

# M.Sc. Pharmaceutical Chemistry

## Semester-I

Course code	Course Title	Credits
PHA-711	Pharmaceutical Engineering –I	3(3-0-0)
PHA-712	General Pharmacology	3(3-0-0)
PHA-713	Organic Chemistry	3(3-0-0)
PHA-714	Physical chemistry	3(3-0-0)
PHA-715	Biophysical chemistry	3(3-0-0)
PHA-716	Organic chemistry Practical	2(0-0-4)
PHA-717	Physical chemistry Practical	2(0-0-4)
	<b>Total Credits</b>	<b>19</b>

## Semester II

Course code	Course Title	Credits
PHA- 721	Pharmaceutical Engineering-II	3(3-0-0)
PHA- 722	Organic Synthesis	3(3-0-0)
PHA- 723	Inorganic Chemistry	3(3-0-0)
PHA- 724	Biochemistry	3(3-0-0)
PHA- 725	Biostatistics	3(3-0-0)
PHA- 726	Pharmaceutical Engineering Practical	2(0-0-4)
PHA- 727	Inorganic chemistry Practical	2(0-0-4)
PHA- 728	Biochemistry Practical	2(0-0-4)
	<b>Total Credits</b>	<b>21</b>

### Semester III

Course code	Course Title	Credits
PHA-831	Medicinal chemistry-I	3(3-0-0)
PHA-832	Medicinal chemistry-II	3(3-0-0)
PHA-833	Physical Pharmacy	3(3-0-0)
PHA-834	Pharmaceutical Analysis	3(3-0-0)
PHA-835	Pollution control and waste treatment	3(3-0-0)
PHA-836	Pharmaceutical Analysis Practical	2(0-0-4)
PHA-837	Drug Synthesis and Natural Product extraction Practical	2(0-0-4)
PHA-838	Summer Placement report	NG
	<b>Total Credits</b>	<b>19</b>

\*No Grading Marked as Satisfactory/ Sot Satisfactory

### Semester IV

Course code	Course Title	Credits
PHA-841	Pharmaceutical Technology	3(3-0-0)
PHA-842	Medicinal Chemistry-III	3(3-0-0)
PHA-843	Drug design and Drug Development	3(3-0-0)
PHA-844	Pharmaceutical Technology Practical	2(0-0-4)
PHA-845	Project Report	4*(0-0-8)
	<b>Total Credits</b>	<b>15</b>

\* No- Grading; marked as Satisfactory/ Not-Satisfactory

## SEMESTER-I

**Pharmaceutical Engineering-I PHA-711**

**Credits: 3**

1. **Flow of Fluids** : Types of flow, Reynolds Number, Velocity distribution in pipes.

Viscosity and its units. Bernoulli's equation, concept of friction, friction factor, friction loss due to sudden enlargement and sudden contraction.

2. **Transportation of Fluids** : Different types of pumps; Positive Displacement Pumps,

Reciprocating pump, Rotary Pumps, Centrifugal Pumps, Suction Head and Net Positive Suction Head, blowers and valves. Flow meters; orificemeter venturimeter, pitot tube, Rotameter.

3. **Heat Transfer** : Modes of Heat Transfer, Conduction, Convection & Radiation, Heat Transfer by Conduction, Thermal Resistance in series under steady state conditions, Conduction through thick walled tube. Conduction through a sphere. Heat Transfer by convection. Natural Convection, Forced Convection, Heat Transfer Equipment, Heat Exchanger shell and Tube Heat Exchanger, Plate Type Heat Exchanger

4. **Mass Transfer** : Introduction, Fick's Law, mass transfer in binary mixtures through a stationary gas, diffusion in liquids, mass transfer across a phase boundary, two film theory.

5. **Measuring Instruments**

(a) **Temperature Measurements** : Solid rod thermometer, Bimetallic thermometer, Electric resistance thermometer, thermo electric sensors (Thermo couple).

(b) **Viscosity Measurement** : Capillary tube viscometer, Efflux type viscometer, rotating concentric cylinder viscometer, variable area viscometer.

(c) **Specific gravity & Density measurement**: Bubbler system, hydrometer method, total immersed float method, Nuclear absorption method, Fixed volume method.

(d) **Liquid Level Measurement**: Dip stick method, Sight glass method, Hook Gauge, Float gauge.

(e) **Pressure Measurements**: Liquid column manometers, Elastic element pressure measurement devices, Pressure transducers.

6. **Crystallization** : Growth and Properties of Crystals, Saturation, Nucleation, Crystallization rate, Fractional Crystallization, types of crystallizers.

7. **Mixing and Homogenisation** : Fluid mixing mechanisms and equipment, their

classification and feasibility of selection based upon Reynolds, Froude and power numbers; Equipment for solid mixing. Study of following mixers; planetary mixer, agitator, triple roller mill, propellor mixer, Pharmaceutical applications of Mixing.

**Books Recommended :**

1. McCabe W.L., Smith J.C., Unit Operations of Chemical Engineering, Fifth Edition, McGraw Hill International Edition New York.
2. Coulson J.M., Richardson J.F., Chemical Engineering, Volume 1 & 4, Fifth edition, Pergamon Press, New York.
3. Peter Max, Elementary Chemical Engineering, Second Edition.
4. Nakra B.C. and Chaudhry K.K., Instrumentation Measurement and Analysis,  
Tata McGraw Hill, New Delhi.

**General Pharmacology PHA-712**

**Credits : 3**

1. Introduction of Human Physiology in relation to drug action, Sources and nature of drugs, routes of administration, factors influencing doses and drug actions.
2. **Pharmacokinetics** : Absorption, distribution, metabolism and excretion of drugs.
3. **Pharmacodynamics** : Mechanism of drug action and sites of drug action including membrane and receptor concepts.
4. Classification of drugs acting on following systems and the pharmacology of prototype drugs with respect to pathophysiology of concerned system.
  - i. **Central nervous system** : General anaesthetics, methods of giving anaesthesia, stages of anaesthesia, narcotic analgesics, sedatives & hypnotics, barbiturate poisoning and treatment.
  - ii. **Autonomic Nervous System** : Cholinergic drugs, adrenergic drugs, Drugs used

in myasthenia gravis.

iii. **Gastrointestinal Tract** : Antacids, laxatives and antidiarrhoeals.

iv. **Cardiovascular** : Anti-anginals and antihypertensive drugs.

v. **Respiratory system** : Anti-asthmatic agents, expectorants and antitussive agents.

vi. **Kidneys** : Diuretics and antidiuretics.

vii. **Blood** : Haematinics, coagulants and anti-coagulants

viii. **Chemotherapy** : Sulphonamides (General Pharmacology, mechanism of action)

and penicillins, B-lactam antibiotics.

#### **BOOKS RECOMMENDED :**

1. Pharmacology by P.C. Dandya and S.K. Kulkarni, Vallabh Prakashan, New Delhi. edition 2001.

2. Textbook of Pharmacology by K.D. Tripathi. edition 2002.

3. Experimental Pharmacology by S.K. Kulkarni, Vallabh Prakashan, New Delhi edition 1997.

#### **SUGGESTED READINGS**

1. The Pharmacological basis of therapeutics by Gillman and Goodman, 8th Ed.

2. B.G. Katzung Basic Clinical Pharmacology Lange Medical Publication, 1995.

### **Organic Chemistry PHA-713**

**Credits : 3**

**1. Conformation and Reactivity** : Conformation of acyclic molecules. Conformations of cyclic molecules. Stereocontrol in acyclic system, Stereocontrol in cyclic systems. Neighbouring group and chelation effects. Acyclic stereocontrol via cyclic precursors, Ring forming reactions and stereochemical influences.

#### **2. Selective Organic Name Reactions :**

Aldol, Perkin, Stobbe, Dieckmann condensations; Hoffmann, Schmidt, Lossen, Curtius,, Reimer-Tiemann, Reformatsky and Grignard reactions. Friedel-Crafts reactions ; Hydroboration, Oppenauer oxidation, Clemmensen, Wolff-Kishner, Meerwein-Ponndorf-Verley and Birch reductions. Stork enamine reactions. Michael addition, Mannich reaction Sharpless asymmetric epoxidation. Ene reaction, Barton reaction, Hofmann-Löffler-Freytag reaction, Shapiro reaction, Chichibabin reaction, Beckmann and Fries rearrangements, Claisen rearrangement, Favorski rearrangement, benzylic acid

rearrangement, Baeyer- Villiger reaction, Pinnacol rearrangement, dienone-phenol rearrangement.

**3. Chemistry of Heterocyclic Compounds:** Nomenclature of heterocyclic compounds. Heterocyclic ring system with one heteroatom: structure, synthesis and reactions of aziridine, azirines, oxiranes, thiranes, pyrrole, furan, thiophene,  $\beta$ -lactam and pyridine.

Heterocyclic ring system with two heteroatom: structure, synthesis and reactions of imidazole, oxazole, thiazole, pyrazole, pyrimidine and pyrazine.

Heterocyclic ring system with three heteroatom: structure, synthesis and reactions of triazole, triazines.

Fused Heterocyclic systems up to two heteroatom: chemistry and reactions of quinolines, isoquinolines, quinazoline, cinnoline, quinoxaline.

## **Organic chemistry Practicals PHA-716**

**Credit-2**

1. Synthesis of Simple Organic Compounds in one examples of :

Acetylation reaction, Nucleophilic substitution reaction, Esterification reaction, Oxidation reaction, Grignard reaction, Borohydride reduction, Friedel-crafts acylation reaction, Diazotization reaction, Benzoin condensation and Chromatographic separation of an isomeric mixtures.

2. Separation of a simple mixture of organic compounds and identification of their components.

### **Books Recommended :**

1. Jerry-March, Advanced Organic Chemistry, IV th edition, 1992, Willey Eastern limited.
2. Reactive Intermediates by C.W. Rees.
3. Organic Chemistry by Clayden, Greeves, Warren and Wothers., Oxford Press Edt 2001.
4. Reaction Mechanism in Organic Chemistry by S.M. Mukherji & S.P. Singh, New Age International, edition 2001.
5. Organic Synthesis by Michael B. Smith, McGraw-Hill International Editions, 1994.

6. Organic Chemistry by Solomon, 7th Ed. Wiley Student Edition, 2002.
7. Modern Synthetic Reactions by Herbert O. House, W.A. Benjamin Inc., Second Edition, 1972.
8. Aspects of Organic Photochemistry by William Horspool.
9. Organic Chemistry, Vol. 1, Vol. 2, I.I. Finar 6th edition ELBS Longman Publication, 1995.

## **Physical Chemistry PHA-714**

**Credits : 3**

**A. Chemical and Statistical Thermodynamics :** Brief review of laws of thermodynamics, Concepts of free energy, entropy, fugacity and activity. Partial molar properties and their determination. Thermodynamics of ideal and non ideal mixtures, dilute solutions, excess functions. Activity coefficients of electrolytes, mean ionic activity coefficient, Debye Huckle treatment of dilute

electrolyte solutions. Probability, ensembles, distribution law, Partition functions: translational, rotational, vibrational and electronic partition functions, Maxwell-Boltzmann, Bose-Einstein and Fermi Dirac Statistics, calculation of thermodynamic functions and equilibrium constants from partition functions, theories of specific heat for solids, Numerical Problems.

**B. Phase Rule :** Recapitulation of thermodynamic derivation of Phase rule, Two component systems, determination of solid liquid equilibria, Classification of two component systems with one example each. Three Component systems, method of graphical representation. Partially miscible, three-liquid systems with examples. (i) One Partially miscible pair, (ii) Two Partially miscible pairs (iii) Three

partially miscible pairs. Effect of temperature. Rochelle's salt (explanation). Systems composed of two salts and water and their application in crystallization of pure components.

**C. Chemical Kinetics :** Recapitulation of first, second and third order rate laws opposing reactions, parallel reactions, consecutive reactions. Photochemical reactions, quantum yield, transfer of excitation energy, actinometry, chain reactions, and oscillator reactions. Theories of reaction rates : Molecular collision theory, Unimolecular Theory, Transition state Theory, Comparison of

results with Eyring and Arrhenius equations. Reactions in solutions: Kinetics in solution, salt effects, influence of the solvent. Fast reactions - Rate constants of fast reactions. Relaxation methods, temperature-jump method. Stopped-flow technique, flash photolysis and magnetic resonance method. (Numerical Problems).

**D. Surface Chemistry and Catalysis :** Pressure difference across a curved phase boundary. Enhanced vapour pressure of small droplets (Kelvin Equation). Gibbs adsorption equation. Homogenous catalysis, Acid-base catalysis as well as general acid-base catalysis, Surface catalysis, Salient features of Langmuir, Freundlich, Sloggin-Frumkin (Temkin). B.E.T. (its derivation), Harkins-Jura equations of sorption. Mechanism of surface reactions.

### **Physical Chemistry Practical PHA-717**

**credits: 2**

1. Determination of total hardness, total alkalinity and chloride content of water.
2. Distribution of solute between two immiscible solvents.
3. Kinetics of hydrolysis of an ester and comparison of relative strength of two acids.
4. To determine the rate constant of a reaction between ethyle acetate and caustic soda solution at two different temperatures and energy of activation.
5. Study the effect of catalyst on the decomposition of hydrogen peroxide.
6. Study the phase diagram of Naphthalene and Benzoic acid.
7. Determination of consolute points (Upper or Lower or both).
8. Construct a phase diagram of 3-component system.
9. Heat of solution by solubility method.
10. Determination of CMC of a surface active agent.
11. Estimation of glucose and Ascorbic acid.
12. Study of adsorption of organic compounds on charcoal.

**Note : Any other experiment(s) may be included in support of the theoretical aspects of the course.**

### **Biophysical Chemistry PHA-715**

**Credits : 3**

1. **Water:** Structure and Interactions, Water as a solvent, proton mobility.
2. **Biophysical Interactions:** Intermolecular interactions effecting conformation of biomolecules; non-covalent interactions e.g., ionic bonds, dipole-dipole interactions, hydrophobic interactions, hydrogen bonds, dispersion forces etc.
3. **Bioenergetics:** Standard free energy change in biochemical reactions, exergonic,

endergonic. Hydrolysis of ATP, synthesis of ATP from ADP.

4. **Statistical Mechanics in Biopolymers:** Chain configuration of macromolecules, statistical distribution end to end dimensions, calculation of average dimensions for various chain structures. Polypeptides and proteins structures, Introduction to protein folding problem.

5. **Thermodynamics of Biopolymer Solutions:** Thermodynamics of biopolymer solutions, osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanochemical system.

6. **Cell Membrane and Transport of Ions:** Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport. Nerve conduction.

7. **Experimental Techniques for the Determination of Size, Shape and Molecular Mass of Biopolymers:**

i). **Viscosity:** Measurement, relation to geometry and correlation with hydrodynamic properties.

ii). **Diffusion:** Fick's law of diffusion, diffusion coefficient and its interpretation, frictional coefficient.

iii). **Ultra centrifugation:** Svedberg equation, sedimentation equilibrium, density gradient sedimentation.

iv). **Electrophoresis:** General Principles, Double layer Techniques Moving Boundary Electrophoresis, Zonal Electrophoresis, Isoelectric Focusing.

v). **Osmotic Pressure:** Second virial coefficient, molecular mass and geometry from O.P. data, Donnan membrane effect, Drug absorption.

vi). **Optical Properties of Biomacromolecules:** Light scattering, Fundamental concepts, Rayleigh scattering, Scattering by larger particles.

vii). **Solubility of Biomolecules:** As solutions of polyelectrolytes, Debye-Huckel

theory, Applications to proteins purification.

viii). **Stability of Biomolecules in Solutions:** Denaturation, Method of Stabilization.

ix). Micells, Reverse micelles and liquid membranes-conformation and bioprocess applications.

**Books Recommended:**

1. Physical Chemistry and its Biological Applications by W.S. Brey , Academic Press (1978).

2. Physical Biochemistry by K.E. Van Holde.

3. Physical Chemistry: Principles and Applications in Biological Sciences. By Tinoco I., Jr., Saver, K. and Wang, J.C., Prentice-Hall.

3. Biochemistry by L. Stryer, GBS Publishers and Distributors, Second Edition, 1972.  
Chapters: 2, 3, 4, 6, 7, 8,11, 12, 13, 24, 25, 26, 27, 33 and 36.

4. Biochemistry by D. Voet and J.G. Voet, John Wiley & Sons, Ist Edition 1995.  
Chapter: 1, 2, 3, 4, 5, 6, 7, 9, 12, 13, 14, 15, 16, 18, 19, 27, 28, 29, 30 and 34.

5. Immobilized Enzymes : An introduction and application in Biotechnology by Michael D. Trevan and John Wiley.

**Pharmaceutical Engineering-II PHA-721**

**Credits : 3**

1. **Evaporation :** Selection of Equipment; Types of Evaporators, Heat Transfer Coefficient, Boiling Point rise due to material in Solutions, Duhring's rule, Boiling Point Rise due to Hydrostatic head, Single and Multiple effect evaporators, Calculations, Important factors in Operation of Evaporators.

2. **Filtration :** Introduction, Classification of Filters, Sand Filters, Filter presses, Chamber presses, Plate-and Frame presses, Washing presses, Leaf filters, Rotary continuous filters, Filter aids, Filter auxiliaries, Comparison of filter types, Filtration theory, Laminar flow through beds of granular particles, Limitations of the Kozeny

equation, constant-pressure filtration, constant pressure filtration-correction for filter cloth resistance, Constant-rate filtration, Rotary-drum filters, Washing of filter cakes,

**3. Centrifugation :** Principles of Centrifugation, Advantages, Disadvantages, and use of Perforated Basket centrifuge (centrifugal filter), sedimentation type centrifuges (centrifugal sedimenters) and continuous centrifuges.

Batch top-driven centrifuges, Batch underdriven centrifuges, Continuous centrifuges, Disc type centrifuges.

**4. Leaching and Extraction :** Factors influencing the rate of Extraction, Equipments, Number of Stages for Counter-Current washing, Graphical Methods, Mixing of Liquid Systems, Calculation of the number of theoretical stages in extraction operation (Co-current contact with Partially Miscible Solvent Co-current Contact with Immiscible Solvents, Counter current contact with Partially Miscible Solvents) Extraction Equipments.

**5. Distillation :** Vapour Liquid Equilibrium, Partial Vaporisation and Partial Condensation, Partial Pressures, Dalton's Raoult's and Henry's Laws, relative, Volatility. The methods of Distillation, Two-component mixture, The Fractionating Column, Calculation of number of Plates using the Lewis-Sorrel Method, Calculation of Number of Plates using the McCabe-Thiele method, Theq-line concept, Efficiency of Distillation, overall Plate Efficiency, Feed Plate Efficiency, Azeotropic Distillation, Extractive Distillation, Steam Distillation, Packed Columns; General description, Types of Packings.

**6. Milling :** Objectives of comminution factors affecting size reduction, processes of milling, theory of milling and energy requirements, milling rate and types of milling machines, size distribution, determination of size, microscopy, sieving and sedimentation of particles. Pharmaceutical applications of milling.

**7. Compression and Consolidation of Pharmaceutical Powders :** Definition, angles of repose, Flow rate through tubes and hoppers, mass - volume - force relationship, Granulation properties and strength of granules, compression and consolidation under high loads including study of compaction profiles.

**8. Materials of Pharmaceutical Plant Construction :** Physical and Chemical factors to be considered, various metals and non-metals that can be used for construction their advantages and disadvantages.

***Books Recommended :***

1. A. Martin, Physical Pharmacy, B. I. Waverly Pvt. Ltd., New Delhi (1994).
2. L. Lachman, H.A. Liebermin and J. L. Kaing, Theory and Practice of Industrial Pharmacy, III Eds. Varghese Publishing House, Bombay (1977).

***Suggested Readings :***

1. A. Osol, Ramington's Pharmaceutical Science, XVIII Edition, Mack Publishing Company, Pennsylvania, USA.
2. J. W. Copper and G. Gunn, Tutorial Pharmacy, Kothari Book Depot, Bombay.
3. Badger et. al. , Introduction to Chemical Engineering, McGraw Hill Co. International Student's edition.
4. Davis et. al. Bentley's Text book of Pharmaceutics, Billiere, Tindarr and Co., London.

