hospitals, microbial contamination in pharmaceutical preparations, microbial limit test and microbial
   challenge test for vaccines.
   Disinfection and Sanitization: Definition of antiseptic, preservative and sanitization with Examples, Chemical classification. Factors affecting disinfectant efficacy. Evaluation of disinfectants by RW coefficient, Kelsey-Syke's test.

5. **Fundamentals of Immunology**
   Definition of Pathogen, Virulence, Attenuation, Exaltation, Antigen, Antibody. Detail Mechanism of Cell Mediated Immunity and Humoral Immunity.

Reference books

1. Tortora, An introduction to microbiology, 9th edition Pearson publication
2. General Microbiology by Powar and Daginawala, Himalaya publications
3. Prescoot, Harley and Kleins, Microbiology 2nd edition, W C Brown Publisher 1993.
4. Pharmaceutical Microbiology- Hugo and Rusell, Sixth Edition Blackwell Science.
5. Tutorial Pharmacy by Cooper and Gunn, CBS Publications
6. General Microbiology by Pelczar and Rid
7. A textbook of Microbiology by Ananatnarayanan, Jayram Panikar.

2.4.8 Microbiology (Practical)

1. To study the principle and working of laboratory equipments like microscope, autoclave, hot air oven, BOD incubator, Laminar air flow, centrifuge and apparatus like filtration assembly, inoculating loop, Glass spreaders, petri plates.
2. Preparation and sterilization of nutrient broth, nutrient agar, slants, stabs and plates.
3. To study different techniques of inoculation of cultures.
4. Isolation of pure culture by streak plate & isolation of pure culture by pour plate technique.
5. Study of Aspergillus, Penicillium and Candida species with respect to morphology (wet mount technique).
6. Observation of motility of bacteria by hanging drop technique.
7. Identification of isolated bacteria by simple, negative, Gram and spore staining
8. Study of Antibiotic sensitivity test by multi disc method or cup plate method.
9. Microbial study of water by IMViC and carbohydrate fermentation.
10. MIC
11. Sterility testing of Pharmaceuticals.

Reference books

1. Baird, R.M., et al. (eds.), (2000). Handbook of Microbiological Quality Control
2. Pharmaceutical and Medical Devices. Taylor and Francis Inc., London.
3. Cappuccino, J. G. and Sherman N., (1992). Microbiology- A Laboratory Manual, Third Edition, The Benjamin / Cumming Publishing Company.
4. Kokare C. R. (2007). Pharmaceutical Microbiology-Experiments and techniques, Second Edition, Career Publications, Nashik, India
5. Carter S. J., (1996). Copper and Gunn's Tutorial Pharmacy, CBS Publishers and Distributors, Delhi.
6. Collee J. G. et al, (1996). Mackey and McCartney Practical Medical Microbiology, Fourteenth Edition, Churchill Livingstone Publications, New York.
7. Hugo W. B. and Russell A. D., (1998). Pharmaceutical Microbiology, Sixth Edition, Blackwell Science.
8. Indian Pharmacopoeia, (1996 & 2007). Govt. of India, Ministry of Health and Family Welfare
9. Rawlins E. A., (eds.), (1992). Bentley's textbook of Pharmaceutics, Eighth Edition, Bailliere Tindall, London.

2.4.3 Organic Chemistry-III (Theory)

1. **Stereochemistry**
   Isomerism and its types. Definition of configuration, conformation
   Geometrical Isomerism: cis-trans, E-Z nomenclature, physical and chemical methods for determining the configuration of geometrical isomers.
   Optical Isomerism: Definition of dextrorotatory, laevorotatory, enantiomers, chirality and diastereomer. Representations of a chiral centre: Dotted-Line-wedge, Fischer formula, Saw horse and Newman projection formula. D/L and R/S nomenclature for one and two chiral centres. Resolution of racemic mixture
   Conformational Isomerism: Potential energy for ethane and n-butane. Conformations and stability of cyclohexane, 1-methylcyclohexane and 1,2-dimethycyclohexane.

2. **Stereoselectivity and stereospecificity**
   Definition, Stereochemistry of SN_l, SN_2 and SN_i reactions
   syn and anti elimination: E_1, E_2, E_{1cb} eliminations, pyrolysis of esters, Chugave elimination (Tschuzaeff), Cope elimination
   syn and anti addition: catalytic hydrogenation, halogenation, hydroxylation, hydroboration of alkenes.

3. **Molecular Rearrangements**
   Definition, mechanism, applications and stereochemistry*
   Rearrangement of electron deficient system (Nucleophilic rearrangement): General theory, Whitmore-1,2-shift, Wagner-Meerwein rearrangement,Wolff rearrangement, Lossen rearrangement, Curtius rearrangement, Schmidt rearrangement, Baeyer-Villiger oxidation*
   Rearrangement of Electron-rich system (electrophilic rearrangement): Wittig rearrangement, Neber reaction, Dakin oxidation, Favourskii rearrangement*
   Migration of aromatic rings (aromatic rearrangement): Fries rearrangement, Claisen rearrangement, Willgerodt rearrangement.
   Free radical rearrangement: Decarbonylation of β- phenyl isovaleraldehyde**.**

4. **Pericyclic reactions**
   Electrocyclic reaction, Cycloaddition reaction & Sigmatropic rearrangement reaction.

