

AC 27/2/2013 Item no 4.86

UNIVERSITY OF MUMBAI



Revised Syllabus

Program: B.Pharm

Semester III & IV

**(Credit Based Semester and Grading System
with effect from the academic year 2013–2014)**

S. Y. B. Pharm.

Syllabus Framework

No	Semester- III	Credits	Contact hrs/week	Weightage		Marks
				Continuous internal assessment	End Semester Examination	
1	Organic Chemistry - I	4	4	30	70	100
2	Biochemistry-II	4	4	30	70	100
3	Dispensing Pharmacy	3	3	30	70	100
4	Pharmaceutical Engineering	3	3	30	70	100
5	Anatomy, Physiology and Pathophysiology- III	3	3	30	70	100
6	Mathematics	3	3	30	70	100
Total		20	20	180	420	600
Practicals						
7	Organic Chemistry Lab - I	2	4	15	35	50
8	Biochemistry Lab	2	4	15	35	50
9	Dispensing Lab	2	4	15	35	50
Total		6	12	45	105	150
Total Teaching Hrs.			32			
Total Credits		26				
Total Marks				225	525	750

No.		Semester IV				
1	Organic Chemistry-II	3	3	30	70	100
2	Pharmaceutical Analysis- I	3	3	30	70	100
3	Pharmaceutics -II	3	3	30	70	100
4	Microbiology	3	3	30	70	100
5	Pharmacology - I	3	3	30	70	100
6	Mathematics and Statistics	3	3	30	70	100
Total		18	18	180	420	600
Practicals						
7	Pharmaceutical Analysis Lab- I	2	4	15	35	50
8	Pharmaceutics Lab- II	2	4	15	35	50
9	Pharmacology Lab- I	2	4	15	35	50
10	Microbiology Lab	2	4	15	35	50
Total		8	16	60	140	200
Total Teaching Hrs.			34			
Total Credits		26				
Total Marks				240	560	800

S. Y. B. Pharm.

Scheme of Examination

No	Semester- III Subject - Theory	No of papers	End Semester Examination			Internal Assessment		Maximum marks	Minimum marks for passing the subject	
			Duration (hrs)	Maximum marks	Minimum for passing	Periodic Test Duration (hrs)	Maximum marks			Continuous Evaluation Maximum marks
1	Organic Chemistry - I	1	3	70	28	1	15	15	100	40
2	Biochemistry - II	1	3	70	28	1	15	15	100	40
3	Dispensing Pharmacy	1	3	70	28	1	15	15	100	40
4	Pharmaceutical Engineering	1	3	70	28	1	15	15	100	40
5	Anatomy, Physiology and Pathophysiology - III	1	3	70	28	1	15	15	100	40
6	Mathematics	1	3	70	28	1	15	15	100	40
Practicals										
7	Organic Chemistry Lab - I	1	4	35	14	4	8	7	50	20
8	Biochemistry Lab	1	4	35	14	4	8	7	50	20
9	Dispensing Lab	1	4	35	14	4	8	7	50	20

No	Semester- IV	No of papers	End Semester Examination			Internal Assessment			Maximum marks	Minimum marks for passing the subject
			Duration (hrs)	Maximum marks	Minimum for passing	Periodic Test	Continuous Evaluation			
						Duration (hrs)	Maximum marks	Maximum marks		
Subject - Theory										
1	Organic Chemistry-II	1	3	70	28	1	15	15	100	40
2	Pharmaceutical Analysis - I	1	3	70	28	1	15	15	100	40
3	Pharmaceutics - II	1	3	70	28	1	15	15	100	40
4	Microbiology	1	3	70	28	1	15	15	100	40
5	Pharmacology - I	1	3	70	28	1	15	15	100	40
6	Mathematics and Statistics	1	3	70	28	1	15	15	100	40
Practicals										
7	Pharmaceutical Analysis Lab - I	1	4	35	14	4	8	7	50	20
8	Pharmaceutics Lab - II	1	4	35	14	4	8	7	50	20
9	Pharmacology Lab - I	1	4	35	14	4	8	7	50	20
10	Microbiology Lab	1	4	35	14	4	8	7	50	20