**Pharmaceutical Engineering Practical :PHA-726      Credits : 2**

**List of Experiments**

1. Verification of Bernaullis theorm.
2. Determination of coefficient of discharge by V-Notch.
3. Determination of coefficient of discharge by orifice meter.
4. To determine the friction factor for given pipe
5. Study of turbulent flow through pipes.

6. Study of Laminar flow.
7. Determination of flow rate using pipot tube.
8. Study of friction-losses in pipe lines, joints and bends.
9. To determine coefficient of contraction (CC), coefficient of velocity (CV) and coefficient of discharge (Cd) for circular / rectangular orifices.
- Determination of heat transfer coefficient under forced convection.
10. To plot log Re vs. Porosity for a fluidized bed.
11. Study of pressure drop through a packed bed.
12. Determination of absolute humidity, relative humidity, dew point, saturated volume and humid heat using psychometric char.
13. To compare efficiencies of simple and differential manometers.
16. To study the effect of viscosity on rate of sedimentation.
17. To study the effect of viscosity on rate of filtration.
18. To verify Darcy's law.

**Note : Any other experiment(s) may be included in support of the theoretical aspects of the course.**

## **Organic Synthesis PHA-722**

**Credits : 3**

1. **Design of Synthesis :** Annelation reaction. Functional group interconversions. Donor acceptor disconnection in the carbon-carbon single bond formation. Retero-analysis. Transforms and retrons, selecting transform. Strategies for reterosynthetic analysis.
2. **Reagents in Organic Synthesis :** Use of following reagents in Organic Synthesis and functional group transformations: Complex metal hydrides, Gilman's reagent, Lithium diisopropyl-amide (LDA), dicyclohexylcarbodiimide, Umpoloung of reactivity (dipole inversions), trimethylsilyl iodide, tri-n-butyltin hydride, Woodward and Prevost hydroxylation, Osmium tetraoxide, selenium dioxide, phase transfer catalysis, Crown ethers, Merifield resin, Peterson's synthesis Wilkinson's catalyst; Bakers Yeast.

**3. Oxidation and Reduction in Organic Synthesis :** Oxidation of alcohols to carbonyl. Phenols to quinones, conversion of alkene to epoxides and diols, Oxidative bond cleavages, Oxidation of sulfur, selenium & nitrogen. Reduction with metal hydrides, Alkoxyaluminates, alkoxy – and alkyl-Borohydrides, Stereoselectivity in hydride reduction. Catalytic hydrogenation and dissolving metal reductions.

**4. Formation of carbon-carbon single bonds :** Ketone enolates, O Vs C alkylation, Enamine and related reactions, Thio and seleno carbanions, Aldol condensation, Allylic alkylations of alkenes. Coupling reactions of Organo copper, Organopalladium and Organonickel complexes, Synthetic applications of carbenes and carbenoids.

**5. Application of cycloadditions in organic synthesis :** Selection rules for cycloaddition [(2+2), (3+2), (4+2), (6+4)]. The Dienes, Heterdienes, Dienophiles and 1,3-Dipoles. Lewis Acid Catalysis, Modern methods to affect cycloadditions (use of high pressure, aqueous medium, ultrasound etc.).

**6. Asymmetric synthesis:** Cram's rule and its variations, Chiral auxiliaries, Chiral Lewis acid catalysis. Asymmetric Reductions. Chiral reagents (Grignards reagent, Organocuprates, organo irons).

**7. Some Classics in Organic Synthesis :** Corey's synthesis of prostaglandins (PGF<sub>2</sub> and PGE<sub>2</sub>). Woodward's Synthesis of Strychnine, synthesis of Progesterone by W.S. Johnson, Synthesis of Reserpine by Woodward, Synthesis of Biotin by Hoffman-LaRoch, Synthesis of Hirsutene and 9 (12)-Capnellene by D.P. Curran. Synthesis of Indolizomycin by Danishefsky. Synthesis of Taxol by K.C. Nicolau, Synthesis of Cholesterol by Woodward.

#### **Books Recommended :**

1. Some Modern methods of Organic Synthesis, IIIrd edition, by W. Carruthers, 1993,
2. Organic Synthesis by M.B. Smith, McGraw International edition, 1994.
3. The Logic of Organic Synthesis by E.J. Corey and X.M. Cheng, John Wiley and Sons, 1989.
4. Modern Synthetic Reactions by Herbert O. House, W.A. Benjamin Inc., Second Edition, 1972.

### **Suggested Readings :**

1. Classics in Total synthesis, by K.C. Nicolau and E.J. Sorensen, VCH, 1996.
2. Cycloadditions in Organic Synthesis, W. Carruthers, Pergamon Press, 1990.

### **Inorganic Chemistry PHA-723**

**Credits : 3**

1. **Symmetry:** Molecular symmetry, Representation of symmetry operations as matrices, set of symmetry operations of molecules satisfying the conditions of point groups, multiplication tables.

#### **2. Theory of Chemical Bonding :**

a) **Valence Bond Theory :** Concepts of VB theory. Hybridization (sp, sp<sup>2</sup>, sp<sup>3</sup>, dsp<sup>2</sup>, sp<sup>3</sup>d, dsp<sup>3</sup>, sp<sup>3</sup>d<sup>2</sup>, d<sup>2</sup>sp<sup>3</sup>). Application of V.B theory to simple inorganic molecules and transition metal complexes. Inner and outer orbital complexes.

b) **Molecular Orbital Theory :** A brief introduction to MO method. Resonance integral, energy level diagrams for O<sub>2</sub>, F<sub>2</sub>, CO, CO<sub>2</sub>, PH<sub>3</sub>, BF<sub>3</sub>, NO, NO<sub>2</sub>, NO<sub>3</sub> and H<sub>2</sub>O, Molecular orbital description of tetrahedral and octahedral complexes of transition metals.

c) **Crystal Field Theory :** Splitting of energies of orbitals under octahedral, tetrahedral and square planar environment, magnetic properties of complexes in terms of CFT. Crystal field stabilization energy and heats of ligation, Lattice energy, Terms and Symbols, Selection rules, Hole formulation, electronic spectra of co-ordination complexes. (Orgel diagrams of d<sup>1</sup>-d<sup>9</sup> tetrahedral and Octahedral complexes. Limitation of CFT. Stability of co-ordination complexes and factors effecting the stability. nephelauxetic effect, ligand field theory. Calculation of B and 10Dq from spectral data.

d) **Inorganic rings, chains and cages :**

i. **Chains:** catenation, heterocatenation, isopolyanions and heteropolyanions.

ii. **Rings:** Borazines, phosphazenes, other heterocyclic inorganic ring systems, homocyclic inorganic systems.

iii. **Cages:** cage compounds having phosphorus, oxygen, nitrogen and sulphur: boron cage compounds, Boranes, carboranes and metallocene carboranes.

3. **Transition metal chemistry :** Magnetic moments, Magnetic properties of transition metal complexes. Intra magnetic coupling. Spin State crossovers. Comparison of first transition series with 2<sup>nd</sup> and 3<sup>rd</sup> transition series.

4. **Industrial Applications of Organometallics :** General considerations, homogeneous catalysis by organometallics (Alkene Hydrogenation, Hydroformylation, pi-acid metal complexes, activation of small molecules by coordination).

5. **Introduction to Ligands, Complexes and their Reactivity:**

Thermodynamics stability in aqueous medium, General classification of ligands, Ligand substitution or exchange reaction to 4-coordinate square planar complexes and 6-coordinate octahedral complexes. Redox or electron transfer reactions. Outer and inner sphere mechanisms for multielectron redox reaction and ligand field considerations. Photochemical reaction of chromium and ruthenium complexes. Fluxional molecules iso- and heteropolyacids, metal clusters. Spin crossover in coordination compounds. 5

6. **Bioinorganic Chemistry :** Metal ions in Biology, Molecular mechanism of ion transport across membranes; ionophores. Photosynthesis, PSL, PSH; nitrogen fixation, oxygen uptake proteins, cytochromes and ferredoxins. Iron-sulphur

proteins.

**Books Recommended :**

- 1 R.S. Drago, Physical Methods in inorganic Chemistry, Affiliated East-West Press (Section 1 & 2).
2. H.B. Gray, Electrons and Chemical Bonding. (Section 2).
3. F.A. Cotton and G.W. Wilkinson, Advanced Inorganic Chemistry. John Wiley and Sons.
4. J.E. Huheay, Inorganic Chemistry, Principles of Structure and Reactivity, Harper International, SI edition.
5. G. Wilkinson (ed.) Comprehensive coordination chemistry vol. 3 chapter 23, Pergamon.
6. N.N. Greenwood and A. Earnshaw Chemistry of elements, Pergamon Press (Section 7).
7. Christopher master, Homogenous Transition metal catalysis (Section 8).
8. A.B.P. Lever : Inorganic Electronic Spectroscopy.
9. B.N. Figgis : Introduction to Ligand Fields.

**Inorganic Chemistry Practical PHA-727**

**Credits:2**

**Suggested Experiments**

1. Analysis of two cation system using complexations.
2. Colorimetric estimation of cations/anions.
3. Ion exchange: Separation of inorganic cations/anions (2 or 3 components).
4. Chromatographic Separation.
5. Preparation their purification, elemental analysis. M.W. determination and elucidation of the structures by available physical method(s).
  - i. Preparation of  $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$ ,  $[\text{Co}(\text{NH}_3)_5\text{NO}_2]\text{Cl}_2$ ;  $[\text{Co}(\text{NH}_3)_5\text{ONO}]\text{Cl}_2$
  - ii. Preparation of  $\text{trans}[(\text{Co}(\text{en})_2\text{Cl}_2)\text{Cl}]$ .

- iii. Preparation of dichlorobis(ethylenediamine)Co(III) chloride.
- iv.  $\text{Na}_2[\text{Fe}(\text{CN})_5\text{NH}_3]\text{H}_2\text{O}$
- v.  $\text{Na}_2[\text{Fe}(\text{CN})_5\text{H}_2\text{O}]$
- vi.  $\text{K}_2[\text{Co}(\text{CN})_5\text{H}_2\text{O}]$
- vii.  $\text{Cu}_2(\text{CH}_3\text{COO})_4(\text{H}_2\text{O})_2$  or  $\text{Zn}_4\text{O}(\text{ac})_2$
- viii. Preparation of chloropentaamminecobalt (III) chloride and its conversion into nitro and nitrito isomers.
- ix. Preparation of mercury tetrakisothiocyanatocobaltate (II)  $\text{HgCo}(\text{NCS})_4$ .
- x. Preparation and resolution of tris(ethylenediamine) cobalt(III) ion. Measurement of optical rotation of these resolved complexes.

**Note : Any other experiment (s) may be included in support of the theoretical aspects of the course.**

## **Biochemistry PHA-724**

**Credits : 3**

**1. Bimolecules :** Broad classification and role of bimolecules. **2**

**2. Amino Acids and Proteins :** Structural and functional classification of proteins. Structure, Physicochemical properties, configuration and optional properties of amino acids. Colour reactions of Proteins and Amino acids, Purification of proteins and Amino acid sequence determination, Peptide bond. Ramachandran Plot. Primary, Secondary Tertiary and quaternary structure of Proteins. Three dimensional structure of proteins, Structure and functioning of Hemoglobin.

**3. Enzymes :** Classification, Mechanism of enzymatic reactions, kinetics of enzymatic reactions, Michaelis Menton model, Measurement of significance of  $K_m$  and  $V_{max}$  perfect enzymes. Inhibition of enzymatic reactions. Kinetics

of competitive and non-competitive Inhibition. Allosteric enzymes Mechanism of enzymatic catalysis by Lysozyme and carboxypeptidase. Zymogens.

**4. Coenzymes :** Classification, Structure and Function of Nicotinamide adenine dinucleotides (NAD and NADP), Riboflavin Nucleotides (FMN and FAD), Lipoic acid, Cytochromes, Pyridoxal phosphate, Nucleoside diphosphates. Tetrahydrofolic acid conjugates, Biotinyl conenzyme. Conenzyme - A, and Thiamine pyrophosphate.

**5. Biotechnological Application of Enzymes :** Large scale production and purification of enzymes, techniques and method of immobilization of enzymes, effect of immobilization on enzyme activity, Application of immobilized enzymes, use of enzymes as targets for drug design. Clinical uses of enzymes, enzyme therapy, enzymes and recombinant DNA technology. 9

**6. Carbohydrates and Metabolism :** Configuration and chemical Transformations of Carbohydrates. Absolute configuration of carbohydrates. General concepts, energetics and control on metabolic pathways. Glycolysis and Citric acid cycle. 7

**7. Genetic Code,** nucleic acids as carrier of genetic information. Structure of DNA, Replication of DNA. Protein biosynthesis. 7

**8. Membranes and Membrane Transport :** Membrane structure, phospho and glycolipids, membrane proteins, Sodium potassium pump, Calcium and Sugar transport, Inophorous antibiotics. 7

**Books Recommended :**

1. Biochemistry by L. Stryer, GBS Publishers and Distributors, Second Edition, 1972. Chapters: 2, 3, 4, 6, 7, 8, 11, 12, 13, 24, 25, 26, 27, 33 and 36.
2. Biochemistry by D. Voet and J.G. Voet, John Wiley & Sons, Ist Edition 1995. Chapter: 1, 2, 3, 4, 5, 6, 7, 9, 12, 13, 14, 15, 16, 18, 19, 27, 28, 29, 30 and 34.

## **Biochemistry Practical PHA-728**

**Credits-2**

### **Suggested Experiments**

1. Estimation of glucose in blood.
2. Estimation of liver glycogen.
3. Estimation of proteins in serum.
4. Determination of creatinine and creatin in blood and urine.
5. Estimation of chloride in serum & urine.
6. Estimation of free fatty acids in serum.
7. Estimation of uric acid in serum & urine.
8. Determination of acid & alkaline phosphatase.
9. Determination of SGOT and SGPT in serum.
10. Determination of blood cholesterol.
11. Electrophoretic separation of serum proteins.
12. Fat determination in milk.

## **Biostatistics PHA-728**

**credits-3**

Significant digits bend rounding of numbers, data collection, random and non-random sampling methods, sample size, data organization, diagrammatic representation of data , bar ,pie, 2-D and 3-D diagrams, measures of central tendency, measures of dispersion, Standard Deviation and standard error of means, coefficient of variation, confidence (fiducial) limits, probability and events, Bayes' theorem, probability theorems, probability distribution, elements of binomial and Poisson distribution, normal distribution curve and properties, kurtosis and skewness, correlation and regression analysis, method of least squares, statistical inference, Student's and paired t-test, F-test and elements of ANOVA, applications of statistical concepts in Pharmaceutical Sciences.

## SEMESTER-III

### Medicinal Chemistry-I PHA831

Credits: 3

1. Introduction to Pharmaceuticals, Historical Development, Classification of Drugs, Nomenclature of Pharmaceuticals, Drug metabolism reactions. 2. Structure, stereochemistry, nomenclature, mode of action, specific clinical applications and structure activity relationships of following classes of drugs and synthesis / commercial routes to specified drugs.

**i) Vitamin and Hormones : Hormones :** Sex hormones and related compounds. (Estrogens, Androgens, Progestational agents, Anabolic steroids, Contraceptives), Adrenal cortex hormones, Thyroid

hormones and antithyroid drugs, Pancreatic hormones, Hypothalamus hormones. **Vitamins:** Fat soluble vitamins (A, D, E and K), water soluble vitamins (Folic acid, B12 and C). **Commercial routes to :** Testosterone, cortisone, Progesterone, Vit. A, D, E, K Folic acid and Vit. C. 12

**ii) Cardiovascular drugs:** Vasodilators, Antihypertensive agents, Antihypercholesterolemic drugs, Antiarrhythmic, drugs, Sclerosing agents, Coagulants and anticoagulants, Cardiotonic compounds, Synthetic

hypoglycemic agents. **Commercial Synthetic route to :** Papverine, oxprenolol, atenolol, propranolol, practolol, Nafidipine, Quinidine, Clofibrate, captopril, Diltiazem, Verapamil, clonidine, prazosine, Dipyrindiamole, Pentoxifylline Procainamide, Enalapril, Guanethidine.

**iii) General and Local Anesthetics:** Theories of General Anesthetics, Electronacrosis, Ethers, Halogenerated hydrocarbons, Cyclopropane, Nitrous oxide, Barbiturates, Adjuncts to general anesthetics,

metabolism of volatile anesthetics. **Local anesthetics:** Cocoa alkaloids- Cocaine and Synthetic compounds, Esters, Amides, Miscellaneous anesthetics. Synthesis of Phenobarbital, Allobarbitol, Pentobarbital. Theopental sodium, Midazolam.

**iv) Analgesics and Antitussives:** Morphine and related opioids, Narcotic antagonists, **Synthetic analgesics-Antitussives:** Opium alkaloid, Morphine analogs, Synthetic non-narcotic antitussives, mucolytic

agents. **Commerical routes to :** Meperidine, Methadone dextro-Propoxyphene, Buprinorphine, Pentanorphine, Pentazocine, dextromrthorphane, Bromohexine, Papaverine, Levopropoxyphene, cyclazocine.

**v) Antipyetics and Non-steroidal Anti-inflammatory agents:**

Salicyclic acid derivatives. Indolyl and Arylacetic acid derivatives. Pyrazole derivatives. Aminophenol derivatives, Arylpropionic acid derivatives, Salol Principle, Anti-Gout Drugs. **Commercial Synthetic route to:** Ibuprofrn, Naproxen, Fenoprofen, Piroxicam, Indomethacin, Sulindac, Diclofenac, Ibufenac, Ketoprofen, Oxyphenbutazone, Phenylbutazone, Zompirac.

**vi) Diuretics:** Osmotic agents, Acidifying salts. Mercurials, Purines and related heterocycles, Sulfonamides, Benzothiadiazene and related compounds, Chlorothiazides and analogs, Sulfamoylbenzoic acid and

analogs, Endocrine antagonists, miscellaneous diuretics. **Commercial Synthetic routes to :** Furosemide, Methalthiazide methylchlorothiazide: Chlorothiazide, Triameterene, Hydrochlorothiazide, Amelorida, Chlorthalidone.

**Books Recommended:**

1. Wilson and Gisvolds Textbook of Organic Medicinal and Pharmaceuticals

Chemistry, 8th edition, edited by R.F. Doerge, J.B. Lippincott Company,

Philadelphia, 1982.

2. Pharmaceutical Chemicals in Perspective, B.G. Reuben and H.A. Wittcoff, John

Wiley & Sons, New York, 1989.

3. W.C. Foye, Principles of Medicinal Chemistry, Lea & Febiger, Philadelphia,

USA.

**Suggested Reading:**

Strategies for Organic Drug Synthesis and Design, D. Lendnicer, John Wiley and Son,

New York, 1998.

**Medicinal Chemistry-II PHA-832**

**Credits: 3**

Structure, stereochemistry, Mode of action, Structure activity relationships, specific clinical applications of following classes of pharmaceuticals with synthetic/commercial route to the indicated examples.

1. **Antibacterials:** Penicillines, Cephalosporins, Tetracyclines, Aminoglycosides, Chloramphenicol, Macrolides, Lincomycins, Polypeptides antibiotics, Polyene antibiotics. Sulfonamides and Sulfones fluoroquinolones, Trimethoprim and other unclassified antibiotics. **Antimycobacterials:** Sulfanilamides, p-Aminosalicylic acid derivatives, Thioamides, Thiourea, derivatives, Thiosemicarbazones,

Isoniazid, Kanamycin sulfate, Capreomycin, Rifaampin, Pyrazinamide, Anthionamide, Clofazimine, Cyclosporin, Dapsone, Sulfazem. **Commercial synthetic/semi-synthetic routes to :** 6-amino penicillanic acid, ampicillin, amoxycillin, production of penicillin, 7-amino cephalosporanic acid, cephalexin, ceftizoxime, cefaclor, cephalothin, **Tetracyclins:** doxycycline, nalidixic acid, sulfadiazine, Norflaxacin, Ciproflexacin, O-flaxacin,

Amiflaxacin, Difloxacin, Chloramphenicol, Nitrofluranton, Sulfamethoxazole, Acetylsulfoxiazole, Trimethoprim.

**2. Antimalarials:** Cinchona alkaloids, 4-Aminoquinolines, 8-Aminoquinolines, 9-Aminoacridines, Biguanides, Pyrimidines and Sulfones, Mefloquine, Sulfonamides. **Commercial synthetic routes to :** Chloroquine, pamaquine, primaquine, proguanil, Amodiaquine, Mefloquine, Pyremethamine, Sontoquine.