Reference books

1. Advanced Organic Chemistry by Jerry March, John Wiley & Sons.
2. Fundamentals of Organic Chemistry by I. L. Finar (Vol. 1&2) ,ELBS.
3. Advanced Organic Chemistry by Bahl & Bahl, S.Chand & Company Ltd, New Delhi.
4. Advanced Organic Chemistry by Solomans
5. Reactions, Mechanisms and Reagents by G. R. Chatwal
6. Organic Chemistry by M. K. Jain
7. A guide book to reaction mechanisms in Organic Chemistry by Peter Sykes
8. Organic Chemistry by Pine
9. Organic Chemistry by Morrison and Boyd, LPE.
10. Advanced general organic chemistry, A modern approach, Part I & II by S. K. Gosh, NCBA.

11. Organic Chemistry, By S. M. Mukherhji, S. P. Singh, R. P. Kapoor, Vol I-III, New age international (P) Ltd, Publishers.
12. Photochemistry & Pericyclic reaction By Jagdamba Singh, Jaya Singh, New age international (P) Ltd, Publishers.
13. Stereochemistry of carbon compounds by Eliel E.L., Tata McGraw Hill Publications, Co. Ltd, New Delhi.
14. Stereochemistry of Organic compounds By D. Nasipuri, New age international (P) Ltd, Publishers.
15. Stereochemistry Conformation and mechanism By P. S. Kalsi, New age international (P) Ltd, Publishers.
16. Reaction Mechanism in Oraganic Chemisty By S. R. Mukherhi, S. P. Singh, Macmillan India Ltd.

2.4.9 Organic Chemistry-III (Practical)

A. Synthesis based on

1. Benzilic acid rearrangement
2. Beckmann rearrangement
3. Hofmann rearrangement
4. Sandmayer reaction
5. Benzidine rearrangement
6. Pinacol rearrangement

B. Determination of configuration of maleic and fumaric acid geometrical isomers by cyclisation.

C. Separation and identification of binary mixture (water soluble, water insoluble amphoteric, eutectic & liquid-liquid mixtures).

D. Building geometrical, optical, & conformational isomers using molecular model set or virtual molecular modeling kit.

Reference books

1. Vogel's text book of Practical Organic Chemistry by B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell
2. Elementary Practical Organic Chemistry, small scale preparations, 6th edition, Arthur I. Vogel
3. Practical Organic Chemistry by F. G. Mann & B. C. Saunders
4. Practical in Organic & Medicinal Chemistry by Dr. Ramesh Goyal, Hardik Bhatt, Bhoomika R. Goyal

2.4.4 Pharmaceutical Analysis-II (Theory)

1. **Complexometric Titration**
   Theory, chelating agents, detection of endpoint, Metallochrome indicators: Erichrome Black T, Calcon, Mordant Blue III, Catechol Violet, Murexide, Xylenol orange (No chemical structure) Masking and Demasking agents. Preparation and standardization of 0.05M EDTA, assay of magnesium sulphate.

2. **Non-aqueous titration**
   Theory, aprotic, protogenic, protophillic and amphiprotic solvents. Preparation and standardisation of 0.1 N Perchloric acid, assay of mebendazole powder IP, norfloxacin powder IP, salbutamol sulphate powder IP.

3. **Sodium Nitrite titrations**
   Theory, Preparation and standardisation of 0.1M $NaNO_2$, Assay of sulphanilamide.

4. **Gravimetric analysis**
   Theory, steps involved in gravimetric analysis. Assay of Sodium Sulphate, Assay of Zinc sulphate.

5. **Radio Immuno Assay (RIA) & related immuno assay techniques.**

6. **Raw material Analysis**
   Introduction, Sampling of solid, liquid and gases**.** RMA of Paracetamol, Starch.

7. **Karl Fischer method**
   Theory, preparation & standardization of Karl-fischer reagent

8. **Miscellaneous methods of analysis**
   Kjeldahl's, gasometry, oxygen flask combustion method.

Reference books

1. Pharmaceutical analysis Volume I & II by Ashutosh Kar.
2. Pharmaceutical analysis by P.C. Kamboj.
3. Pharmaceutical analysis, Volume I by Dr. A. V. Kasture & S. G. Wadodkar- Nirali Prakashan.
4. Vogel's Text book of Practical organic chemistry- 6th edition.
5. Practical Pharmaceutical Chemistry, part I & II by Beckett & Stenlake.
6. Inorganic Pharmaceutical chemistry by Tipnis & Dhake.
7. Analytical chemistry by Gary Chrstian
8. Pharmaceutical Analysis by David G. Watson.
9. Basic concepts of Analytical Chemistry S. M. Khopkar.