S. Y. B. Pharm.

Syllabus

Semester III

Organic Chemistry – I

4 hrs/week

Unit	Topics	Hours
1.	Basic concepts	11
1.1	Electronegativity, Inductive effect, Dipole moment, Polarizability	1
1.2	Resonance in aliphatic and aromatic systems: Rules of resonance, Stability of the resonating structures	2
1.3	Tautomerism (including types of tautomerism), Hyperconjugation	2
1.4	Reactive Intermediates in Organic Chemistry: Electrophiles and Nucleophiles (including charged and neutral species), Carbocations, Carbanions, Carbenes and Carbon radicals: Geometry, stability and properties. Concept of leaving groups, alkyl shift, migratory aptitude.	3
1.5	Acidity and Basicity (Excluding discussion of acidity and basicity of heterocyclic compounds).	3
1.6	Basics of mechanism writing using curved arrows-Homolytic, Heterolytic, Homogenic, Heterogenic.	
2.	Nomenclature of multifunctional organic compounds.	6
2.1	Writing common names of some common compounds.	
2.2	Writing IUPAC nomenclature of compounds containing multiple functional groups, use of priority charts.	
2.3	Writing structures of compounds containing multiple functional groups given the Nomenclature.	
2.4	Nomenclature of stereo isomers including cis/trans, D/L, E/Z and R/S designations.	
3.	Stereochemistry-I	9
3.1	Concept of configuration and chirality, axis of symmetry, plane of symmetry, centre of symmetry, representation of molecules by the use of projection formulae: Fischer, Wedge, Sawhorse and Newman.	2
3.2	Geometric isomerism: Methods of determination of configuration of geometric isomers, Optical isomerism: Enantiomers and diastereoisomers, Resolution of a racemic mixture, Atropisomerism in biphenyls.	2
3.3	Stereospecificity and stereoselectivity in organic reactions: S_N1 , S_N2 , E1, E2 and E1cb reactions, syn and anti additions of H_2 to alkynes, addition of halogens (X_2), Halogens in water (X_2 and H_2O), $KMnO_4$, OsO_4 and alkaline H_2O_2 to alkenes, Hydroboration-Oxidation, Oxymercuration-Demercuration of alkenes.	5
4.	Benzene and aromaticity	6
4.1	Concept of aromaticity: Huckel's rule for aromaticity, identification of aromatic, non-aromatic and anti aromatic systems based on planarity, conjugation and Huckel's rule.	1
4.2	Electrophilic Aromatic Substitution: Reactions of benzene (with mechanism and structures of intermediate/s involved) like nitration, sulphonation, protonation, halogenation, Friedel-Crafts alkylation and acylation. Classification and influence of substituent groups on orientation and reactivity, orientation in disubstituted benzenes.	3
4.3	Nucleophilic Aromatic Substitution: Bimolecular displacement mechanism with evidence, reactivity and orientation in nucleophilic aromatic substitution, Elimination-Addition mechanism.	2
5.	Functional group Chemistry	16
	Discussion of the following classes of compounds in brief, with regard to sources, methods	

	of preparation, general reactions with mechanism.	
5.1	Alkanes: Physical properties, Preparation of alkanes: Hydrolysis of Grignard reagent, reduction of alkyl halides by metal and acid, Corey House reaction, Wurtz reaction; Reactions: halogenation of alkanes (Mechanism and orientation)	2
5.2	Alkenes: Physical properties, Preparation of Alkenes: Dehydrohalogenation of Alkyl halides (Mechanism and orientation of E1 and E2), dehydration of alcohols, dehalogenation of vicinal dihalides, conversion of aldehydes and ketones to alkenes (Wittig reaction, Peterson reaction, Shapiro reaction). Reactions: Addition of H ₂ , HX (Markovnikov and Anti-Markovnikov), H ₂ SO ₄ , H ₂ O, free radicals, alkenes (dimerization), alkanes (Alkylation), ozonolysis, Michael addition, Simmons-Smith reaction, epoxidation, halogenation by allylic substitution.	6
5.3	Dienes: Resonance in conjugated dienes, electrophilic addition to conjugated dienes: 1, 2 and 1, 4 additions.	1
5.4	Alkynes: Physical properties, Preparation of alkynes: dehydrohalogenation of alkyl dihalides, reaction of metal acetylides with primary alkyl halides; Addition reactions: Addition of X ₂ , addition of HX, addition of H ₂ O (Hydration), formation of metal acetylides.	2
5.5	Alkyl halides: Physical Properties, Preparation: Hunsdieker reaction (other methods are covered under reactions of other functional groups). Reactions: Nucleophilic Aliphatic Substitution reaction (Mechanism, Factors affecting S _N 1 and S _N 2 reactions to be discussed in detail), S _N i reaction.	5
	Conversions to be discussed	
	Total	48

Books (Latest Editions to be adopted)