**2. Antiamoebic and antiprotozoal drugs:** Emetine hydrochloride, 8- Hydroxyquinoline, Iodochlorohydroxyquinol, Metronidazole, Diloxanide furoate, Bilamical hydrochloride, Hydroxystilbamidine isothionate, Pentamidine isothionate, Nifurtimox, Suramin sodium, Carbarsone, Glycobiarsol, Melarsoprol, Sodium stibogluconate, Dimercapool, Diethylcavamazine citrate, Centarsone,

Acetarsona, Antimony potassium tartarate, Bismuth sodium thioglycollate, Sulphonamide, Stibiophen. Bismuth sodium thioglycollamate, Furazolidone. **Commercial synthetic routes to :** Metronidazole, Ronidazole, Flunidazole, Iodoquinol, Nifurfimax, Benzindazole, Tryparsamide.

**3. Anthelmintics:** Introduction, Tetrachloroethylene, Piperazines, Gentian violet, Pyrvinium pamoate, Thiabendazole, Mabendazole, baphenium hydroxynaphthoate, Dichlophen, Niclosamide, Levamisole hydrochloride, Tetramisole, Niridazole, Biothional, Antimonypotassium tartarate, Stibiophen, Sodium Stibiocaptate.

**4. Antifungal drugs:** Fatty acids and their derivatives (Propionic acid, zinc propionate, sodium caprylate, zinc caprylate, undecylenic acid, Zinc undecylenate, Triacetin), Salicylanilids, Salicylic acid, Tolnaftate, pchloromethoxylenol, Acrisocrin, Fluconazole, Itraconazole, Haloprogin, Clotrimazole, Econazole, Miconazole, Ketoconazole, Flucytosine, Griseofulvin, Polyene antibiotics (Nystatin, Amphoetericin-B), Chlorophenesin, Dithranol. **Commercial synthetic routes to:** Miconazole, Clotrimazole, Econazole,

Fluconazole, Griseofulvin, Ketoconazole, Naftidine, Tolnaftate, Flucytosin.

#### **Books Recommended:**

1. Wilson and Gisvolds Textbook of Organic Medicinal and Pharmaceuticals Chemistry, 8<sup>th</sup> edition, edited by R.F. Deorge, J.B. Lippincott Company, Philadelphia, 1982.
2. Pharmaceutical Chemicals in Perspective. B.G. Reuben and H.A. Wittcoff, John Wiley & Sons, New York, 1989.
3. W.C. Foye, Principles of Medicinal Chemistry, Lea & Febiger, Philadelphia, U.S.A.

#### **Suggested Readings**

1. Strategies of Organic Drug Synthesis and Design, D. Lendnicer, John Wiley and Sons, New York, 1998.

## Physical Pharmacy PHA-833

Credits: 3

1. **Surface activity and interfacial phenomenon** : Surface tension and interfacial tension, surface active agents and their chemical classification, hydrophilic - Lipophilic balance, critical micelle concentration, solubilization, emulsification, wetting detergency etc. Interfacial films, Unimolecular film formation, diffused double layer and zeta potential, thickness of double layer, state of aggregation and crystal growth.

Pharmaceutical applications of surface phenomenon.

2. **Colloids and Macromolecular System** : Dispersed systems method of preparation of colloidal dispersions, size and shape of colloidal particles. Pharmaceutical applications. Types of colloidal systems. Optical kinetics and electrical properties. Stability of colloidal systems. Sensitization of protective

colloidal action

3. **Monophasic liquid dosage forms** : Types, advantages and disadvantages, Techniques of increasing solubility of drugs, other problems involved in preparation and stability of liquids.

### 4. Coarse Dispersions

i) *Suspensions* : Preparation and evaluation of suspensions, stability testing. Problems in suspension formulation, flocculated and non-flocculated suspensions.

ii) *Emulsions* : Advantages of emulsion dosage form, types, identification, selection of emulsifying agents, Preparation, Calculation of HLB value and stability studies.

5. **Rheology** : Shear rate-shear stress relationship and its measurement, pseudoplastic, thixotropic and dilatant types of flow, viscoelastic properties, Couette viscometer, Cup and bob viscometer, Red wood viscometer, Brookfield viscometer, Cone and Plate viscometer and Penetrometer,

Applications of Rheology in Pharmaceuticals, Solving of numerical problems related to rheology.

6. **Chemical, Kinetics and drug stability** : General consideration and concepts, complex reactions, influence of temperature, light, heat, oxygen, solvent, catalytic species and other factors in stability of drugs, Prediction of stability of common pharmaceutical substances. Thermodynamic considerations and

mechanisms in general.

7. **Complexation** : Metal complexes, organic molecular complexes, inclusion/occlusion compounds and analysis.

8. **Micromeretic and Powder Rheology** : Particle size and distribution. Average particle size, number and weight distribution, particle number, methods for determining

particle volume , optical microscopy, sieving, sedimentation, measurement, particle shape, specific surface, methods for determining surface area, permeability, adsorption, derived properties of powders, porosity, packing arrangement, densities, bulkiness and flow properties.

***Books Recommended :***

3. A. Martin, Physical Pharmacy, B. I. Waverly Pvt. Ltd., New Delhi (1994).
2. L. Lachman, H.A. Liebermin and J. L. Kaing, Theory and Practice of Industrial Pharmacy, III Eds. Varghese Publishing House, Bombay (1977).

***Suggested Readings :***

3. A. Osol, Ramington's Pharmaceutical Science, XVIII Edition, Mack Publishing Company, Pennsylvania, USA.
4. J. W. Copper and G. Gunn, Tutorial Pharmacy, Kothari Book Depot, Bombay.
5. Badger et. al., Introduction to Chemical Engineering, McGraw Hill Co. International Student's edition.
6. Davis et. al. Bentley's Text book of Pharmaceutics, Billiere, Tindarr and Co., London.

**Pollution Control & Waste Treatment PHA-835 Credits: 3**

1. ***Atmosphere, Different zones, Chemical composition, Role of different constituents :*** Physical characteristics. Solar spectrum, Albedo, Thermal radiations. Temperature variation, Atmospheric Pressure & Density, Gravity, Winds, Water and the evolution of atmosphere.

2. ***Air Pollution, Definition :*** Ambient air quality and standards, Types of Air Pollution, Smog, Haze, Emission Atmospheric Transport & Dispersion Means, Receptors and Criteria study. Pollutants and kinds of pollution, Concentration representation of Gaseous Pollutants (CO, CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>x</sub>, HC, etc.) Particulates (SiO<sub>2</sub>, Iron oxides, Asbestos, Hg, Be, Pb, Odours.)

A) ***Atmospheric Effects :*** Visibilty, Turbidity, Thermal air Pollution, Acidic deposition, Effects of Ozone layer on earth, Effects on Climate.

B) ***Health Effects :*** Exposure, Impact of Pollutants on Human Body, Effects of Criteria Pollutants (CO, CO<sub>2</sub>, SO<sub>x</sub>, NO<sub>x</sub>, Particulates, HC, O<sub>3</sub>).

C) **Welfare Effects** : Vegetation, Domesticated Animals and Materials.

D) **Atmospheric Air Pollution Control Methods** : Measurement of Air Pollution, Ambient Air quality and Source Emissions, monitoring, Methods of Analysis (Dispersive IR, Gas Chromatography, Electro chemistry, Photometry) Sampling Techniques & Standards. Selection of Control of Gaseous Emission (Absorption, Adsorption, Condensation, Chemical Reaction and Incineration) Control of Particulate Emission (Concept, Gravity settling Centrifugal and Cyclonic collection, Electrostatic Precipitation, Collection efficiency), Filtration Techniques, Wet Scrubbing Techniques.

3. (i) **Water Pollution** : Concept, water quality Parameters, Color Taste & Odour, Temperature, Turbidity Conductivity Dissolved Solids, suspended solids, Redox, Potential, Alkalinity, Acidity, Dissolved oxygen, BOD, COD, Sulphates, Phosphates, Chlorides, Silica, Hardness, Iron, Heavy Metals.

(ii) **Sampling** : Sites, procedures, preservation and Handling of samples.

(iii) Physico - chemical analysis of water (Alkalinity, Acidity, DO, BOD, COD, Hardness, Chloride, residual Chlorine). Water Pollution Indices, General concept, Nygard's and Polymer's Algel Pollution Indices.

iv) **Waste Water Treatment Plants** : Biological Waste Treatment, Primary Clarification, Activated Sludge Process, Anaerobic Lagoons, Aerobic & Facultative lagoons. Electrostatic Treatment of Water.

(v) **Waste Water Reuse or Recycling Techniques** : Objectives & Techniques (Brief introduction).

#### 4. **Waste Minimization Technology** :

a). Relationships of waste minimization technology to integrated hazardous waste management.

b). Hazardous control, Disaster planning 'onsite and offsite.

#### **Books Recommended :**

1. Air Quality by Thad Godish.

2. Chemical and Biological Methods for Water Pollution Studies by R.K. Trivedy and P.K. Goel (1986).

3. Waste Water Engineering by Matcalf and Eddy, (1993).

4. Hazardous Waste Minimization by Harry Freeman (1990).

5. Pollution Control in Process industries by S. P. Mahajan, (1994).

# Pharmaceutical Analysis (Spectroscopic and Instrumental Techniques) PHA-834

Credits : 4

## 1. Electrochemical methods

**a. Conductometric method :** Introduction, theory ostwald's dilution, measurements of conductance conductivity cells, and applications.

**b. Potentiometric measurements :** Calomel electrode, Normal hydrogen electrode silver-silver chloride electrode, Quinhydrone electrode, general applications.

**c. pH Measurements:** Glass electrode, combination glass electrode and applications.

**d. Polarography & Amperometry:** Calculation of half wave potential, polarograph and amperometric titrations.

**2. Ultraviolet & Visible absorption Spectroscopy :** Introduction, Fundamental laws of photometry (Lambert Beer's Law); Radiation Sources (Hydrogen/Deuterium lamp, tungsten filament lam, Xenon lamp); Monochromator, Prisms (Cornu, Littrow), resolution of prisms, Detectors (Photovoltaic cell, Phototubes Photomultiplier tubes, silicon photodiodes) Filters (glass & absorption) single & double beam spectrophotometer, Sample handling; Presentation of spectral, data, Quantitative methods, Simultaneous determination, Derivative Spectroscopy & its applications.

**3. Infrared Spectroscopy :** Introduction, Requirements of molecule to absorb in IR: calculations of Fundamental frequency; Molecular Vibrations Radiation Sources, (Incandescent wire source, Nernst glower, Globar, Mercury arc and carbon dioxide laser); Detectors (Thermal/thermocouples, Bolometer, pyroelectric, Golay pneumatic & photon detector); Dispersive and nondispersive spectrophotometers (schematic optics of double beam spectrophotometer); Fourier transform infrared spectrometer; Sample handling techniques (gases liquid & solid samples); correlation of infrared

spectra with molecular structure; Quantitative measurements.

**4. Mass Spectroscopy:** Introduction, Components of Mass spectrometer, Dempster's mass spectrometer, Ionization sources-Electron impact ionization; field ionization, chemical ionization, Fast atom bombardment, Mass analyzer, Resolution of mass spectrometer, single focusing analyzer system, Double focusing analyzers, Quadrupole analyzer, Time of flight analyzer, spark source spectrometry, Ion collecting systems, correlation of mass spectra with molecular structure.

**5. NMR Spectroscopy:** Introduction, Basic principle, Quantum description classical description, Relaxation processes, Chemical shift, spin splitting, instrumentation. Continuous wave NMR spectrometer, Applications of NMR spectroscopy,

**6. Molecular Fluorescence & Phosphorescence :** Theory, (single-triplet states, deactivation process) Quantum yield, Effect of concentration on fluorescence (derivation), Fundamentals of Instrumentation for fluorescence & phosphorescence, Applications.

**7. Flame Emission and Atomic Absorption Spectroscopy:** Introduction, Atomization, Continuous Atomizers, Discrete atomizers; Flames, Nebulizer-Burner system (concentric, cross flow, laminar flow); Non-flame techniques (Electrothermal analyzers cold vapour technique); Radiation sources (hollow cathode lamp and electrodeless discharge lamp monochromator, Detectors, Interference (spectral, chemical, ionization, matrix effect, molecular absorption); Background Effects; Background correction Methods (Deuterium Arc, Zeeman Effect and Smith-Hieftje System); Schematic diagram of Flame photometer and Atomic Absorption Spectrophotometer.

**8. Refractometry & Polarimetry :** Principle, Instrumentation & Applications of refractometry. Polarimetry: Theory, fundamentals of instrumentation. Optical rotatory dispersion (ORD), Circular Dichroism (CD), ORD/CD curves,

instrumentation, applications.

### **9. Processes involving Chemical Composition Analyzer :**

Chromatographic analysis (GC, HPLC).

### **Books Recommended :**

4. H.H. Willard, D.D. Meritt, J.A. Dean and W.A. Settle, 'Instrumental Methods of Analysis', 6th Edition (for 1 & 3). (1986); 7th Edition (1988).
5. D.A. Skoof, "Principles of Instrumental Analysis", 3rd Edition. (1984), 4th Edition (1992).
6. R.L. Pecsok, "Modern Method of Chemical Analysis" (for 7 only). (1976).

## **SEMESTER-III**

### **Pharmaceutical Analysis Practical**

**Course Code: GPC- 636**

**Credits: 3**

1. Determine the concentration of  $\text{Na}^+$ ,  $\text{K}^+$  and  $\text{Ca}^{2+}$  present in tap water using flame Photometer.
- 2.. Standardization of an acid with a standard solution of base using pH-meter.
3. Determine the  $pK$  values of an amino acid by pH metry.
4. Titration of a strong acid vs strong base, weak acid vs strong base and weak acid vs weak base by conductometry.
5. Titration of mixture of strong and weak acids with a strong base by conductivity.
6. Determination of dissociation constant of acetic acid by conductometry.
7. Verify Lambert-Beer Law and determine the molar extinction co-efficient : copper sulphate pentahydrate / or potassium dichromate.
8. The determination of aspirin and Caffein in a proprietary Analgesic by spectrophotometry.
9. Measurement of optical rotation and study of muta rotation in glucose.

10. Titration of HCL with NaCH using potentiometer.
11. Determination of composition of unknown sample by Refractometry. Molar refraction is an additive property.
12. Determination of water content by moisture balance and by Karl Fischer method.
13. Measurement of Specific Optical Rotation of ibuprofen and determination of unknown concentration.
14. Volumetric analysis of ibuprofen in tablets.
15. Analysis of ascorbic acid in given tablets.
16. Spectrophotometric determination of Paracetamol in tablets.
17. Analysis of Ampicillin trihydrate.
18. Analysis of citric acid.
19. Determination of Vitamin B1 in given tablets.
20. Determination of Vitamin B2 in given tablets.
21. Determination of ephedrine hydrochloride in given syrup.
22. Determination of tetracycline in given capsules.
23. Determination of phenobarbitone in given cough syrup.
24. Determination of chloremphenicol in given capsules.
25. To perform I.P. monograph of tablets.
26. To perform I.P. monograph of hard gelatin capsules.

**Note : Any other experiment (s) may be included in support of the theoretical aspects of the course.**

**Drug Synthesis and Natural product extraction Practicals PHA-837**  
**Credits 3**

**Suggested Experiments**

3. Preparation / multistep synthesis, purification and spectroscopic characterization of organic Pharmaceuticals and intermediate given below.

Acetanilide, Aspirin, Barbituric acid, Hippuric acid, 3,4 - dihydro-3-(p-methylphenyl)-I-(2H)-Benzoxazine, Diketopiperazine, Paracetamol, Thenacetin, Antipyrine 2-amino-5 bromopyridine, Nitrazepam, Azo sulfomarides, sulfarilamide, Sulfathiazole, Diphenylhydantoin, Phenylbutazone, Nifedipine, Alclofenac, Baclofen, Brimindiene, Tolmetin, Procarbazine, Ketoprofen, I-phenyl-3-alkylthioureas, Sodium-7-iodo-8-quinoline-1, 5-sulfonate, NDichloroacetyl-N-methyl-p-hydroxy aniline, Amphetamine, Aminopyrine, Oxolamine, hydralazine, tetrahydroiso-quinolines. Oxazolidine-I, 4-dione.

4. Extraction and analysis of the following natural products.

- a). Eugenol from cinnanan leaf oil or cloves.
- b). Piperine from black pepper.
- c). Cucumarin from turmeric.
- d). Pectins from organe peels.
- e). Carotene from carrots.
- f). Oleo-resin from ginger.
- g). Alkaloid from cinchona bark.
- h). Trimyristin and tetraclecanoic acid from nutmeg.

**Note: Any other experiment(s) may be included in support of the theoretical aspects of the course.**

**Summer placement PHA-838**

**Non-credit**

**Satisfactory/ Not Satisfactory**

## **SEMESTER-IV**

**Pharmaceutical Technology PHA-841**

**Credits: 3**

1. *Introduction to different Pharmaceutical dosage forms.*

2. **Preformulation considerations** : Analytical methods for Characterization of drugs, determination of PKa value, pH solubility profile and effect of temperature, stability, calculation of shelf life.

3. **i) Processing of tablets** : Advantages and disadvantages of tablets, types of tablets. Granulation – manufacture of granules, their basic characteristics and properties with reference to different types of substances. Various additives included in tablet formulations. Compression of tablets - compressing machines and their tooling, processing problems and their remedy. Evaluation of tablets as per official standards.

**ii) Tablet coating** : Coating principles and equipment. Coating processes - sugar coating, Film coating and enteric coating. Materials used in coating. Tensile strength of film. Evaluation of coated tablets, defects of films.

4. **Processing of Capsules** : Hard gelatin capsules - Materials and production. Filling equipment, hand filling, semiautomatic and automatic filling. Operations, formulation. Finishing and evaluation. Soft gelatin capsules - manufacture process, nature of capsule shell and contents. Evaluation, physical stability and packing.

5. **Microencapsulation** : Importance and applications of microencapsulation in Pharmacy. Various techniques and equipment employed for microencapsulation.

6. **Semi – solid dosage forms** : A brief review of the preparation of ointments, creams and suppositories.

7. **Pharmaceutical aerosols** : Advantages of aerosol dosage form. Formulation of aerosol products and their standardization.

***Books Recommended :***

1. C. W. Copper and G. Gunn, Dispensing Pharmacy, CBS Publishers & Distributors, Delhi – 110032
2. L. Lachman et. al., Theory and Practice of Industrial Pharmacy, Varghese Publishing House, Dadar, Bombay – 400014, 1987.

***Suggested Readings :***

1. A. Osol Remington's Pharmaceutical Sciences, XVIII edition, Mack Publishing co., Pennsylvania, USA, 1990.
2. The Pharmacopoeia of India, IIIrd Edition, Vol. I and Vol. II, 1996, Govt. of India, Ministry of Health and Family Welfare, Delhi.
3. British Pharmacopoeia, International Edition, 1993.
4. The United States Pharmacopoeia, XXII & NF XVII and addenda, 1995.
5. The Pharmaceutical Codex, 12th Edition, The Pharmaceutical Press, London, 1994.
6. Patrick B. Deasy, Microencapsulation and related drug processes, Dekker series Vol. 20
7. F.J. R. Nixon, Microencapsulation., Dekker series Vol 3.
8. Joseph R. Robinson, Sustained and Controlled Drug Delivery Systems, Dekker Series. Vol. 6.

**Medicinal Chemistry-III PHA-842**

**Credits: 3**

Structure, stereochemistry, nomenclature, mode of action, specific clinical applications and structure activity relationships of following classes of drugs and synthesis/commercial routes to specified drugs.

**1. CNS Active Drugs: CNS Depressants : Hypnotics and sedatives:** Barbiturates, Non-barbiturates, Amides and Imides, Glutethimide, Benzodiazepines, Aldehydes and derivatives, Methaqualone and other miscellaneous agents. **Anticonvulsants:**

Barbiturates, Hydanatoin, Oxazolidinediones. Succinimides, Bezodiazepines, Thenacemide, Glutethimide. **CNS-stimulants & Psychoactive drugs:**

Analeptics, Purines, Psychomotor stimulants, Sympathomimetics, Monamine oxidase inhibitors, Tricyclic antidepressants, Miscellaneous psychomotor stimulants. Hallucinogens (**Psychodelics, Psychomimetics**): Indolethylamines,  $\beta$ -phenylethylamines, Butyrophenones and other miscellaneous drugs.