2.4.10 Pharmaceutical Analysis-II (Practicals)

1. Preparation & standardization of 0.05 M disodium EDTA.
2. Assay of Calcium gluconate powder IP, Magnesium sulphate IP or Magnesium carbonate IP(light or heavy)
3. Preparation & standardization of 0.1 M $HClO_4$
4. Assay of Salbutamol sulphate powder IP or Norfloxacin powder IP.
5. Preparation & standardization of 0.1 M sodium nitrite IP.
6. Assay of sulpha drug(s).
7. Assay of Zinc sulphate by gravimetry
8. Raw material analysis of Starch IP, Paracetamol IP
9. Standardization of Karl-fischer reagent.
10. Determination of moisture by Karl-fischer method.
11. Determination of hardness of water.
12. Water chemistry analyses.

Reference books

1. Indian Pharmacopoeia.
2. Practical pharmaceutical chemistry, A. H.Beckett, J. B.Stenlake
3. Laboratory handbook of Instrumental Drug analysis by B. G. Nagavi.
4. Vogel's Textbook of quantitative chemical analysis by G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney.
5. Pharmaceutical analysis –I (practical) by Mrs. Sonali Sheorey, Ms Meera Honrao

2.4.5 Pathophysiology & Clinical Biochemistry-II (Theory)

1. **Cardiovascular system**
   Electrophysiology of Heart, Cardiac arryhythmogenesis. Heart Failure-Types of heart failure, Pathophysiology and clinical manifestations of congestive heart failure. Ischemia: Process & consequences of coronary atherosclerosis, Angina Pectoris-Types of Angina Pectoris. Pathophysiology of Hypertension and shock.

2. **Disorder of Respiration**
   Chronic Obstructive Pulmonary Disease, Asthma, Diffuse Interstitial lung disease, Acute Respiratory Failure, Pneumonia, and Pulmonary Embolism.

3. **Central Nervous System**
   Pathophysiology of Epilepsy, Parkinson's and Alzheimer's disease. Psychosis, Neurosis, Schizophrenia and Depression.

4. **Endocrine System**
   Pathophysiology of Diabetes Mellitus, Hypo and Hyperthyroidism & AIDS.

5. **Disorder of Immune system**
   Hypersensitivity reactions, Rheumatoid Arthritis, Myasthenia gravis.

6 **Clinical Biochemistry**
   Interpretation of biochemical data: Diagnostic, prognostic and screening tests, Normal and abnormal range. Concept of core biochemical tests like renal function tests (RFT), Liver function tests (LFT), Thyroid function tests (TFT).
   Enzymology: Enzyme pattern in health and diseases with special reference to plasma lipase, amylase, cholinesterase, SGOT, SGPT, LDH and CPK. Analytical, diagnostic and therapeutic uses of enzymes.

Reference books

1. Textbook of Pathology by Harsh Mohan, Jaypee brothers, Medical Publishers (P) Ltd, New Delhi.
2. Pathologic Basis of disease by Robbins and Cotran, Elsevier, Philadelphia.
3. Textbook of medical Physiology by Guyton and Hall, Elsevier, Philadelphia.
4. Pathophysiology by Carol Mattson Porth, Lippincott, New York.
5. Physiology : V. D. Joshi
6. Human Physiology by C. C Chatterjee, Medical allied Agencies, Kolkatta.

2.4.11 Pathophysiology & Clinical Biochemistry-II (Practicals)

1. Biochemical analysis of blood: Colorimetric estimation of
   Blood Glucose,
   Urea,
   Uric acid
   Total protein,
   Cholesterol,
   Creatinine,
   Bilirubin.
2. Measurement of glucose by glucometer.
3. Study of Histopathological slides of CVS, Respiratory, Nervous, Reproductive and Endocrine Disorders.
4. Serum enzyme analysis AST, ALT, ALP (Demo / Kit Method).
5. Estimation of SGOT, SGPT. (Demo / Kit Method).
6. Visit to Pathological Lab.
7. Study of Pathological Reports: Case studies.

Reference books

1. Manual of clinical Lab procedure for non-Routine problems: S.Winsten
2. Clinical lab methods: John D
3. T.B of clinical Medical biochemistry and immunology: Dr. S. Ramakrishnan, Dr. Raji Swami
4. Handbook of Medical laboratory Technology by V. H. Talib, CBS Publishers and Distributors, New Delhi.
5. Handbook of Experimental Physiology and biochemistry: Dr P. V. Chadha
6. Medical Laboratory Technology: Kinari L. Mukherjee
7. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi.
8. Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana .
9. Practical biochemistry, R. C. Guptha, S. Bhargava, CBS publishers, New Delhi.
10. Biochemical Methods by Sadasivam & Manickam (1996) New Age International (P) Ltd.
11. A Handbook of Practical and Clinical Immunology 2nd Ed, G. P. Talwar and S. K. Gupta (eds) (2005) Publishers: CBS Publishers and distributors.