1. Organic Chemistry by R.T. Morrison and R.N. Boyd, 6th edition, Prentice Hall Publications
2. Organic Chemistry by Pine, Stanley H.; Hendrickson, James B.; Cram, Donald J.; Hammond, George S., 4th edition. The Macgraw hill publications
3. Organic Chemistry by I.L. Finar, Vol 1 & 2, 6th edition, Pearson education
4. Advanced Organic Chemistry: Reactions, Mechanisms, Structures by Jerry March, John Wiley and sons
5. Organic Chemistry, Part A: Structures and Mechanism, Part B: Reactions and Synthesis, Francis and Carry, Richard J Sundberg. Springer publications
6. A Guidebook to Mechanism in Organic Chemistry, 6th edition, Peter Sykes, Pearson Education
7. Peter Sykes, Essentials of Organic chemistry by Paul M Dewick, Wiley, Pine
8. Essentials of Organic chemistry by Paul M Dewick, Wiley
9. Eliel, Kalsi, Organic Chemistry by L.G. Wade, Jr., Maya Shankar Singh, Pearson Education, 6th Ed, Organic Chemistry, 2nd Ed., Thomas Sorrell, University Science Books
10. Stereochemistry: Conformation and Mechanism, b) Organic Reactions And Their Mechanisms. By P. S. Kalsi. New age International
11. Organic Chemistry through Solved Problems, *Goutam Brahmachari*. Edition, Morgan & Claypool
12. Organic Name Reactions: A Unified Approach. *Goutam Brahmachari*. Alpha Science publications

Biochemistry II

4 hrs/week

Unit	Topics	Hours
1	Carbohydrate metabolism discussed with respect to the structures of intermediates, enzymes and cofactors, energy yield/requirements and regulation. Examples of drugs modulating carbohydrate metabolism.	12
1.1	Glycolysis (Embden Meyerhoff Pathway), TCA cycle (Kreb's Cycle, Citric acid Cycle) and glyoxalate shunt. Entry of sugars other than glucose into glycolytic pathway. Discussion of shuttle systems to transfer NADH to the mitochondria.	04
1.2	Electron Transport Chain discussed with respect to the components of the ETC, explanation of oxidative phosphorylation vs substrate level phosphorylation. Discussion of proton motive force and generation of ATP using proton gradients. Discussion of uncouplers of oxidative phosphorylation.	04
1.3	Discussion of pentose phosphate pathway, glycogenesis, glycogenolysis, gluconeogenesis and other systems involved in carbohydrate metabolism	04
2.0	Lipid metabolism discussed with respect to the structures of intermediates, enzymes and cofactors involved, energy yield/requirements and regulation.	08
2.1	Beta oxidation pathway for catabolism of saturated and unsaturated even number fatty acids, catabolism of odd number carbon containing fatty acids, formation of ketone bodies,	03
2.2	Acetate mevalonate pathway to cholesterol biosynthesis,	02
2.3	Biosynthesis of fatty acids and phospholipids.	02
2.4	Examples of drugs modulating lipid/cholesterol metabolism.	01
3	Nucleic Acid Metabolism discussed with respect to the structures of intermediates, enzymes and cofactors, energy yield/requirements and regulation	08
3.1	Discussion of biosynthesis of purines.	03
3.2	Discussion of biosynthesis of pyrimidines.	02
3.3	Salvage pathways for nucleic acid metabolism. Examples of drugs modulating purine/pyrimidine biosynthesis.	03
4	DNA replication	08
4.1	Details of DNA replication, differences between prokaryotes/eukaryotes. Brief description of telomeres and telomerase activity. DNA polymorphisms and SNPs. Examples of drugs modulating these pathways (polymerase inhibitors, telomerase inhibitors, topoisomerase inhibitors) and polymorphisms involved in disease states.	04
4.2	Discussion of solid phase DNA synthesis, DNA synthesizers and comparison between biosynthesis and chemical synthesis.	02
4.3	Discussion of DNA sequencing (Sanger dideoxy method)	02
5	Protein biosynthesis	10
5.1	Details of DNA transcription and RNA translation. Transcriptional and translational differences in prokaryotes and eukaryotes especially with respect to post-transcriptional and post-translational modifications. Examples of drugs modulating these pathways with emphasis on protein synthesis inhibitors used as drugs.	06
5.2	Discussion of solid phase peptide synthesis, peptide synthesizers and comparison between biosynthesis and chemical synthesis.	02
5.3	Discussion of peptide sequencing (Edman method and its automation). Utility of peptidases and chemical agents to cleave proteins in preparation for sequencing.	02
	Total	48

Books

1. Lehninger, Principles of Biochemistry, Replika Press.
2. Stryer L, Biochemistry, W. H. Freeman & Co.
3. Harper's Biochemistry, Appleton and Lange, USA.
4. Conn E, Stumpf PK, Brueing G and Doi Roy H, Outlines of Biochemistry, Wiley Liss, USA.
5. Wilson and Gisvolds Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams and Wilkins, USA
6. Foye's Principles of Medicinal Chemistry, Lippincott Williams and Wilkins, USA.