**Commercial Synthetic routes to :** Thioridazine, Haloperidol, Chlorpromazine, Phenytoin, Phenobarital, Carbamazepine valproic acid, Methaqualone, Nitrazepam, Oxazepam, Diazepam, Chlorthalidone, Lorazepam, Flurazepam, Triazolam, Alprazolam, Amitriptyline, Imipramine, Amphetamine, Protriptyline, Chloripramine, Iproniazide, tranylcypromine, Doxepin, phenteramine, caffeine 12

**2. Adrenergic and cholinergic drugs:** Sympathomimetics, Catecholamines, Phenylethanolamines, Phenylethylamines, Non-catecholamines, Imidazoline derivatives, Adrenergic blocking agents. **Cholinergic agents:** Autonomic blocking and related drugs. Antispasmodic and antiulcer drugs. Antiparkinsonism drugs.

**Commercial Synthetic route to :** Tiquinamide, Elantone, Phentolamine, Tolazoline, Salbutamol, Terbutaline, Dicyclomine, Clidinium bromide, Ranitidine, cimetidine, Chlorpheniramine, Hydroxyzine, Terfenadine, Isoproterenol, Albuterol, Tolimidine. 5

**4. Antiviral agents:** Introduction, Screening methodology, Admantane derivatives (Amantadine, Rimantadine), Idoxuridine, Trifluridine, Vidarabine, Ribavirin, Acycloguanosine, Inosiplex, Methisazone, Zidovudine, Acyclovir, Ganciclovir, Foscarnet, Human Interferon.

**Commercial synthetic routes to :** Acyclovir, Ganciclovir, Zidovudine, Enviroxime, Lamivudine, Idoxuridine, Disoxaril. 8

4. **Antineoplastic agents:** Alkylating agents (Nitrogen mustards, Aziridines, Sulfonic acid Esters, Epoxides, Nitrosoureas, Triazenes, Phosphamides, Mitomycin, Comparative activity of alkalyting agents). **Antimetaboilities:** Antifolates (Methotrexate), Mercaptopurine, Thioguanine, Flourouracil, Floxuridine, Cytarabine, Azathioprine, Antitumor, antibiotics, Dactinomycin, Daunorubicin, Aclacinomycin, Mithramycin, Bleomycin, **Miscellaneous compounds:** Cisplatin, Taxol, Gunazole, Pipobromin. **Antitumor alkaloids:** Vincristine, Vinblastine. **Hormones agonist and antiagonists:** Steroids, Tamoxifen, Mitotane, Dromastanolone propionate, Testalactone, Megestrol acetate Immunotherapy. **Commercial synthetic routes to :** Methtrexate, Trimetrexate, Adatrexate, Mercaptopurine, Dromostanolone, Cytarabine, Fludarabine, Thioguanine, Dezaguanine, Bisanterene, Acivicin, Piroxanthrone. 10

5. **Antiallergenics:** Serotonin, Bradykinin, Antihistamines (ethylenediamine derivatives of aminoalkyl ethers, derivatives of cyclic basic chains, Monoaminopropyl derivataives, derivatives of tricyclic compounds).

**Commercial Synthetic routes to :** Chlorpheniramine, hydroxyazine, diphenylhydroxamine, acrivastine, Meclizine, Altaersin. 5

6. **Diagnostic Agents and Organic Pharmaceutical Aids : Diagnostic agent:** Introduction, Radiapaques for Alimentary tract, (urography, angiography and cholecystography), liverfunction dyes. **Organic Pharmaceuticals Aids:** Preservatives and antioxidants. Colouring, Flavouring and Sweetening agents, Emulsifying agents, Stabilising and suspending agents, Ointment bases, solvents. 5

**Books Recommended:**

1. Wilson and Gisvolds Textbook of Organic Medicinal and Pharmaceuticals Chemsitry, 8th edition, edited by R.F. Doerge, J.B. Lippincott Company, Philadelphia, 1982.

2. Pharmaceutical Chemicals in Perspective, B.G. Reuben and H.A. Wittcoff, John Wiley & Sons, New York, 1989.
3. W.C. Foye, Principles of Medicinal Chemistry, Lea & Febiger, Philadelphia, USA.

**Suggested Reading:**

1. Strategies for Organic Drug Synthesis and Design, D. Lendnicer, John Wiley and Son, New York, 1998.

**Drug Design and Drug Development PHA-843**

**Credits: 3**

1. **Introduction History and Objective of drug designing** : Economic aspects of drug designing. Procedures followed in drug designing. Lead based methods. Approaches to lead discovery. Drug discovery without a lead-de Novo drug designing.

2. **Structure Activity Relationships** : Quantitative analysis of structure activity relationships. Hansch Paradigm for pharmaceuticals - Apparent lack of structure-activity relationships. Apparent structure activity relationships, True structure activity relationships. **Extra-thermodynamic parameters:** Electronic, Steric and Hydrophobic substituents constant. Structural and theoretical parameters. Bioisostreism. Hansch analysis, Free and Wilson method Physicochemical parameters, Craig Plot, Topliss operational scheme. Cluster analysis. Pattern recognition. Partition coefficient and its significance.

3. **Drug Designing and molecular orbital method** : Molecular orbital calculations and chemical reactivity. Perturbation theories of drug action. Pullman's dipositive bond theory. Role of charge transfer processes in drug action. Conformational aspects and molecular orbital calculations. Molecular

orbital approach to drug design with specific example of thiadiazine antihypertensives.

4. **Drug Receptor - Interaction** : Historical, Receptor theories and forces involved in drug receptor interaction. Stereochemical and conformational aspects of drug receptor interaction. Agonists and Antagonists. Designing or receptor antagonists. Receptor binding as a tool in designing biologically active steroids. **Peptidomimetics** : Peptidomimetics research, Rational design of Peptidomimetics, nonpeptide, ligands for peptide receptors, Applications of oligonucleotides in antiviral and antitumoral chemotherapy. Antisense nucleotides designing.

5 **Prodrug Approach** : Basic concept, Common prodrugs. Reversal of prodrugs - chemical and enzymatic. Application of prodrug approach to alter taste and odour, reduction of pain at injection site, reduction of gastrointestinal irritability. Alteration of drug solubility, increasing chemical stability. Prevention of presystemic metabolism. Prolongation of drug action, site specific drug delivery. Reduction in drug toxicity. Alteration of drug metabolism.

6. **Computer Aided Drug Designing** : Computer requirement hardware, software, Data base and information retrieval techniques. Graphical description of chemical structure. Molecular interactions and interactive graphics. Modelling in medicinal chemistry-uses and limitations. Logical structural approaches. Activity feature selection within a group of compounds, Activity profile selection. Topological and topographical descriptors.

***Books Recommended :***

The Organic Chemistry of Drug Design and Drug Action, by R. B. Silverman, Academic Press, 1992.

Drug Designs - A series of monographs in medicinal chemistry edited by A. J. Ariens. 1st edition, Vol. I, II, V, VIII & IX (only relevant chapters).

Comprehensive medicinal chemistry. Pergamon Press. 1990, Vol. 4.

Modern Drug Research , Paths to Better and Safer Drugs, Medicinal research series, volume 12, edited by Yvonne Connolly Martin Eberhard Kutter Vokhard Austel

***Suggested Readings :***

1. Medicinal Chemistry for 21<sup>st</sup> century edited by C. G. Wermuth, Blackwell Scientific Publications, 1997.

**Pharmaceutical Technology Practical PHA-844 Credits: 3**

**Suggested Experiments**

1. Preparation of tablets by dry / wet granulation method and their evaluation.
2. Coating of granules and tablets and their evaluation.
3. Microencapsulation and evaluation in microcapsules.
5. Filling sealing and evaluation of hard galatin capsules.
6. Preparation of emulsion and evaluation.
7. Preparation of simple syrup and evaluation.
8. (i) Preparation of iodine solution and evaluation.  
(ii) Preparation of strong iodine solution and evaluation.
9. Preparation of magnesiumhydroxide mixture and evaluation.

10. Preparation of Calamine lotion.
11. Preparation of Boric acid glycerin/tannic acid glycerin/phenol glycerin.
12. Preparation of cough mixture.
13. Preparation of peppermint water / rose water.
14. Preparation of cresol with soap solution.
15. Preparation of non-staining iodine ointment cum methyl salicylate.
16. Formulation of suppositories.
17. Formulation of ointment(s).
18. Preparation of cold cream, vanishing cream and after-shave lotion.
19. To carry out accelerated stability studies of tablets / capsules / syrups.
20. To find out base adsorption for a given drug.
21. Evaluation of packing materials (strip packs & Blisher Packs)
  - i) Thickness of Aluminium foil and lamination.
  - ii) Water permeability and quality of printing.
22. Evaluation of injections (ampoules 2 ml. and 5 ml.).
23. **In-vitro** comparative study of the release and penetration of drugs from topical preparations.
24. To perform quality control tests on surgical gauge Bandage cotton.

**Note : Any other experiment (s) may be included in support of the theoretical aspects of the course.**

**Practical**

**Project Report PHA-845**

**Credit: 4**

**Reflected as Non- grade- (Satisfactory/Not-satisfactory) in mark sheet**

## Undergraduate Programmes

### BACHELOR OF PHARMACY



#### Course Structure (I Year) Semester I

<b>Course code</b>	<b>Course Title</b>	<b>Credits</b>
<b>PHA-310</b>	Pharmaceutical Analysis-1	<b>3(3-0-0)</b>
<b>PHA-311</b>	Pharmaceutical Analysis-1 Practical	<b>2(0-0-4)</b>
<b>PHA-312</b>	Pharmaceutical Chemistry-I (Inorganic Pharm. Chemistry)	<b>3(3-0-0)</b>
<b>PHA-313</b>	Pharmaceutical Chemistry-I (Inorganic Pharm. Chemistry) Practical	<b>2(0-0-4)</b>
<b>PHA-314</b>	Pharmaceutics –I (General Pharmacy)	<b>3(3-0-0)</b>
<b>PHA-315</b>	Pharmaceutics –I (General Pharmacy) Practical	<b>2(0-0-2)</b>
<b>COMP-401</b>	Basic Electronics & Computer Applications	<b>3(3-0-0)</b>
<b>COMP-402</b>	Basic Electronics & Computer Applications Practical	<b>2(0-0-4)</b>
<b>MAS-</b>	Remedial Mathematics	<b>4(4-0-0)</b>
<b>PHA-316</b>	Remedial Biology	<b>5(3-0-4)</b>

<b>LNG 401</b>	English for Professionals -I	<b>2(2-0-0)</b>
	<b>Total Credits</b>	<b>24/25</b>

**(I Year) Semester II**

<b>Course code</b>	<b>Course Title</b>	<b>Credits</b>
<b>PHA-320</b>	Pharmaceutical Chemistry-II (Physical Chemistry)	<b>3(3-0-0)</b>
<b>PHA-321</b>	Pharmaceutical Chemistry-II Practical (Physical Chemistry)	<b>2(0-0-4)</b>
<b>PHA-322</b>	Pharmaceutical Chemistry-III (Organic Chemistry –I)	<b>3(3-0-0)</b>
<b>PHA-323</b>	Pharmaceutical Chemistry-III Practical (Organic Chemistry –I)	<b>2(0-0-4)</b>
<b>PHA-324</b>	Pharmaceutics-II (Unit Operation – I)	<b>3(3-0-0)</b>
<b>PHA-325</b>	Human Anatomy, Physiology & Health Education –I	<b>3(3-0-0)</b>
<b>PHA 326</b>	Human Anatomy, Physiology & Health Education – I Practical	<b>2(0-0-4)</b>
<b>MAS-</b>	Advanced Mathematics	<b>4(4-0-0)</b>
	<b>Total Credits</b>	<b>22</b>

**BACHELOR OF PHARMACY**  
**(II Year) Semester III**

<b>Course code</b>	<b>Course Title</b>	<b>Credits</b>
<b>PHA-430</b>	Pharmaceutical Analysis-II	<b>3(3-0-0)</b>
<b>PHA-431</b>	Pharmaceutical Analysis-II Practical	<b>2(0-0-4)</b>
<b>PHA-432</b>	Pharmaceutical Chemistry-IV (Organic Chemistry - II)	<b>3(3-0-0)</b>
<b>PHA-433</b>	Pharmaceutical Chemistry-IV Practical (Organic Chemistry – II)	<b>2 (0-0-4)</b>
<b>PHA-434</b>	Pharmaceutics-III (Unit Operation – II)	<b>3(3-0-0)</b>
<b>PHA-435</b>	Pharmaceutics-III (Unit Operation – II) Practical	<b>2(0-0-4)</b>
<b>PHA-436</b>	Pharmacognosy-I	<b>3(3-0-0)</b>
<b>PHA-437</b>	Pharmacognosy-I Practical	<b>2(0-0-4)</b>
<b>PHA-438</b>	Human Anatomy, Physiology & Pathophysiology of Common Diseases-II	<b>4(4-0-0)</b>
<b>SES-415</b>	Environmental Sciences -I	<b>2(2-0-0)</b>

	<b>Total Credits</b>	<b>26</b>
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**(II Year) Semester IV**

<b>Course code</b>	<b>Course Title</b>	<b>Credits</b>
<b>PHA-440</b>	Pharmaceutics-IV (Physical Pharmacy)	<b>3(3-0-0)</b>
<b>PHA-441</b>	Pharmaceutics-IV Practical (Physical Pharmacy)	<b>2(0-0-4)</b>
<b>PHA-442</b>	Pharmaceutical Microbiology	<b>4(4-0-0)</b>
<b>PHA-443</b>	Pharmaceutical Microbiology Practical	<b>2(0-0-4)</b>
<b>PHA-444</b>	Pharmacognosy-II	<b>3(3-0-0)</b>
<b>PHA-445</b>	Pharmacognosy-II Practical	<b>2(0-0-4)</b>
<b>PHA-446</b>	Human Anatomy, Physiology & Pathophysiology of Common Diseases-III	<b>4(4-0-0)</b>
<b>SES-416</b>	Environmental Sciences-II	<b>2(2-0-0)</b>
	<b>Total Credits</b>	<b>22</b>

**BACHELOR OF PHARMACY**  
**(III Year) Semester V**

<b>Course code</b>	<b>Course Title</b>	<b>Credits</b>
<b>PHA-550</b>	Pharmaceutical Chemistry-V (Biochemistry)	<b>3(3-0-0)</b>
<b>PHA-551</b>	Pharmaceutical Chemistry-V (Biochemistry) Practical	<b>2(0-0-4)</b>
<b>PHA-552</b>	Pharmaceutics-V (Pharmaceutical Technology – I)	<b>3(3-0-0)</b>
<b>PHA-553</b>	Pharmaceutics-V Practical (Pharmaceutical Technology – I)	<b>2(0-0-4)</b>
<b>PHA-554</b>	Pharmaceutics-VI (Hospital Pharmacy)	<b>3(3-0-0)</b>
<b>PHA-555</b>	Pharmacognosy-III	<b>3(3-0-0)</b>
<b>PHA-556</b>	Pharmacognosy-III Practical	<b>2(0-0-4)</b>
<b>PHA-557</b>	Pharmacology-I	<b>3(3-0-0)</b>

<b>PHA-558</b>	Pharmacology-I Practical	<b>2(0-0-4)</b>
	<b>Total Credits</b>	<b>23</b>

**(III Year) Semester VI**

<b>Course code</b>	<b>Course Title</b>	<b>Credits</b>
<b>PHA-560</b>	Pharmaceutical Chemistry-VI (Medicinal Chemistry –I)	<b>3(3-0-0)</b>
<b>PHA-561</b>	Pharmaceutical Chemistry-VI Practical (Medicinal Chemistry–I)	<b>2(0-0-4)</b>
<b>PHA-562</b>	Pharmaceutics-VII (Biopharmaceutics and Pharmacokinetics)	<b>3(3-0-0)</b>
<b>PHA-563</b>	Pharmaceutics-VII Practical (Biopharmaceutics and Pharmacokinetics)	<b>2(0-0-4)</b>
<b>PHA-564</b>	Pharmaceutical Jurisprudence & Ethics.	<b>4(4-0-0)</b>
<b>PHA-565</b>	Pharmacognosy-IV	<b>3(3-0-0)</b>
<b>PHA-566</b>	Pharmacognosy-IV Practical	<b>2(0-0-4)</b>
<b>PHA-567</b>	Pharmacology-II	<b>3(0-0-4)</b>
<b>PHA-568</b>	Pharmacology-II Practical	<b>2(0-0-4)</b>
	<b>Total Credits</b>	<b>24</b>

**BACHELOR OF PHARMACY  
(IV Year) Semester VII**

<b>Course code</b>	<b>Course Title</b>	<b>Credits</b>
<b>PHA-570</b>	Pharmaceutical Chemistry-VII (Medicinal Chemistry II)	<b>3(3-0-0)</b>
<b>PHA-571</b>	Pharmaceutical Chemistry-VII Practical (Medicinal Chemistry II)	<b>2(0-0-4)</b>
<b>PHA-572</b>	Pharmaceutics-VIII (Pharmaceutical Technology –II)	<b>3(3-0-0)</b>
<b>PHA-573</b>	Pharmaceutics-VIII Practical (Pharmaceutical Technology–II)	<b>2(0-0-4)</b>
<b>PHA-574</b>	Pharmaceutical Bio-Technology	<b>4(4-0-0)</b>
<b>PHA-575</b>	Pharmaceutical Industrial Management	<b>3(3-0-0)</b>
<b>PHA-576</b>	Pharmacognosy-V (Chemistry of Natural Products)	<b>3(3-0-0)</b>
<b>PHA-577</b>	Pharmacognosy-V Practical (Chemistry of Natural Products)	<b>2(0-0-4)</b>

<b>PHA-578</b>	Pharmacology-III	<b>3(3-0-0)</b>
<b>PHA-579</b>	Pharmacology-III Practical	<b>2(0-0-4)</b>
	<b>Total Credits</b>	<b>27</b>

**(IV Year) Semester VIII**

<b>Course code</b>	<b>Course Title</b>	<b>Credits</b>
<b>PHA-580</b>	Pharmaceutical Analysis-III	<b>3(3-0-0)</b>
<b>PHA-581</b>	Pharmaceutical Analysis-III Practical	<b>3(0-0-6)</b>
<b>PHA-582</b>	Pharmaceutical Chemistry-VIII (Medicinal Chemistry III)	<b>3(3-0-0)</b>
<b>PHA-583</b>	Pharmaceutical Chemistry-VIII Practical (Medicinal Chemistry III)	<b>2(0-0-4)</b>
<b>PHA-584</b>	Pharmaceutics-IX (Dosage Form Design)	<b>4(4-0-0)</b>
<b>PHA-585</b>	Pharmacology IV (Clinical Pharmacy & Drug Interactions)	<b>4(4-0-0)</b>
<b>PHA-590</b>	Project Related to Elective TOPICS	<b>2(0-0-4)</b>
	<b>Total Credits</b>	<b>21</b>

**SEMESTER –I**

**PHARMACEUTICAL ANALYSIS – I**

**THEORY**

Course Code: PHA- 310

Credits- 3

1. Significance of quantitative analysis in quality control, different techniques of analysis, preliminaries and definitions, significant figures, rules for retaining significant digits, types of errors, mean deviation, standard deviation, statistical treatment of small data sets, selection of sample, precision and accuracy, fundamentals of volumetric analysis, methods of expressing concentration, primary and secondary standards.
2. **Acid Base Titrations** : Acid base concepts, Role of solvent, Relative strengths of acids and bases, Ionization, Law of mass action, Common ion effect, Ionic product of water, pH, Hydrolysis of salts, Henderson- Hesselbach equation, Buffer solutions, Neutralization curves, Acid- base indicators, Theory of indicators, Choice of indicators, mixed indicators, Polyprotic system, Polyamine and amino acid systems, Amino acid titration, applications in assay H<sub>3</sub>PO<sub>4</sub>, NaOH, CaCO<sub>3</sub> etc.

3. **Oxidation Reduction Titrations** : Concepts of oxidation and reduction, Redox reactions, strengths and equivalent weights of oxidizing and reducing agents, Theory of redox titrations, Redox indicators, Cell representations, Measurement of electrode potential, Oxidation –reduction curves, Iodimetry and Iodometry, Titrations involving ceric sulphate, potassium iodate, potassium bromate, potassium permanganate, titanous chloride and Sodium 2, 6-dichlorophenol indophenol.
4. **Precipitation Titrations** : Precipitation reactions, Solubility products, Effect of acids, temperature and solvent upon the solubility of a precipitate. Argentometric titrations and titrations involving ammonium or potassium thiocyanate, mercuric nitrate and barium sulphate, Indicators, Gay-lussac method; Mohr's method, Volhard's method and Fajan's method.
5. **Gravimetric Analysis** : Precipitation techniques, Solubility products; The colloidal state, Supersaturation co-precipitation, Post- precipitation, Digestion washing of the precipitate, Filtration, Filter papers and crucibles, Ignition, Thermogravimetric curves, specific examples like barium sulphate, aluminium as aluminium oxide, calcium as calcium oxalate and magnesium as magnesium pyrophosphate, Organic precipitants.

## **PHARMACEUTICAL ANALYSIS – I** **PRACTICAL**

**Course Code: PHA 311**

**Credits: 2**

The students should be introduced to the main analytical tools through demonstrations. They should have a clear understanding of a typical analytical balance, the requirements of a good balance, weights, care and use of balance, methods of weighing and errors in weighing. The students should also be acquainted with the general apparatus required in various analytical procedures.

1. Standardization of analytical weights and calibration of volumetric apparatus.
2. **Acid Base Titrations** : Preparation and standardization of acids and bases; some exercises related with determination acids and bases separately or in mixture form, some official assay procedures e.g. boric acid should also be covered..

3. **Oxidation Reduction Titrations** : Precipitation and standardization of some redox titrants e.g. potassium permanganate, potassium dichromate, iodine, sodium thiosulphate, etc.. Some exercises related to determination of oxidizing and reducing agents in the sample should be covered. Exercises involving potassium iodate, potassium bromate, iodine solution, titanous chloride, sodium 2,6-dichlorophenol indophenol and ceric ammonium sulphate.
4. **Precipitation titrations** : Preparation and standardization of titrants like silver nitrate and ammonium thiocyanate, Titrations according to Mohr's, Volhard's and Fajan's methods.
5. **Gravimetric Analysis**: Preparation of gooch crucible for filtration and use of sintered glass crucible; Determination of water of hydration, Some exercises related to gravimetric analysis should be covered.

**PHARMACEUTICAL CHEMISTRY – I**  
**(INORGANIC PHARMACEUTICAL CHEMISTRY)**

*THEORY*

**Course Code: PHA 312**

**Credits - 3**

AN OUTLINE OF METHODS OF PREPARATION, USES, SOURCES OF IMPURITIES, TESTS FOR PURITY AND IDENTITY, INCLUDING LIMIT TESTS FOR IRON, ARSENIC, LEAD , HEAVY METALS, CHLORIDE, SULPHUR AND SPECIAL TESTS IF ANY, OF THE FOLLOWING CLASSES OF INORGANIC PHARMACEUTICALS INCLUDED IN INDIAN PHARMACOPOEIA.

1. **Acids and Bases**: Buffers, Water.
2. **Gastrointestinal Agents**: Acidifying agents, Antacids, Protectives and Adsorbents, Cathartics.
3. **Major intra- and Extra-cellular Electrolytes**: Physiological ions, Electrolytes used for replacement therapy, acid-base balance and combination therapy.
4. **Essential and Trace Elements**: Transition elements and their compounds of pharmaceutical importance: Iron and haematinics, mineral supplements.
5. **Cationic and anionic components of inorganic drugs useful for systemic effects.**
6. **Topical Agents**: Protectives, Astringents and Anti-infectives.
7. **Gases and Vapours** : Oxygen, Anesthetics and Respiratory stimulants.

8. **Dental Products :** Dentifrices, Anti-caries agents.
9. **Complexing and chelating agents used in therapy.**
10. **Miscellaneous Agents:** structure chemical properties and uses of Sclerosing agents, expectorants, emetics, poisons and antidotes, sedatives etc.
11. **Pharmaceutical Aids used in Pharmaceutical industry.** Anti-oxidants, preservatives, filter aids, adsorbents, diluents, excipients, suspending agents, colorants etc.
12. **Inorganic Radio Pharmaceuticals:** Nuclear radio pharmaceuticals, Reactions, Nomenclature, Methods of obtaining their standards and units of activity, measurement of activity, clinical applications and dosage, hazards and precautions. Sources of impurities & their control, limit test for iron, arsenic, lead, heavy metals, chloride & sulphate

**PHARMACEUTICAL CHEMISTRY – I**  
**(INORGANIC PHARMACEUTICAL CHEMISTRY)**

***PRACTICAL***

**Course Code: PHA – 313**  
**Credits - 2**

1. To perform limit test of chloride, sulphate, Iron, Heavy metal and arsenic in the given sample.
2. Salt analysis .
3. Preparation of chemical compounds elonging to the different classes.

All identification tests for pharmacopoeial inorganic pharmaceuticals and qualitative tests for cations and anions should be covered.

**PHARMACEUTICS- I**  
**(General Pharmacy)**  
**THEORY**

**Course Code: PHA-314**  
**Credits-3**

**1. History of Pharmacy :** Origin & development of pharmacy, scope of pharmacy, introduction to pharmacopoeias with special reference to I.P, B.P., U.S.P.,

**2. Pharmaceutical Additives :** Coloring, flavouring & sweetening agents, cosolvents, preservatives, surfactants & their applications, antioxidants.

**3. Pharmaceutical calculations :** Posology, calculation of doses for infants, adults and elderly patients; Enlarging and reducing recipes, percentage solutions, allegation, alcohol dilution, proof spirit, isotonic solutions, displacement values, etc. Metrology, latin terms & abbreviations.

**4. Principles involved and procedures adopted in dispensing of :**

**Monophasic liquid dosage forms**

Solutions taken orally, solutions applied externally, solutions instilled into body cavities.

**Biphasic liquid dosage forms**

Emulsions & suspensions

**Official solutions.**

**Semisolid dosage forms**

ointments, pastes, creams

**Solid dosage forms.**

Powders.

**5. Incompatibilities :**

Physical and chemical incompatibilities, inorganic incompatibilities including incompatibilities of metals and their salts, non-metals, acids, alkalis, organic incompatibilities, Purine bases, alkaloids, pyrazolone derivatives, amino acids, quaternary ammonium compounds, carbohydrates, glycosides, anesthetics, dyes, surface active agents, correction of incompatibilities. Therapeutic incompatibilities.

**PHARMACEUTICS – I  
(General pharmacy)**

***PRACTICAL***

**Course Code: PHA-315  
Credits-2**

1. Dispensing of prescriptions falling under the categories : Mixtures, solutions, emulsions, creams, ointments, powders, suppositories, ophthalmics, capsules, pastes, jellies, pastiles, lozenges, pills, tablet triturates, lotions, liniments, inhalations, paints, etc.
2. Identification of various types of incompatibilities in prescription, correction of thereof and dispensing of such prescriptions.
3. Dispensing procedures involving pharmaceutical calculations, pricing of prescriptions and dosage calculations for pediatric and geriatric patients.
4. Dispensing of prescriptions involving adjustment of tonicity.

## **BASIC ELECTRONICS AND COMPUTER APPLICATIONS**

### ***THEORY***

**Code: COMP 401**

**Credits: 3(3+0+0)**

#### **1. Basic Electronics**

Semiconductors, p-n junction diode, LED, Photodiode and its uses, Half & Full wave rectifiers, Transistors configuration, Transistor amplifiers, introduction to integrated circuit, photo cell and photo multiplier tubes.

#### **2. Computers.**

##### **2.1 Introduction to Computers**

Need and Role, Definition, Characteristics and Applications, Hardware: Basic block diagram & components, System & Application Softwares, Data & its Representation.

##### **2.2 Operating System**

Introduction, Functions, Working with DOS and Windows.

##### **2.3 Computer Networks & Internet**

Introduction , Types, Internet: History, usage and applications , Intranet.

##### **2.4 Computer Languages**

Generations, Translators (Assembler, Interpreter and compiler), Programming Techniques, Algorithms & Flowcharts

##### **2.5 'C' Language**

Expressions & Operators, Input/Output Statements, Control Statements, Array, Functions

## 2.6 Introduction to MS Office

MS-Word, MS-Excel and MS-Power point

## 2.7 Computer applications in Pharmacy.

# BASIC ELECTRONICS AND COMPUTER APPLICATIONS

## *PRACTICAL*

**Code: COMP 402**

**Credits: 2**

### **Practicals:**

1. Working with operating systems like MS-DOS, Windows
2. Study of Software packages like MS-Word, MS-Excel and MS-Power point
3. Packages related to Medical Applications
4. How to search data, workable knowledge of Internet
5. Cyber etiquettes
6. Simple programs in C language
  - i. To find the largest among three numbers
  - ii. To check whether the given number is palindrome or not.
  - iii. To find whether the given number is the prime.
  - iv. To find sum and average of n integer using linear array
  - v. To generate the Fibonacci series
  - vi. To find factorial of a given number using function.

# REMEDIAL MATHEMATICS

## *THEORY*

Course Code: MAS-

Credits-4

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1. **Algebra** : Equations reducible to quadratics, simultaneous equations (linear and quadratic), determinants, properties of solution of simultaneous equations by Cramer's rule, matrices, definition of special kinds of matrices, arithmetic operations on matrices, inverse of a matrix, solution of simultaneous equations by matrices, pharmaceutical applications of determinants and matrices. Evaluation of  $E_{n1}$ ,  $E_{n2}$ , and  $E_{n3}$ , mensuration and its pharmaceutical applications..

2. **Trigonometry** : Measurement of angle, T- ratios, addition, subtraction and transformation formulae, T- ratios of multiple, submultiple, allied and certain angles, Application of logarithms in pharmaceutical computations.
3. **Analytical Plane Geometry** : Certain co-ordinates, distance between two points, area of triangle, a locus of point, straight line slope and intercept form, double- intercept form, normal (perpendicular form), slope-point and two point form, general equation of first degree.
4. **Calculus**:
  - (A) **Differential** :  
Limits and functions, definition of differential coefficient, differentiation of standard functions, including function of a function ( Chain rule). Differentiation of implicit functions, logarithmic differentiation, parametric differentiation, successive differentiation.
  - (B) **Integral** :  
Integration as inverse of differentiation, indefinite integrals of standard forms, integration by parts, substitution and partial fractions, formal evaluation of definite integrals.

## REMEDIAL BIOLOGY

### *THEORY*

**Course Code: PHA 316**

**CREDITS- 5(3-0-2)**

1. Methods of classification of plants.
2. **Plant Cell** : Its structure and non -living inclusions; mitosis and meiosis, different types of plant tissues and their functions.
3. Morphology and histology of root , stem , bark , wood , leaf, flower fruit and seed. Modification of root and stem.
4. General Survey of Animal Kingdom, Structure and life history of parasites as illustrated by amoeba, entamoeba, trypanosoma, plasmodium, taenia, ascaris, schistosoma, oxyuris, and ancylostoma.
5. General Structure and life history of insects like mosquito, housefly, mites and silkworm.

### REMEDIAL BIOLOGY PRACTICAL

1. Morphology of plant parts indicated in theory.
2. Care, use and type of microscopes.
3. Gross identification of slides of structure and life cycle of lower plants, animals mentioned in theory.
4. Morphology plant parts indicated in theory.
5. Preparation, microscopic examination of stem, root and leaf of monocot and dicot plants.
6. Structures of human parasites and insects mentioned in theory with the help of specimens.

## COURSE: ENGLISH FOR PROFESSIONALS-I

**Course Code: LNG 401**

**Credit Hours: (2-0-2) 3**

**Language:**

- a. Voice
- b. Parts of Speech
- c. Tense
- d. Vocabulary Building (Synonyms, Antonyms, One word substitution, Homonyms  
Homophones)
- e. Concord
- f. Effective use of Punctuation

**Technical Writing :**

- a. Formal letters
- b. Essay Writing
- c. Précis Writing

**Spoken English :**

- a. Phonetics
- b. Accent
- c. Ettiquettes

**Books Prescribed:**

- Martinet A.V. and Thomson A.J.A Practical English Grammar, IV ed. 1986, Oxford University Press, Delhi.
  - Agarwal, Malti: Krishna's Professional Communication, KRISHNA Prakashan Media(P) Ltd, Meerut.
  - Iyadurai P. English Phonetics for Beginners, I ed, 1992, Jones Publications, Tirunelvely
  - Balasubramaniam, T: A Text Book of English Phonetics for Indian Students, MACMILLAN INDIA LTD.
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**SEMESTER –II**  
**PHARMACEUTICAL CHEMISTRY – II**  
**(PHYSICAL CHEMISTRY)**

**THEORY**

**Course code: PHA-320**

**Credits-3**

1. **Behaviour of Gases:** Kinetic theory of gases, deviation from behaviours and explanation.
2. **The Liquid state:** Physical Properties (surface tension, parachor, viscosity, refractive index, optical rotation, dipole moments and chemical constituents).
3. **Solutions:** Ideal and real solutions, solutions of gases in liquids, - colligative properties, partition coefficient, conductance and its measurement, Debye Huckel theory.
4. **Thermodynamics:** First, second and third laws, Zeroth law, absolute temperature scale, thermochemical equations.
5. **Adsorption:** Freudlich and Gibbs adsorption, isotherms, Langmuir theory of adsorption.
6. **Electro chemistry :** Faraday's Laws of Electrolysis, Electrolytic conductance & its measurement, molar & equivalent conductivity, its variation with dilution. Kohlrausch law, Arrhenius theory, degree of ionisation & Ostwald dilution law. Transport number & migration of ion, Hittorfs theoretical device, theory of strong electrolytes (Debye Huckle theory).]
7. **Chemical Kinetics:** Zero, first and second order reactions, complex reactions, theories of reaction kinetics, characteristics of homogeneous and heterogeneous catalysis, acid base and enzyme catalysis.

- 8. Phase equilibria :** Phase, component, degree of freedom, phase rule (excluding derivation). Cooling curves & Phase diagrams for one & two component system involving eutectics, congruent & incongruent melting point (examples-water, sulphur, KI-H<sub>2</sub>O, NaCl-H<sub>2</sub>O system). Distribution law & application to solvent extraction.

## PHARMACEUTICAL CHEMISTRY – II (PHYSICAL CHEMISTRY)

### *PRACTICAL*

**Course code: PHA-321**

**Credits-2**

1. To determine refractive index of given liquids and find out the contribution of carbon, hydrogen and oxygen in molar refraction of a compound.
2. To determine the specific rotation of sucrose at various concentrations and determine the intrinsic rotation.
3. To determine the cell constant, verify Ostwald dilution law and perform conductometric titration.
4. To determine rate constant of simple reaction.
5. Determination of cell constant, verify Ostwald dilution law and perform conductometric Titrations.
6. Determination of surface tension.
7. Determination of partition co-efficient. Determination of viscosity.
8. pH determination by different methods.
9. Determination of solubility.

## PHARMACEUTICAL CHEMISTRY –III

### (ORGANIC CHEMISTRY-I)

*THEORY*      Course code: PHA-322  
Credits-3

The subject of organic chemistry will be treated in its modern perspective keeping for the sake of convenience, the usual classification of organic compounds:

- 1. Structure and Properties :** Atomic structure, Atomic orbitals, Molecular orbital theory, wave equation, Molecular orbitals, Bonding and antibonding orbitals, Covalent bond, Hybrid orbitals, intramolecular forces, Bond dissociation energy, Polarity of bonds, Polarity of molecules, structure and physical properties, intermolecular forces, Acids and bases.

- 2. Stereochemistry :** Isomerism and nomenclature and associated physicochemical properties, optical activity, stereoisomerism, specification of configuration, Reactions involving stereoisomers, chirality, chiral reagents conformations.
- 3. Structure, Nomenclature, Preparation and Reactions of :** Alkanes, Alkenes, Alkynes; Cycloalkanes, Dienes, Benzene, Polynuclear aromatic compounds, Arenes, Alkyl halides, Alcohols, Ethers, Epoxides, Amines, Phenols, Aldehydes and ketones, carboxylic acids, Functional derivatives of carboxylic acids, Reactive intermediates- carbocations, carbanions, carbenes, nitrene and nitrenium ions.

### PHARMACEUTICAL CHEMISTRY –III

#### (ORGANIC CHEMISTRY-I)

#### *PRACTICAL*

Course code: PHA-323

Credits-2

- The student should be introduced to the various laboratory techniques through demonstrations involving synthesis of selected organic compounds ( e.g. aspirin, p-bromoacetanilide, anthraquinone from anthracene, reduction of nitrobenzene etc.)
- Identification of organic compounds and their derivatisation.
- Introduction to the use of stereomodels.
- Purification of solvents like Benzene, chloroform, acetone and Preparation of absolute alcohol.
- Synthesis of compounds involving benzylation, acetylation, bromination, reduction & oxidation.
- Purification of solvents like Benzene, chloroform, acetone and preparation of absolute alcohol.

### PHARMACEUTICS - II

#### (UNIT OPERATION- I)

#### *THEORY*

Course code: PHA-324

Credits- 3

- 1. Unit Operations :** Introduction, basic laws.
- 2. Stoichiometry :** Unit processes, material and energy balances, molecular units, mole fraction, tie substance, gas laws, mole volume, primary and secondary quantities, equilibrium state, rate processes, steady and unsteady states, dimensionless formulae, dimensionless groups, different types of graphic representation, mathematical problems.

**3. Heat transfer** : Source of heat, heat transfer, steam and electricity as heating media, determination of requirement of amount of steam/electrical energy, steam pressure, Boiler capacity, mathematical problems on heat transfer.

**4.Fluid Flow** : Types of flow, Reynold's number, Viscosity, Concept of boundary layer, basic equations of fluid flow, valves, flowmeters, manometers and measurement of flow and pressure.

**5. Material Handling Systems :**

- a. Liquid handling – Different types of pumps.
- b. Gas handling - Various types of fans, blowers and compressors.
- c. Solid handling – Bins, Bunkers, Conveyors, Air transport.

**6. Filtration and centrifugation:** Theory of filtration, filter aids, filter media, industrial filters including filter press, rotary filter, edge filter, etc. Factors affecting filtration, mathematical problems on filtration, optimum-cleaning cycle in batch filters, Principles of centrifugation, industrial centrifugal filters, and centrifugal sedimenters.

**7. Crystallization:** Characteristics of crystals like – purity, size, shape, geometry, habit, forms size and factors affecting them. Solubility curves and calculation of yields. Material and heat balances around Swenson Walker Crystallizer. Supersaturation theory and its limitations, Nucleation mechanisms, crystal growth. Study of various types of crystallizer, tanks, agitated batch, Swenson Walker, Single vacuum, circulating magma and crystal Crystallizer, caking of crystals and its prevention. Numerical problems on yields.

**8. Material of Construction :** General study of composition , corrosion, resistance, Properties and applications of materials of construction with special reference to stainless steel and glass.

**9. Industrial Hazards and Safety Precautions :** Mechanical, Chemical, Electrical, fire and dust hazards. Industrial dermatitis, Accident records, Radiation hazards. etc.

***HUMAN ANATOMY, PHYSIOLOGY & HEALTH EDUCATION –I***

***THEORY***

**Course Code: PHA- 325**

**Credit - 3**

**Unit –I**

- a. Introduction to human body & organization of human body.
- b. Functional & structural characteristics of cell.
- c. Detailed structure of cell membrane & physiology of transport process.
- d. Structural & functional characteristics of tissues- epithelial, connective, muscle and nerve.

**Unit-II**

**Skeletal system-**

Structure, composition & functions of skeleton. Classification of joints, types of movements of joints.

Anatomy & physiology of skeletal & smooth muscle, neurotransmission, physiology of skeletal muscle contraction, energy metabolism, types of muscle contraction, muscle tone.

### **Unit-III**

Haemopoietic system: Composition & function of blood & its elements, erythropoiesis, blood groups, blood coagulation.

### **Unit-IV**

a) Concepts of health & disease: Disease causing agents & prevention of disease.

b) Classification of food requirements: Balanced diet, Nutritional deficiency disorders, their treatment & prevention, specification for drinking water.

### **Unit-V**

**Sense Organs:** Basic anatomy and physiology of the eye (vision), ear (hearing), taste buds, nose (smell), and skin (superficial receptors).

### **Lymphatic System**

Composition, formation and circulation of lymphs, lymph node and spleen.

## **HUMAN ANATOMY, PHYSIOLOGY & HEALTH EDUCATION-I**

### ***PRACTICAL***

**Course Code: PHA-326**

**Credit - 2**

1. Study of human skeleton.
2. Microscopic study of different tissues.
3. Estimation of haemoglobin in blood, Determination of bleeding time, clotting time, R.B.C, Count, Total leucocyte count, D.L.C. and E.S.R.
4. Recording of body temperature, pulse rate and blood pressure, basic understanding of Electrocardiogram – PQRST waves and their significance.

## **ADVANCED MATHEMATICS**

## ***THEORY***

**Course Code: MAS-408**

**Credit - 4**

- 1. Differential Equations :** Revision of integral calculus, definition and formation of differential equations, equations of first order and first degree, variable separable, homogeneous and linear differential equations reducible to such types, linear differential equations of the order greater than one with constant coefficients, complementary function and particular integral, simultaneous linear differential equations, pharmaceutical applications.
- 2. Laplace transforms :** Definition, transforms of elementary functions, properties of linearity and shifting, inverse laplace transforms, transforms of derivatives, solution of ordinary and simultaneous differential equations.
- 3. Biometrics:** sample size, data organization, diagrammatic representation of data, bar ,pie, 2-D and 3-D diagrams, measures of central tendency, measures of dispersion, Standard Deviation and standard error of means, coefficient of variation, probability and events, Bayes' theorem, probability distribution, elements of binomial and Poisson distribution, normal distribution curve and properties, kurtosis and skewness, correlation and regression analysis, method of least squares, statistical inference, Student's and paired t-test, F-test and elements of ANOVA, applications of statistical concepts in Pharmaceutical Sciences.

## **SEMESTER –III PHARMACEUTICAL ANALYSIS – II**

### ***THEORY***

**Course code: PHA-430**

**Credits- 3**

Theoretical considerations and application in drug analysis and quality control of the following analytical techniques.

- 1. Non-aqueous titrations**
- 2. Complexometric titrations**

3. **Miscellaneous Methods of Analysis** : Diazotisation titrations, Kjeldahl method of nitrogen estimation, Karl-Fischer titration, Oxygen flask combustion, gasometry.
4. **Extraction procedures including separation of drugs from excipients**
5. **Chromatography**: The following techniques will be discussed **with relevant examples of Pharmacopoeial products**.

### **TLC, HPLC, GLC, HPTLC, Paper Chromatography and Column Chromatography.**

6. **Potentiometry**
7. **Conductometry**
8. **Coulometry**
9. **Polarography**
10. **Amperometry**

## **PHARMACEUTICAL ANALYSIS – II**

### ***PRACTICALS***

**Course code: PHA-431**

**Credits- 2**

1. **Nonaqueous Titrations** : Preparation and standardization of perchloric acid and sodium/potassium/lithium methoxides solutions; Estimations of some pharmacopoeial products.
2. **Complexometric Titrations**: Preparations and standardization of EDTA solution, some exercises related to pharmacopoeial assays by complexometric titrations.
3. **Miscellaneous Determinations** : Exercises involving diazotisation, Kjeldahl, Karl-Fischer, Oxygen flask combustion and gasometry methods. Determination of alcohol content in liquid galenicals, procedure (BPC) shall be covered.
4. Experiments involving separation of drugs from excipients.
5. Chromatographic analysis of some pharmacopoeial products.
6. Exercises based on acid base titration in aqueous and non-aqueous media, oxidation reduction titrations using potentiometric technique, Determination of acid-base disassociation constants and plotting of titration curves using pH meter.
7. Exercises involving polarimetry.
8. Exercises involving conductometric and polarographic techniques.

PHARMACEUTICAL CHEMISTRY – IV  
(ORGANIC CHEMISTRY – II)

*THEORY*

**Course code: PHA-432**

**Credits- 3**

Nucleophilic aromatic substitutions;  $\alpha,\beta$ -unsaturated carbonyl compounds; conservation of orbital symmetry and rules.

Electrocyclic, Cycloaddition and sigmatropic reactions.

**Heterocyclic Compound** – Nomenclature, Chemistry, preparation, properties and Pharmaceutical importance of pyrrole, furan, thiophene, pyridine, pyrimidine, imidazole, pyrazole, thiazole, benzimidazole, indole, phenothiazines.

**Classification, structure, reactions, structure elucidation, identification of Carbohydrates:**

Monosaccharides – Glucose and fructose.

Disaccharides – Sucrose, lactose and maltose.

Polysaccharides – Starch.

**Classification, identification, general methods of preparation and reactions of amino acids and proteins.**

**Chemistry of lipids and Nucleic acids.**

*PHARMACEUTICAL CHEMISTRY – IV  
(ORGANIC CHEMISTRY – II)*

*PRACTICAL*

Course code: PHA-433

Credits- 2

At least five exercises in synthesis involving various heterocyclic ring systems, An exercise involving stereoselective synthesis of a compound. Resolution of racemic DL- alanine or any other example. Workshop on molecular modelling of primary, secondary and tertiary structures of proteins, molecular modeling on double helical structure of nucleic acid showing hydrogen bonding. Identification of organic compounds with derivatization.

## PHARMACEUTICS –III

### (UNIT OPERATION- II)

#### ***THEORY***

**Course Code: PHA-434**

**Credits-3**

- 1. Evaporation** : Basic concept of phase equilibria, factor affecting evaporation, evaporators, film evaporators, single effect and multiple effect evaporators, mathematical problems on evaporation.
- 2. Distillation** : Raoult's law, phase diagrams, volatility; simple steam and flash distillations, principles of rectification, McCabe Thiele method for calculation of number of theoretical plates, Azeotropic and extractive distillation. Mathematical problems on distillation.
- 3. Drying** : Moisture content and mechanism of drying, rate of drying and time drying calculations; classification and type of dryers, dryers used in pharmaceutical industries and special drying methods. Mathematical problems in drying.
- 4. Size reduction and size separation** : Definition, objectives of size reduction, factors affecting size reduction, laws governing energy and power requirements of mills including ball mill, hammer mill, fluid energy mill, etc.
- 5. Mixing** : Theory of mixing, solid-solid, solid-liquid and liquid-liquid mixing equipments.
- 6. Dehumidification and Humidity Control** : Basic concepts and definition, wet bulb and adiabatic saturation temperatures, Psychrometric chart and measurement of humidity, application of humidity measurement  
in pharmacy, equipments for dehumidification operations.
- 7. Refrigeration and Air conditioning:** Principal and applications of refrigeration and air conditioning.

## PHARMACEUTICS –III

### (UNIT OPERATION- II)

#### ***PRACTICAL***

**Course Code: PHA-435**

**Credits-2**

1. Measurement of flow of fluids and their pressure determination, Reynolds's number and calculation of Frictional losses.
2. Evaluation of filter media, determination of rate of filtration and study of factors affecting filtration.
3. Experiments to demonstrate applications of centrifugation.
4. Thermometers and Psychrometric charts.
5. Determination of humidity- use of Dry bulb and Wet bulb.
6. Determination of rate of evaporation.
7. Experiments based on steam, extractive and azeotropic distillations.
8. Determination of rate of drying, free moisture content and bound moisture content.
9. Experiments to illustrate the influence of various parameters on the rate of drying
10. Experiments to illustrate principles of size reduction, laws governing energy and power requirements of size reduction.
11. Experiments to illustrate solid-solid mixing, determination of mixing efficiency using different types of mixers.

**PHARMACOGNOSY – I**

Course Code: PHA- 436

Credits - 3

1. Definition, history, scope and development of Pharmacognosy.
2. **Sources of drugs** : Biological, marine, mineral and plant tissue cultures as sources of drugs.
3. **Classification of drugs**: Alphabetical, morphological, taxonomical, chemical and pharmacological classification of drugs.
4. **Plant taxonomy**: Study of the following families with special reference to medicinally important plants- Apocynaceae, Solanaceae, Compositae, Umbelliferae, Leguminosae, Rubiaceae, Liliaceae, Labiatae, Cruciferae, Papaveraceae.
5. **Cultivation, collection, processing and storage of crude drugs**: Factors influencing cultivation of medicinal plants. Types of soils and fertilizers of common use. Pest management and natural pest control agents. Plant hormones and their applications. Polyploidy, mutation and hybridization with reference to medicinal plants.

6. **Quality control of crude drugs:** Adulteration of crude drugs and their detection by organoleptic, microscopic, physical chemical and biological methods of evaluation as per WHO guidelines.
7. **Systematic pharmacognostic study of following :**
- a) **Carbohydrates and derived products:** Agar, Algin, Guar gum, acacia, Honey, Isabgol, Pectin, Starch, Sterculia and Tragacanth..
  - b) **Lipids:** Bees wax, Castor oil, Cocoa butter, Cod liver oil, Hydnocarpus oil, Linseed oil, Rice bran oil, Shark liver oil and Wool fat, Lard & Suet.
  - c) **Fibres :** Study of fibres used in pharmacy such as cotton, silk, wool, nylon glass-wool, polyester and asbestos.
  - d) **Pharmaceutical aids :** Study of pharmaceutical aids like talc, diatomite, kaolin, bentonite, gelatin and natural colours.

## PHARMACOGNOSY – I

### *PRACTICAL*

**Course Code: PHA 437**

**Credits-2**

1. Morphological characteristics of plant families mentioned in theory.
2. **Microscopic measurements of cells and Cell contents :** Starch grains, calcium oxalate crystals ,Phloem fibres and other diagnostic characters.
3. Determination of leaf constants such as stomatal index, stomatal number, vein-islet number, vein termination number and palisade ratio.
4. Identification of crude drugs belonging to carbohydrates and lipids.
5. Study of fibres and pharmaceutical aids.
6. Preparation of herbarium sheets.

## HUMAN ANATOMY, PHYSIOLOGY & PATHOPHYSIOLOGY OF COMMON DISEASES-II

**Course Code: PHA- 438**

**Credit - 4**

**Unit-I:**

**Central Nervous System:**

Functions of different parts of brain and spinal cord. Neurohumoral transmission in the central nervous system, reflex action, electroencephalogram, specialized functions of the brain. Cranial nerves and their functions.

### **Autonomic Nervous System**

Physiology and functions of the autonomic nervous system. Mechanism of neurohumoral transmission the A.N.S.

### **Unit-II:**

#### **Cell injury & Adaptation**

Courses of cell injury, pathogenesis & morphology of cell injury.

#### **Cellular Adaptation**

Atrophy, hypertrophy, aplasia, metaplasia, & dysplasia, intracellular accumulation & pathophysiology of Neoplasm.

### **Unit III**

Basic mechanisms involved in the process of inflammation and repair Alterations in vascular permeability and blood flow, migration of WBC's, mediators of inflammation. Brief outline of the process of repair.

#### **Pathophysiology of Joints disorder**

Arthritis, gout, myasthenia gravis, spasticity, tetany, fatigue.

### **Unit-IV:**

**Demography and Family Planning**, Medical termination of pregnancy.

**First Aid** : Emergency treatment of shock, snake bites, burns, poisoning, fractures and resuscitation methods.

#### **Communicable Diseases**

Brief outline, their causative agents, modes of transmission and prevention (Chicken pox, measles, influenza, diphtheria, whooping cough, tuberculosis, poliomyelitis, helminthiasis, malaria, filariasis, rabies, trachoma, tetanus, leprosy, syphilis, gonorrhoea, and AIDS).

#### **Miscellaneous**

Pathophysiology of anaemia, AIDS, hypersensitivity, allergic conditions, epilepsy, Parkinson & Alzheimer's diseases pathophysiology of cataract, glaucoma etc.

**SEMESTER –IV  
PHARMACEUTICS – IV**

**(PHYSICAL PHARMACY)**

*THEORY*

**Course code: PHA-440**

**Credits-3**

1. **Micromeretic and Powder Rheology :** Particle size and distribution. Average particle size, number and weight distribution, particle number, methods for determining particle volume , optical microscopy, sieving , sedimentation, measurement, particle shape, specific surface, methods for determining surface area, permeability, adsorption, derived properties of powders, porosity, packing arrangement, densities, bulkiness and flow properties.
2. **Surface and interfacial Phenomenon:** Liquid interface, surface and interfacial tensions, surface free energy, measurement of 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. **Viscosity and Rheology :** Newtonian systems, Law of flow, kinematic viscosity, effect of temperature, non- Newtonian systems, pseudoplastic, dilatant, plastic, thixotropy in formulation, determination of viscosity, capillary, falling ball, rotational viscometers.
4. **Dispersion Systems :**  
**Colloidal Dispersions :**

Definition, types, properties of colloids, protective colloids, applications of colloids in pharmacy;

**Suspensions:**

Interfacial properties of suspended particles, settling in suspensions, theory of sedimentation, effect of Brownian movement, sedimentation of flocculated articles, sedimentation parameters, wetting of particles, controlled flocculation, flocculation in structured vehicles, rheological considerations;

**Emulsions:**

Types, identification, theories, preparation & physical stability.

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

**PHARMACEUTICS – IV  
(PHYSICAL PHARMACY)**

**PRACTICAL**

**Course code: PHA-441**

**Credits-2**

.Determination of particle size, particle size distribution and surface area using various methods of particle size analysis.

1. Determination of derived properties of powders like density, porosity, compressibility, angle of repose etc.

2. Determination of surface / interfacial tension, HLB value and critical micellar concentration of surfactants.
3. Study of rheological properties of various types of systems using different Viscometers.
4. Studies of different types of colloids and their properties.
5. Preparation of various types of suspensions and determination of their sedimentation parameters.
6. Preparation and stability studies of emulsions.
7. Studies on different types of complexes and determination of their stability constants.

### ***PHARMACEUTICAL MICROBIOLOGY***

#### **THEORY**

**Course Code: PHA-442**

**Credits-4**

1. Introduction to the scope of microbiology
2. Structure of bacterial cell
3. Classification of microbes and their taxonomy. Actinomycetes, bacteria, rickettsiae, spirochetes and viruses
4. Identification of microbes: Stains and types of staining techniques, electron microscopy.
5. Nutrition, cultivation, isolation of bacteria, actinomycetes, fungi, viruses, etc.
6. Control of microbes by physical and chemical methods.
  - a. Disinfection, factors influencing disinfectants, dynamics of disinfection, disinfectants, disinfectants and antiseptics and their evaluation.
  - b. Sterilization, different methods, validation of sterilization methods and equipment.
7. Sterility testing of all pharmaceutical products.
8. Immunity, primary and secondary, defensive mechanisms of body, microbial resistance, interferon.
9. Microbial assays of antibiotics, vitamins and amino acids as per pharmacopoeia..

### **PHARMACEUTICAL MICROBIOLOGY**

#### ***PRACTICAL***

**Course Code: PHA-443**

**Credits-2**

Experiments devised to prepare various types of culture media, subculturing of common aerobic and anaerobic bacteria, fungus and yeast, various staining methods, various methods of isolation and identification of microbes, sterilization techniques and their validation, evaluation of antiseptics and disinfectants, testing the stability of pharmaceutical products as per IP requirements, microbial assay of antibiotics and vitamins, etc.

### **PHARMACOGNOSY - II**

#### ***THEORY***

**Course code: PHA-444**

**Credits- 3**

**Resins** : Study of Drugs containing Resins and Resin Combination like Colophony, podophyllum, jalap, cannabis, capsicum, myrrh, asafoetida, balsam of tolu, balsam of peru, benzoin, turmeric, ginger.

1. **Tannins**: Study of tannins and tannin containing drugd like Gambir, black catechu, gall and myrobalans, Ashoka.
2. **Volatile Oils** : General methods of obtaining volatile oils from plants, Study of volatile oils of Mentha, Spearmint, Cinnamon, Cassia, Orange peel, Clove, Coriander, Fennel, Caraway, Dill, Nutmeg, Eucalyptus, Chenopodium, Cardamom, Valerian, Lemon grass, Citronella.
3. Utilization of aromatic plants and derived products with special reference to sandalwood oil, lemon grass oil, vetiver oil, geranium oil and eucalyptus oil.
4. Natural Allergans, Photosensitizing agents & fungal toxins
5. Chemotaxonomy of medicinal plants.
6. **Phytochemical Screening** :
  - a. An introduction to extraction, isolation, & purification.
  - b. classification and properties of phytoconstituents.
  - c. Screening of alkaloids, saponins, cardenolides and bufadienolides, flavonoids and leucoanthocyanidins, tannins and polyphenols, anthraquinones, cynogenetic glycosides, amino acids in plant extracts.

## **PHARMACOGNOSY - II**

### ***PRACTICAL***

**Course code: PHA-445**

**Credits- 3**

1. Identification of crude drugs mentioned in theory.
2. Microscopic studies of - selected crude drugs of volatile oils and their powders
3. Microscopic studies of - selected crude drugs and their powders mentioned under the category of resin & tannins in theory with their chemical tests.
4. General chemical tests for alkaloids, glycosides, steroids, flavonoids, resins and tannins.

## **HUMAN ANATOMY, PHYSIOLOGY & PATHOPHYSIOLOGY OF COMMON DISEASES-III**

### ***THEORY***

**Unit I**

**Digestive system**

Parts of digestive system, their structure and functions. Various gastrointestinal secretions & their role.

Pathology of disorders related to digestive system Peptic Ulcer, Ulcerative colitis, Crohns disease, Zollinger- Ellison syndrome, Amoebiasis, typhoid, Hepatitis, Cirrhosis of liver, pancreatitis.

**Unit-II**

**Urinary System**

Anatomy & physiology of urinary system, physiology of urine formation, acid- base balance, pathophysiology of renal feature, glomerulonephritis, Urinary tract infection.

**Reproductive system**

Male & female reproductive system. Menstruation, Pathophysiology of sexually transmitted diseases, spermatogenesis, oogenesis, pregnancy.

**Unit-III**

**Endocrine system**

Anatomy & Physiology of pituitary, thyroid, parathyroid, adrenal, pancreas, control of hormone secretion, pathophysiology of hypo & hyper secretion of endocrine glands & their disorders e.g. – Diabetes mellitus.

**Unit-IV**

**Respiratory System**

Anatomy & function of respiratory structures, Mechanism of respiration, regulation of respiration, pathophysiology of Asthma, Pneumonia, Bronchitis, Emphysema, Tuberculosis.

**Unit-V**

**Cardiovascular System**

Functional Anatomy of heart, conducting system of heart, cardiac cycle, ECG (Electro cardiogram). Pathophysiology of hypertension, Angina, CHF, myocardial infarction, cardiac arrhythmias, Ischaemic heart disease, Arteriosclerosis.

**SEMESTER –V**  
**PHARMACEUTICAL CHEMISTRY-V**  
**(BIOCHEMISTRY)**

***THEORY***

**Course Code: PHA-550**

**Credits-3**

1. Biochemical organization of the cell and transport processes across cell membrane.
2. The concept of free energy, determination of change in free energy from equilibrium constant and reduction potential, bioenergetics, production of ATP and its biological significance.
3. **Enzymes:** Nomenclature, enzyme kinetics and its mechanism of action, mechanism of inhibition, enzymes and iso enzymes in clinical diagnosis.
4. **Co-enzymes:** Vitamins as co-enzymes and their significance. Metals as co-enzyme and their significance.
5. **Carbohydrate Metabolism:** Conversion of polysaccharide to glucose –1-phosphate, Glycolysis and fermentation and their regulation, Gluconeogenesis and glycogenolysis, Metabolism of galactose and galactosemia, Role of sugar nucleotides in biosynthesis, and Pentosephosphate pathway.
6. **The Citric acid Cycle:** Significance, reaction and energetic of the cycle, Amphibolic role of cycle, and glyoxalic acid cycle.
7. **Lipid Metabolism:** Oxidation of fatty acids,  $\beta$ - oxidation & energetic,  $\alpha$ -oxidation,  $\omega$  oxidation, Biosynthesis of ketone bodies and their utilization. Biosynthesis of saturated and unsaturated fatty acids, control of lipid metabolism, Essential fatty acid and eicosanoids (prostaglandins, thromboxanes and leukotrienes), phospholipids and sphingolipids.
8. **Biological oxidation:** Redox –potential, enzymes and coenzymes involved in oxidation reduction its control, The respiratory chain, its role in energy capture and its control, Energetic of oxidative phosphorylation, inhibitors of respiratory chain and oxidative phosphorylation. Mechanism of oxidative phosphorylation
9. **Metabolism of Ammonia and nitrogen containing Monomers:** Nitrogen balance, Biosynthesis of amino acids, Catabolism of amino acids, conversion of amino acids to specialized

products, assimilation of ammonia, urea cycle, Metabolism of sulphur containing amino acids, Porphyrin biosynthesis, and formation of porphyrin pigments, hyperbilirubinemia, purine biosynthesis, urine nucleotide interconversion, Pyrimidine biosynthesis, and formation of deoxyribonucleotides

11. **Biosynthesis of Nucleic Acids:** Brief introduction of genetic organization of the mammalian genome, alteration and rearrangements of genetic material, Biosynthesis of DNA and its replication, Mutation, physical and chemical mutagenesis / carcinogenesis, DNA repair mechanism biosynthesis of RNA.

12. Brief account on genetic engineering, polymerase chain reactions.

Genetic code and protein synthesis:

### **PHARMACEUTICAL CHEMISTRY-V (BIOCHEMISTRY)**

#### ***PRACTICAL***

**Course Code: PHA-551**

**Credits-2**

1. Preparation of standard buffers (citrate, phosphate and carbonate) and measurement of pH.
2. Separation of amino acids by chromatography.
3. The determination of glucose by means of the enzyme glucose oxidase. Enzymatic hydrolysis of glycogen by  $\alpha$  &  $\beta$  amylase.
4. Effects of temperature on the activity of alpha amylase.
5. Qualitative analysis of inorganic as well as organic constituents of Urine.
6. Titration curve for amino acids.
7. The separation of lipids by TLC.
8. Quantitative estimation of amino acids.
9. Estimation of cholesterol in Blood.
10. Estimation of Glucose in blood & urine.
11. Estimation of Urea in blood.
12. Estimation of ketone bodies in blood. Estimation of cholesterol in Blood.

### **PHARMACEUTICS - V (PHARMACEUTICAL TECHNOLOGY- I)**

#### ***THEORY***

**Course Code: PHA-552**

**Credits-3**

**1. LIQUID DOSAGE FORMS:** Introduction, types of additives used in formulations, vehicles, stabilisers, preservatives, suspending agents, emulsifying agents, solubilizer, colors, flavours and

others, manufacturing packaging and evaluation of clear liquids, suspensions and emulsions official in pharmacopoeia.

**2.SEMISOLID DOSAGE FORMS:** Definitions, types, mechanism of drug penetration, factors influencing penetration, semisolid bases and their selection. General formulation of semisolids, clear gels manufacturing procedure, evaluation and packaging.

**3. SUPPOSITORIES:** Ideal requirements, bases , manufacturing procedure ,packaging and evaluation.

**4.EXTRACTION AND GALANICAL PRODUCTS:** Principle and method of extraction, preparation of infusions, tinctures, dry and soft liquid extracts

**5. PHARMACEUTICAL AEROSOLOS:** Definition, propellants, and general formulation, manufacturing and packing methods, pharmaceutical applications

**6.Packaging of Pharmaceutical Products:** Packaging components, types, specifications and methods of evaluation, stability aspects of packaging. Packaging equipments, factors influencing choice of containers, legal and other official requirements for containers, package testing.

**7. COSMETICOLOGY AND COSMETIC PREPARATIONS:** Fundamentals of cosmetic science, structure and functions of skin and hair. Formulation, preparation and packaging of cosmetics for skin, hair, dentifrice and manicure preparation like nail polish ,lipsticks, eye lashes, baby care products etc.

PHARMACEUTICS V  
(PHARMACEUTICAL TECHNOLOGY I)  
*PRACTICALS*

**Course Code: PHA-551**

**Credits-2**

- 1. Preparation, evaluation and packaging of liquid orals like solutions, suspensions and emulsions, ointments, suppositories, aerosols, eye drops, eye ointments etc.*
2. Preparation of pharmacopoeia extracts and galanical products utilizing various methods of extraction.
3. Formulation of various types of cosmetics for skin, hair, dentifrices and manicure preparations.

**PHARMACEUTICS- VI**  
**(HOSPITAL PHARMACY & COMMUNITY PHARMACY)**

***THEORY***

**Course Code: PHA-554**  
**Credits-3**

1. **Organization and structure:** Organization of a hospital and hospital pharmacy, responsibilities of a hospital pharmacist, pharmacy and therapeutic committee, budget preparation and implementation.
2. **Hospital formulary:** Contents, preparation and revision of hospital formulary.
3. **Prescription :** Handling of prescription, source of errors in prescription, care required in dispensing procedures including labeling of dispensed products.

General dispensing procedures including labeling of dispensed products.

**4. Drug store management and inventory control:**

- a. Organization of drug store, types of materials stocked and storage conditions.
- b. Purchase and inventory control principles, purchase procedures, purchase order, procurement and stocking.

**5. Drug distribution systems in hospitals:**

- c. out-patient dispensing, methods adopted.
- d. Dispensing of drugs to in-patients. Types of drug distribution systems. Charging policy, labeling.
- e. Dispensing of drugs to ambulatory patients.
- f. Dispensing of controlled drugs.

**6. Central sterile supply unit and their management:** Types of materials for sterilization, packing of materials prior to sterilization, sterilization equipments, supply of sterile materials.

**7. Drug information services:** Sources of information on drugs, disease, treatment schedules, procurement of information, computerized services (Medline), Retrieval of information, medication error.

**8. Nuclear pharmacy:** production of radio-pharmaceuticals, methods of isotopic tagging, preparation of radio-isotopes ,radio isotope generators, permissible radiation dose level, Role of pharmacist in handling radio isotopes.

**9. Surgical products:** Definition, Primary wound dressing, absorbents, surgical gauzes etc., bandages, adhesive tape, protective cellulosic hemostatics, official dressings, absorbable nonabsorbable sutures, ligatures and catguts. Medical prosthetics and organ replacement materials

**10. Community Pharmacy :** Organisation and structure of retail and whole sale drug store types of drug store design, legal; requirements for establishment, maintenance and drug store-

dispensing of proprietary products, maintenance of records of retail and whole sale, patient counseling, role of pharmacist in community health care and education.

### **PHARMACOGNOSY-III**

#### **THEORY**

**Course Code: PHA-555**

**Credits-3**

1. Study of the biological sources, cultivation, collection, commercial varieties, chemical constituents, substitutes, adulterants, uses, diagnostic macroscopic and microscopic features and specific chemical tests of following groups of drugs containing glycosides:
  - (i) **Saponins:** Liquorice, Ginseng, Methi, dioscorea, and senega.
  - (ii) **Cardioactive sterols :** Digitalis, Squill, Strophanthus and thevetia
  - (iii) **Anthraquinone cathartics :** Aloe, Senna, Rhubarb and Cascara.
  - (iv) **Others :** Psoralea, *Ammi majus* *Ammi visnaga* Gentian, Saffron, Chirata, Quassia, Kalmegh.
2. Studies of traditional drugs, common vernacular names, botanical sources, morphology, chemical nature of chief constituents, pharmacology, categories and common uses and marketed formulations of following indigenous drugs:

Amla, satavari, Tylophora, Kalijiri, Bach, Punarnava, Chitrack, Aparnarg, Gokhru, Shankhapusphi, Brahmi, Adusa, Lahsun, ,Guggal, Gymnema, Shilajit, Nagarmotha, Stevia and Neem.
3. The holistic concept of drug administration in traditional systems of medicine. Introduction to ayurvedic preparations like Aristas, Asvas, Gutikas, Tailas, Churnas, Lehyas and Bhasmas.
4. Role of medicinal and aromatic plants in national economy.
5. A brief account of plant based industries and institutions involved in work on medicinal and aromatic plants in India
6. World-wide trade in medicinal plants and derived products with special refernce to diosgenin (Dioscorea), taxol (Taxus sps) digitalis, Liquorice, Ginseng, Aloe, and plants containing laxatives.
7. Utilization and production of phytoconstituents such as calcium Sennoside, podophyllotoxin, diosgenin.
8. Herbs as health foods And Herbal cosmetics.

### **PHARMACOGNOSY - III**

#### ***PRACTICAL***

**Course Code: PHA-556**

**Credits-2**

### **Identification of crude drugs listed in theory.**

1. Microscopic study of some important glycoside containing crude drugs as outlined above. Study of powdered drugs.

Standardization of some traditional drug & their formulations

## **PHARMACOLOGY – I**

### ***THEORY***

**Course Code: PHA- 557**

**Credit – 3**

#### **Unit-I :**

##### **General Pharmacology**

Introduction to pharmacology, sources of drugs, dosage forms & routes of administration, mechanism of action, concept of receptors, combined effect of drugs, factors modifying drug action, tolerance & dependence, absorption, distribution.

#### **Unit-II :**

Metabolism & excretion of drugs, principles of Clinical Pharmacokinetics. Adverse drug reactions & treatment of poisoning. ADME drug interactions, Bioassay of drugs & Biological standardization. Discovery & development of new drugs.

#### **Unit-III :**

##### **Pharmacology of ANS**

a) Neurohumoral transmission (autonomic & somatic)

b) Parasympathomimetics, Parasympatholytics, Sympathomimetics, adrenergic receptor & neuron blocking agents, ganglionic stimulants & blocking agents.

#### **Unit-IV :**

##### **Pharmacology of CNS**

- a. Neurohumoral transmission in the CNS
- b. General anesthetics
- c. Alcohols and disulfiram
- d. Sedatives, hypnotics, anti-anxiety agents, and centrally acting muscle relaxants
- e. Psychopharmacological agents (anti-psychotics), anti depressants, anti-manics and hallucinogens
- f. Anti-epileptics drugs
- g. Anti-parkinsonian drugs
- h. Analgesics, antipyretics, anti-inflammatory and anti-gout drugs

- i. Narcotic analgesics and antagonists
- j. CNS stimulants
- k. Drug addiction and drug abuse

**Unit-V:**

**Drugs acting on PNS**

Neuromuscular blockers, Local anaesthetics.

**PHARMACOLOGY- I**

***PRACTICAL***

**Course Code: PHA- 558**

**Credit - 3**

**1. Introduction to Experimental Pharmacology:**

Preparation of different solutions for experiments

Drug dilutions, use of molar and w/v solutions in experimental pharmacology.

Commonly used instruments in experimental pharmacology

Commonly used animals and anesthetics used in animal studies.

Some common and standard techniques

Bleeding and intravenous injection, intragastric administration.

Procedures for rendering animals unconscious- stunning of rodents, pithing of frogs, chemical euthanasia.

**2. Experiments on Intact Preparations**

Study of different routes of administration of drugs in mice /rats

To study the effect of hepatic microsomal enzyme inhibitors and induction on the pentobarbitone sleeping time in mice.

**3. Experiments on Central Nervous System**

Recording of spontaneous motor activity, stereotypy, analgesia, anticonvulsant activity, anti-inflammatory activity and muscle relaxant activity of drugs using simple experiments

**SEMESTER VI**

**PHARMACEUTICAL CHEMISTRY-VI  
(MEDICINAL CHEMISTRY-I)**

***THEORY***

**Course Code: PHA-560**

**Credits-3**

**Basic principles of Medicinal Chemistry:** Physio-chemical aspects (Optical, geometric and bio-isoterism) of drug molecules and Biological action. Drug receptor interaction including transduction mechanisms. Drug-receptor interaction including transduction mechanism, concept of prodrug.

**Mode of action, uses, structure activity relationship of the following classes of drugs (Synthetic procedures of individually mentioned drugs only)**

**Drugs acting at Synaptic and neuro-effector junction sites:**

Cholinergic, Anticholinergic & Anticholinesterases-Neostigmine, carbachol, Methacholine, dicyclamine, Atropine.

Adrenergic Drugs-Ephedrine, Isoproterenol, Amphetamine, Salbutamol, Terbutaline, Adrenaline, methyl dopa.

**Psychopharmacological Agents :**

Antispasmodic and Antiulcer drugs-Dicyclomine, Ranitidine, Omeprazole.

Neuromuscular Blocking Agents – Gallamine Mephenesin, Pancuronium.

Neuroleptics – Imipramine, Amitriptyline, fluoxetine, buspirone, phenazine.

Antidepressants – Meprobamate, Chlordiazepoxide, Diazepam, phenobarbital, pentobarbital.

**Autocoids :**

**Antihistaminics :** Diphenhydramine, Promethazine, Cyproheptadine, Cetrizine. Ranitidine, Famotidine, ketofen, promethazine.

**Drugs acting on the Central Nervous System :**

General Anaesthetics-Thiopental, Ketamine, Methohexital.

Local Anaesthetics-Lignocaine, Benzocaine.

Hypnotics and Sedatives-Phenobarbitone, Pentobarbitone, alprazolam,

Opioid Analgesics-Pethidine, Methadone, Pentazocine.

**Analgesics-antipyretics, anti-inflammatory (Non steroidal) agents** Aspirin, Mefenamic Acid, Ibuprofen, Diclofenac,

### **Drugs affecting uterine motility**

Oxytocics (including oxytocin and ergot alkaloid.), **Eicosanoids** Misoprostol, Carboprost.

## **PHARMACEUTICAL CHEMISTRY-VI (MEDICINAL CHEMISTRY-I)**

### **PRACTICAL**

**Course Code: PHA-561**

**Credits-2**

1. Synthesis of selected drugs from the course content involving two or more steps.
2. Establishing the pharmacopoeial standards of the drugs synthesized.

## **PHARMACEUTICS VII (BIOPHARMACEUTICS & PHARMACOKINETICS)**

### **THEORY**

**Course Code: PHA-562**

**Credits-3**

1. Introduction to biopharmaceutics and Pharmacokinetics and their role in formulation development and clinical setting.
2. **Biopharmaceutics**
  - a. Factors influencing absorption- physiochemical, physiological and pharmaceutical.
  - b. Plasma protein binding.
3. **Pharmacokinetics**
  - a. Significance of plasma drug concentration measurements.
  - b. Compartment kinetics – Definition & scope. One compartment and two compartment models. Determination of pharmacokinetic parameters from plasma and urine data after drug administration by intravascular and oral route.
  - c. Pharmacokinetics of drug absorption- Zero order and first order absorption rate constant using wagner- Nelson and Loo Reigelman method.
  - d. Volume of distribution and distribution coefficient.
  - e. Clearance concept, mechanism of renal clearance, clearance ratio, determination of clearance.
  - f. Extraction ratio, hepatic clearance, biliary excretion, Entero-hepatic circulation.
  - g. Non-linear pharmacokinetics with reference to one compartment model after I.V. drug administration, Michaelis Menton Equation, detection of non-linearity (saturation mechanism)
4. **Clinical Pharmacokinetics**
  - a. Dosage adjustment in patients with & without renal hepatic failure.
5. **Bio-availability and bio-equivalence:**

- a. Measures of bioavailability,  $C_{max}$ ,  $T_{max}$  and Area Under the Curve (AUC)
- b. Design of single dose bio-equivalence study and relevant statistics.

## PHARMACEUTICS VII

### *(BIOPHARMACEUTICS & PHARMACOKINETICS)*

#### **PRACTICAL**

*Course Code: PHA 563*

*Credits -2*

1. In vitro evaluation of different dosage forms for drug release.
2. Interpretation of Data's as mentioned in the above topics.

## PHARMACEUTICAL JURISPRUDENCE & ETHICS

**Course Code: PHA-564**

**Credits-4**

1. Introduction
  - a. Pharmaceutical legislations – A brief review.
2. An elaborate study of the following
  - b. Pharmaceutical Ethics
  - c. Pharmacy Act 1948
  - d. Drugs & Cosmetics Act 1940 & rules 1945.
  - e. Medicinal toilet Preparations (excise Duties) Act 1955.
  - f. Narcotic Drugs & Psychotropic Substances Act 1985 & rules.
  - g. Drugs Price Control order.
3. A brief study of the following with special reference to the main provisions.
  - a. poisons Act 1919.
  - b. Drugs & Magic remedies (Objectionable advertisements) Act 1954
  - c. Medical Termination of pregnancy Act 1970 & rules 1975
  - d. States Shops & establishments Act & rules.
  - e. Ipr & Patent Act 1970.
  - f. Prevention of cruelty to animals act.

**Note:** The Teaching of all the above **Acts** should cover the latest amendments

## PHARMACOGNOSY- IV

### *THEORY*

**Course Code: PHA-565**

**Credits-3**

1. Systemic study of source, cultivation, collection, processing, commercial varieties, chemical constituents, substitutes, adulterants, uses, diagnostic, macroscopic and microscopic features and specific chemical tests of following alkaloid containing drugs:

- a. Pyridine- Piperidine: Tobacco, Areca, and Lobelia
  - b. Tropane: Belladonna, Hyoscyamus, Datura, Coca, and Withania
  - c. Quinoline and isoquinoline: Chincona, Ipecac, Opium
  - d. Indole: Ergot, Rawolfia, Canthanathus, Nux-vomica
  - e. Imidazole: Pilocarpus
  - f. Steroidal: Veratrum, and Kurchi
  - g. Alkalioidal amine: Ephedra and Colchicum
  - h. Glycoalkaloid: Solanum xanthocarpum
  - i. Purines: Coffee, Tea
2. Biological sources, preparation, identification, tests and uses of the following enzymes: Diastase, Papain, streptokinase, Penicillinase, Haluronidase, Urokinase
3. Plant bitters and sweeteners
4. Introduction, classification and study of different chromatographic methods and their applications in evaluation of herbal drugs.
5. World-wide trade in medicinal plants and derived products with special reference to tropane alkaloid containing plants, Cinchona, Ipecac, Valerian, Rauwolfia and Papain .
5. Utilization and production of phytoconstituents such as Quinine, Solasodine & Tropane alkaloids.
6. Marine Pharmacognosy

## **PHARMACOGNOSY- IV**

### ***PRACTICAL***

**Course Code: PHA-566**

**Credits-2**

1. Identification of crude drugs listed above.
2. Microscopic study of characters of eight- selected drugs given in theory in entire and powder form
3. Chemical evaluation of powdered drugs and enzymes
4. Chromatographic studies of some herbal constituents.

## **PHARMACOLOGY – II**

### ***THEORY***

**Course Code: PHA- 567**

**Credit – 4**

**Unit-I:**

**Pharmacology of Cardiovascular System**

- a) Digitalis and cardiac glycosides.
- b) Antihypertensive drugs.
- c) Antianginal and vasodilator Drugs, including calcium channel blockers and beta-adrenergic antagonists.
- d) Antiarrhythmic drugs
- e) Antihyperlipidemic drugs.
- f) Drugs used in the therapy of shock.

**Unit-II:**

**Drugs Acting on Hemopoietic System**

- a) Hematinics.
- b) Anticoagulants, Vitamin K and haemostatic agents.
- c) Fibrolytic and anti-platelet drugs.
- d) Blood and plasma volume expanders.

**Unit III:**

**Drugs Acting on Respiratory System**

- a) Anti-asthmatic drugs including bronchodilators.
- b) Anti-tussives and expectorants.
- c) Respiratory stimulants.

**Unit-IV:**

**Autocoids**

- a) Histamine, 5-HT and their antagonists.
- b) Prostaglandins, thromboxanes and leukotrienes.
- c) Pentagastrin, Cholecystokinin, Angiotensin, Bradykinin and Substance P.

**Unit-V:**

**Drug acting on the Gastro Intestinal tract**

- a) Antacids, antisecretory and anti-ulcer drugs.
- b) Laxatives and antidiarrhoeal drugs.
- c) Emetics and anti-emetics.

**Unit VI:**

**Drugs acting on urinary system**

- a) Fluid and electrolyte balance.
- b) Diuretics.

- a) To record the dose response curve (DRC) of Acetylcholine using ileum of rat / rectus abdominis muscle preparation of frog.
- b) To study the effects of Physostigmine and d-tubocurarine on the CRC of acetylcholine using rat ileum / rectus abdominis muscle preparation of frog.
- c) To record the CRC of 5-HT on rat fundus preparation.
- d) To study the parallel shift of DRC in presence of competitive antagonist on DRC of Ach using frog/ rat ileum.
- e) To study the CRC of histamine on guinea pig on ileum preparation & study the effect of antihistaminics.
- f) Effects of autonomic drugs on rabbit eye.

## SEMESTER –VII

### PHARMACEUTICAL CHEMISTRY – VII

#### (MEDICINAL CHEMISTRY-II)

#### ***THEORY***

*Course Code: PHA-570*

*Credits: 3*

Synthetic procedures of selected drugs, mode of action, uses, structure activity relationship including Physio-chemical properties of the following classes of drugs.

**Cardiovascular Agents** – Antianginal & vasodilators, antiarrhythmics, antihypertensives, anticoagulants and Antiplatelet drugs,

antihyperlipidemics & cardiotonics – Nifedipine, Procainamide, Propranolol, Methyldopa, Captopril, guanethidine.

Clofibrate, Warfarin, Phenidione.

**Antibacterials** – Sulphamethoxazole, Sulphadiazine, Sulphacetamide, Nalidixic acid. [08]

**Diuretics** – Acetazolamide, Chlorthiazide; Frusemide, Spironolactone triamtrine.

**Steroids and related drugs** : Introduction, Classification, Nomenclature & Stereochemistry.

(A) Androgens and Anabolic steroids – Testosterone, Stanozolol.

(B) Estrogens and Progestational agents – Progesterone, Estradiol.

(C) Adrenocorticoids – Prednisolone, Dexamethasone, Betamethasone.

**Antibiotics**-Penicillins, Semi-synthetic, penicillins, streptomycin, tetracyclines, Cephalosporins, Chloramphenicol, Fluroquinolones.

**Antimalarials:** Cholroquine, Primaquine, Pyrimethamine

**Antiparkinsonism drugs**-Carbidopa, Levodopa.

**CNS Stimulants**-Caffeine, Nikethamide.

**Antiseptic and disinfectant** nalidixic acid

**Antitussives**-Cramiphen, Dextromethorphen.

**Anticonvulsants**-Phenytoin, Carbamazepine, Ethosuximide, Valproic Acid.

## PHARMACEUTICAL CHEMISTRY – VII

### (MEDICINAL CHEMISTRY-II)

#### *PRACTICAL*

*Course Code: PHA-571*

*Credits: 2*

1. Synthesis of selected drugs from the course content involving two or more steps.
2. Establishing the Pharmacopoeial standards of the drugs synthesized.
3. Spectral analysis of the drugs synthesized.

## PHARMACEUTICS-VIII

## (PHARMACEUTICAL TECHNOLOGY II)

### ***THEORY***

Course Code: PHA-572

Credits: 3

#### **1. Tablets:**

- a) Formulation of different types of tablets, granulation technology on large-scale by various techniques, physics of tablets making, different types of tablet compression machinery and equipments employed, evaluation of tablets.
- b) Coating of Tablets: Types of coating, film forming materials, formulation of coating solution, equipments for coating, coating process, evaluation of coated tablets.

Stability kinetics and quality assurance.

**2. Capsules:** Advantages and disadvantages of capsule dosage form, material for production of hard gelatin capsules, size of capsules, method of capsule filling, soft gelatin, capsule shell and capsule content, importance of base absorption and minimum/gm factors in soft capsules, quality control, stability testing and storage of capsule dosage forms.

#### **3. sterile products.**

##### **i. Parenteral Products:**

- a) Preformulation factors, routes of administration, water for injection, pyrogenicity, nonaqueous vehicles, isotonicity and methods of its adjustment.
- b) Formulation details, containers and closures and selection.
- c) Prefilling treatment, washing of containers and closures, preparation of solution and suspensions, filling and closing of ampoules, vials, infusion fluids, lyophilization and preparation of sterile powders, equipment for large-scale manufacture and evaluation of parenteral products.
- d) Aseptic Techniques-source of contamination and methods of prevention, Design of aseptic area, laminar low bench services and maintenance.

Sterility testing of pharmaceuticals.

**ii. Ophthalmic preparations:** Requirements, formulations and method of preparation, containers and evaluation.

**4. Microencapsulation:** Types of microcapsules, importance of microencapsulation in pharmacy, micro encapsulation by phase separation, coacervation, multi orifice, spray drying, spray congealing, polymerization complex emulsion, air suspension technique, coating pan and other techniques, evaluation of microcapsules.

## PHARMACEUTICS-VIII

## (PHARMACEUTICAL TECHNOLOGY II)

### PRACTICAL

Course Code: PHA-573

Credits: 2

1. Experiments to illustrate preparation, stabilization, physical and biological evaluation of pharmaceutical products like powders, capsules, tablets, parenterals, microcapsules, surgical dressing etc.
2. Evaluation of materials used in pharmaceutical packaging.

### PHARMACEUTICAL BIOTECHNOLOGY

#### THEORY

Course Code: PHA-574

Credits: 4

1. **Immunology and Immunological preparations:** Principles, antigens and haptens, immune system, cellular humoral immunity, immunological tolerance, antigen-antibody reactions and their application. Hypersensitivity, Active & Passive immunization; Vaccines-their preparation, standardization and storage.
2. **Genetic Recombination:** Transformation, conjugation, transduction, protoplast fusion and gene cloning and their applications. Development of hybridoma for monoclonal antibodies. Study of drugs produced by biotechnology such as activase, humulin, and humatrope, HB etc.
3. **Antibiotics:** Historical development of antibiotics. Antimicrobial spectrum and methods for their standardization. Screening of soil for organisms producing antibiotics, fermenter, its design, and control of different parameters. Isolation of mutants, factors influencing rate of mutation. Design of fermentation process. Isolation of fermentation products with special reference to penicillins, streptomycins, tetracyclines and vitamin B<sub>12</sub>.
4. **Microbial transformation:** Introduction, types of reactions mediated by microorganisms, design of biotransformation process and its improvements with special reference to steroids.
5. **Enzyme Immobilization:** Techniques of immobilization, factors affecting enzyme kinetics. Study of enzymes such as hyaluronidase, penicillinase, streptokinase and streptodornase, amylases and proteases etc. Immobilization of bacteria and plant cells
6. **BLOOD PRODUCTS AND PLASMA SUBSTITUTES:** Collection, processing and storage of whole human blood, concentrated human RBCs, dried human plasma, human fibrinogen, human thrombin, human normal immunoglobulin, human fibrin, foam plasma substitutes- ideal requirements, PVP, Dextran etc. for control of blood pressure as per I.P

### PHARMACEUTICAL INDUSTRIAL MANAGEMENT

#### THEORY

Course Code: PHA-575

Credits: 3

1. **Concept of Management:** Management and Administration (Planning, Organizing, Staffing, Directing and Controlling), Entrepreneurship development, Operative Management. Principles of Management (Co-ordination, Communication,

Motivation, Decision-making, leadership, Innovation, Creativity, Delegation of Authority/ Responsibility, Record Keeping). Identification of key points to give maximum thrust for development and perfection.

**2. Accountancy:**

Principles of Accountancy, Ledger posting and book entries, preparation of trial balance, columns of a cash book, bank reconciliation statement, rectification of errors, profits and loss account, balance sheet, purchase, keeping and pricing of stocks, treatment of cheques, bills of exchange.

**3. Economics:** Principles of economics with special reference to the laws of demand and supply, demand schedule, demand curves, labor welfare, general principles of insurance and inland and foreign trade, procedure of exporting and importing goods.

**4. Pharmaceutical Marketing:** Functions, buying, selling, transportation, storage, finance, feedback, information, channels of distribution, wholesale, retail, departmental store, multiple shop and mail order business, Function of Markets.

**5. Salesmanship:** Principles of sales promotion, advertising, ethics of sales, merchandising literature, detailing. Recruitment, training, evaluation, compensation to the pharmacist and direct marketing.

**6. Market research:**

(a) Measuring and Forecasting Market Demands: Major concept in demand measurement, estimating current demand, estimating industry sales, Market share and future demand.

(b) Market segmentation and Market Targeting.

**7. Production management:**

A brief exposure of the different aspects of production management- Performance Evaluation Technique, Process-Flow, Process Know-how, Maintenance Management.

Introduction of Material management with inventory and evaluation of material management.

PHARMACOGNOSY-V

(CHEMISTRY OF NATURAL PRODUCTS)

*THEORY*

*Course Code: PHA-576*

*Credits:3*

1. Introduction to -
  - a. Chemical and spectral approaches to simple molecules of natural origin.
  - b. Stereoisomerism taking examples of natural products.
2. General techniques of biosynthetic studies and basic metabolic pathways. Brief introduction to biogenesis of secondary metabolites of pharmaceutical importance.

3. Chemistry, biogenesis and important pharmacological activity of following phytoconstituents
  - a. Medicinally important monoterpenes, sesquiterpene, diterpenes, and triterpenoids.
  - b. Carotenoids:  $\alpha$ -carotenoids,  $\beta$ -crotenes, vitamin A, Xanthophylls of medicinal importance.
  - c. Glycosides: digitoxin, sennosides, diosgenin
  - d. Alkaloids: atropine and related compounds, quinine, reserpine, morphine, ephedrine, ergot
  - e. Lignans, Quassanoids & flavonoids.
4. Extraction & Isolation procedures of-  
Terpene, Carotene, Digitoxin, Sennoside, Atropine, Quinine, Reserpine, Morphine, Flavanoids.
5. Chemistry and therapeutic activity of Penicillin, Streptomycin and Tetracyclines.
6. Historical development of plant tissue culture, types of cultures, nutritional requirements, growth and their maintenance. Applications of plant tissue in pharmacognosy.

**PHARMACOGNOSY- V**  
**(CHEMISTRY OF NATURAL PRODUCTS)**

***PRACTICAL***

**Subject Code: PHA-577**

**Credits: 2**

- 1) Laboratory experiments on isolation, separation, purification of various groups of chemical constituents of pharmaceutical significance.
- 2) Exercises on paper and thin layer chromatographic evaluations of herbal drug constituents.
- 3) Extraction of volatile oils and their chromatographic profiles.
- 4) Introductory Technique experiments in plant tissue culture.

**PHARMACOLOGY –III**

***THEORY***

**Course Code: PHA- 578**

**Credit – 3**

**Unit-I:**

### **Pharmacology of endocrine system**

- a) Hypothalamic and pituitary hormones.
- b) Thyroid hormones and antithyroid drugs, parathormone, calcitonin and vitamin D.
- c) Insulin, oral hypoglycaemic agents & glucagons.
- d) ACTH and corticosteroids.
- e) Androgens and anabolic steroids.
- f) Estrogens, progesterone and oral contraceptives.
- g) Drugs acting on the uterus.

### **Unit II:**

- a) General principles of chemotherapy.
- b) Sulfonamides and co-trimoxazole.
- c) Antibiotics-penicillin, cephalosporins, chloramphenicol, erythromycin quinolones and miscellaneous antibiotics.

### **Unit III:**

#### **Chemotherapy**

- a) Chemotherapy of tuberculosis leprosy, fungal diseases, viral diseases, urinary tract infection and sexually transmitted diseases.
- b) Chemotherapy of malignancy and immunosuppressive agents.

### **Unit IV:**

#### **Principles of Toxicology**

- a) Definition of poison, general principles of treatment of poisoning with particular reference to barbiturates, opioids, organophosphorous and atropine poisoning.
- b) Heavy metals and heavy metal antagonists.

## **PHARMACOLOGY –III**

### **PRACTICAL**

**Course Code: PHA- 579**

**Credit – 3**

#### **Experiments on Isolated Preparations:**

- a) To calculate the pA<sub>2</sub> value of Atropine & chlorpheniramine using acetylcholine as an agonist on rat ileum preparation.
- b) Bioassay of Ach, histamine & oxytocin on suitable isolated preparations using matching bioassay, bracketing bioassay, three point assay & four point bioassay.

## SEMESTER VIII

### *PHARMACEUTICAL ANALYSIS-III*

#### **THEORY**

Course code: PHA-580

Credits-3

GLP, ISO 9000, TQM, Quality Review and Quality Documentation.

Regulatory control, regulatory drug analysis, interpretation of analytical data.

Validation, quality audit: quality of equipment, validation of equipment, and validation of analytical procedures.

**Ultraviolet and Visible Spectrophotometry :** Electronic, excitation, quantitative laws, deviation from Beer's law, graphical presentation of data. Chromophores photometric error, instrumentation, single and double beam spectrophotometer.

Colorimetric methods : Chemistry of colorimetry, instrumentation, application (direct methods and indirect methods). Nephelometry & turbidimetry and densitometry.

**Infra Red Spectrophotometry :** Theory, characteristics absorbance, bands of organic functional groups, interpretation of infrared absorption spectra, preparation of sample, sample cells, IR instrumentation qualitative and quantitative applications in pharmaceutical analysis.

**Fluorimetric Analysis :** Theory, quantitative description, experimental factors affecting fluorescence intensity, factors affecting IC and F directly, relationship of fluorescence to molecular structure, instrumentation, correction of spectra, pharmaceutical applications.

**Nuclear Magnetic Resonance Spectroscopy**

An introduction to the theory of  $^1\text{H-NMR}$ , chemical shift & spin-spin coupling, spectra of ( $\text{CH}_3\text{CH}_2\text{-OH}$ ,  $\text{Cl-CH}_2\text{OH}$ ,  $\text{CH}_3\text{-CHO}$ ,  $\text{CH}_3(\text{CH}_2)_4\text{CH}_3$ ,  $\text{C}_6\text{H}_6$ ,  $\text{CH}_3\text{C}_6\text{H}_5$ ).

### **Mass Spectrometry**

Introduction to mass spectra, molecular ion peak, fragmentation peaks, mass spectra of some simple

compounds.

### **Flame Photometry**

Origin of spectra, atomization and ionization, instrumentation, background emission, interference, qualitative & quantitative applications in pharmaceutical analysis.

### **Theory, instrumentation and applications of:**

Emission Photometry

Atomic absorption spectroscopy

## ***PHARMACEUTICAL ANALYSIS-III***

### **PRACTICAL**

***Course code: PHA-581***

***Credits-3***

1. Quantitative estimation of at least ten formulations containing single drug or more than one drug, using instrumental techniques.
2. IR of samples with different functional groups ( $-\text{COOH}$ ,  $-\text{COOR}$ ,  $-\text{CONHR}$ ;  $-\text{NH}_2\text{-NHR}$ ,  $-\text{OH}$ , etc.).
3. workshop to interpret the structure of simple organic compounds using UV, IR, NMR and MS.

## **PHARMACEUTICAL CHEMISTRY-VIII**

**(MEDICINAL CHEMISTRY III)**

## **THEORY**

**Course code: PHA-582**

**Credits-3**

Drug metabolism and Concepts of Prodrugs.

Principles of Drug Design: Traditional analogs. Introduction to QSAR and mechanism based approaches,

Computer –aided drug design and molecular modeling. Biochemical approaches in drug designing wherever applicable should be discussed

**Mode of action, uses, structure activity relationship of the following classes of drugs (Synthetic procedures of individually mentioned drugs only)**

**Antiamoebics:** Metronidazole, Tinidazole, Diloxanide

**Antimycobacterial Agents:** PAS, Ethambutol, Isoniazid, Dapsone

**Anthelmintics-** Mebendazole

Antineoplastic agents: 5-FU, methotrexate, cisplatin.

**Thyroid and Antithyroids** – Carbimazole, Levothyroxine, Propylthiouracil, Methimazole.

**Insulin & Oral Hypoglycaemics** – Chlorpropamide, Metformin, Tolbutamide, Glybenclamide.

HIV agents – Zidovudine, Zalcitabine, Saquinavir.

Antivirals – Amantadine, Acyclovir, Lamivudine.

**Diagnostic Aids:** Iopanoic Acid

**Antiseptics & Disinfectants** – Benzalkonium chloride

## **PHARMACEUTICAL CHEMISTRY-VIII (MEDICINAL CHEMISTRY III)**

### **PRACTICAL**

**Course code: PHA-583**

**Credits-4**

1. Workshop related to Computer –aided drug design, QSAR analysis.

2. Synthesis of selected drugs.
3. Establishing the pharmacopoeal standards and spectral studies.

## **PHARMACEUTICS IX**

### **(Dosage Form Design)**

#### ***THEORY***

**Course Code: PHA-584**

**Credits: 3**

1. Preformulation studies:
  - (a) Study of physical properties of drug like physical form, particle size shape, density, wetting, dielectric constant. Solubility dissolution and organoleptic property and their effect on formulation, stability and bioavailability.
  - (b) Study of chemical properties of drugs like hydrolysis, oxidation, reduction, racemization, polymerization, etc., and their influence on formulation and stability of products.
  - (c) Study of prodrugs in solving problems related to stability, bioavailability and elegance of formulations.
2. Process validation methods for pharmaceutical operations involved in the production of Solid, Liquid and Semi- solid dosage form.
3. Stabilization and stability testing protocol for various pharmaceutical products.
4. Performance evaluation methods:
  - a) In-vitro dissolution studies for solid dosage forms methods, interpretation of dissolution data.
  - b) Bioavailability studies and bioavailability testing protocol and procedures.
  - c) In-vivo methods of evaluation and statistical treatment.
5. Introduction to Novel Drug Delivery System with special reference to Colloidal System (Liposomes, proneosomes, neosomes, etc), Transdermal delivery system, Ocular delivery system and Nasal delivery system.

## **CLINICAL PHARMACY AND DRUG INTERACTIONS**

#### **THEORY**

**Course Code: PHA- 585**

**Credit – 4**

**Unit I:**

**Introduction to Clinical Pharmacy**

**Unit II:**

### **Basic concepts of Pharmacotherapy**

- a) Clinical Pharmacokinetics and individualization of Drug Therapy.
- b) Drug Delivery Systems and their Biopharmaceutics and Therapeutical considerations.
- c) Drug Use during Infancy and in the elderly (Pediatrics and Geriatrics).
- d) Drug use during Pregnancy
- e) Drug induced diseases.
- f) The Basics of Drug Interactions.
- g) Interpretation of Clinical Laboratory Tests.

### **Unit III:**

#### **Important disorders of Organ systems and their Management**

- a) Cardiovascular Disorders-Hypertension, Congestive heart Failure, Angina, Acute Myocardial Infarction, Cardiac arrhythmias.
- b) CNS Disorders: Epilepsy, Parkinsonism, Schizophrenia, Depression
- c) Respiratory Disease-Asthma.
- d) Gastrointestinal Disorders-Peptic ulcer, Ulcerative colitis, Hepatitis, Cirrhosis.
- e) Endocrine Disorders-Diabetes mellitus and thyroid Disorders.
- f) Infectious diseases- Tuberculosis, Urinary tract infection, Enteric Infections, Upper Respiratory Infections.
- g) Hemopoietic Disorders- Anemia's
- h) Joint and connective Disorders- Rheumatic Diseases, Gout and Hyperuricemia.
- i) Neoplastic Diseases-Acute Leukemia's, Hodgkin's disease.

### **Unit IV:**

#### **Therapeutic Drug Monitoring**

### **Unit V:**

#### **Concept of Essential drugs and Rational Drug use.**

Students of FHMS are either well placed or perusing higher qualifications in various institutes of India and abroad. Every year many students of B. Pharm qualify GATE competition which is a must for higher M.Pharm and other higher degree in academics

**List Of Gate Qualified Students, each year**

**YEAR 2006**

- Shilpy 02BPH020
- Gaurav Sharma 02BPH014
- Jitendra Kumar 02BPH011
- Uday Pratap Singh 02BPH062
- Abhishek Kumar 03 BPH061

**YEAR 2007**

- Mayank Gupta 03BPH023
- Chandan Kashyap 03BPH062
- Abhisekh Kumar 03BPH056
- Md.Nurullah Ansari 03BPH024
- Pappu Kumar 03BPH030
- Sunil Kumar 03BPH058
- Sarika Pandey
- Mala Mishra
- Mithilesh Kumar 04BPH012
- Singh Nadkar nr. Singh 02BPH053
- Rajeev Satyarthi 02BPH037

**YEAR 2008**

- Nitish Kumar
- Mithilesh
- Goldi Sahu
- Shweta Kumari Singh
- Kaushal Kr. Mehato

**YEAR 2009**

- Amit Kumar
- Lav Keshari
- Peyush Kumar
- Rakesh Kumar
- Ravi Nandan Chaubey
- Rajeev Kumar