Dispensing Pharmacy

3 hrs/week

Unit	Topics	Hours
1.	Introduction_	6
1.1	Introduction to compounding and dispensing.	
1.2	Prescription and its parts.	
1.3	Types of prescriptions.	
1.4	Pricing and recording of prescriptions.	
1.5	Types of dispensed preparations.	
1.6	Weights and measures including imperial weights (Apothecary system).	
2.	General dispensing_	6
2.1	Fundamentals of compounding and dispensing including good practices.	
2.2	Formulation of dispensed products.	
2.3	Containers and closures/packaging for dispensed products.	
2.4	Storage and stability of dispensed products.	
2.5	Labeling of dispensed preparations.	
2.6	Latin Terms and abbreviations.	
2.7	Preparation of stock solutions.	
2.8	Dispensing of proprietary medicines.	
3.	Calculations.	4
3.1	Calculations based on expressions of concentration and dilution (percentage, parts, alligation) ,proof strength.	
3.2	Calculations based on Isotonicity.	
3.3	HLB calculations.	
3.4	Posology.	
4.	Solutions.	2
4.1	Solutions taken orally.	
4.2	Solutions used in body cavities.	
4.3	Solutions for external use.	
5.	Suspensions.	3
5.1	Suspensions containing diffusible solids.	
5.2	Suspensions containing indiffusible solids.	
5.3	Suspensions containing poorly wettable solids.	
5.4	Suspensions containing precipitate forming liquids.	
5.5	Dispersion of oil in inhalation.	
5.6	Suspensions produced by chemical reaction.	
6.	Emulsions	3
6.1	Types of Emulsions.	
6.2	Emulsifying agents.	
6.3	Compounding and preservation of Emulsions.	
6.4	Emulsions for external use (Creams).	
7.	Ointments_ Pastes_and_Gels_	3
7.1	Types of Ointment bases.	
7.2	Preparation Of Ointments.	
7.3	Pastes and Poultices.	
7.4	Gels.	
8.	Dispensed Oral Solid Dosage forms.	4
8.1	Powders.	
8.2	Granules.	
8.3	Tablet Triturates.	
8.4	Pills.	
8.5	Lozenges and Pastilles.	

8.6	Capsules.	
9.	Suppositories and Pessaries.	2
9.1	Types of Suppository base.	
9.2	Compounding of Suppositories.	
10.	Incompatibilities.	3
10.1	Physical Incompatibilities.	
10.2	Chemical Incompatibilities.	
	Total	36

Comment on Prescriptions to be covered for all types of formulations listed in the syllabus.

Books

1. Cooper and Gunns Dispensing for Pharmaceutical Students, Edns. 11 and 12; Edited by S.J.Carter, Indian Edition, CBS Publishers, Delhi.
2. Pharmaceutical Practice; Edited by D.M.Collet and M.E.Aulton; Churchill Livingstone, ELBS Edition, 1991.
3. Pharmaceutical Practice Edited by A.J.Winfield and R.M.E. Richards, Second Edition, Churchill Livingstone, 1998.
4. Pharmaceutical Practice; Edited by A.J. Winfield and R.M.E. Richards, Third Edition, Churchill Livingstone, 2004.
5. Husa's Pharmaceutical Dispensing, Edited by Eric Martin, Sixth Edition, Mack Publishing Company, 1996.
6. Pharmaceutical Calculations, A.C. Ansel and M.J.Stoklosa, Lippincott Williams and Wilkins, 2006.
7. Pharmaceutical Calculations – Bradley, Gustafson and Stoklosa, Third Edition, Lea and Febiger, 1957.

Coverage: Only theory, principles, equipments and pharmaceutical applications to be covered. Mathematical derivations and numerical problems are not within the scope.

Unit	Topics	Hours
1	Fluid flow	3
1.1	Mention fluid properties such as viscosity, compressibility and surface tension of fluids. Hydrostatics influencing fluid flow. Fluid dynamics- Bernoulli's theorem, flow of fluids in pipes, laminar and turbulent flow.	
2	Fluid and pressure measurements	4
2.1	<ul style="list-style-type: none"> Measurement of flow- Classification of flow meters, venturimeter, orificemeter, pitot tube, rotameter and current flow meters. 	2
2.2	<ul style="list-style-type: none"> Pressure measurement- Classification of manometers, simple manometer, U tube manometer and modifications, Bourdon gauge. 	2
3	Pumps:	2
3.1	<ul style="list-style-type: none"> Positive displacement pumps-reciprocating pumps, rotary pumps. 	1
3.2	<ul style="list-style-type: none"> Centrifugal pumps 	1
4	Heat and Mass transfer	4
4.1	<ul style="list-style-type: none"> Modes of heat transfer- conduction, convection and radiation, Heat exchangers-tubular and plate, Temperature measurement-basic principles and devices Mass transfer in turbulent and laminar flow 	3
4.2	<ul style="list-style-type: none"> Concept of interfacial mass transfer 	1
5	Conveying of solids	1
	<ul style="list-style-type: none"> Belt conveyor, Bucket conveyor, Screw conveyor and Pneumatic conveyor. 	
6	Crystallization	6
6.1	<ul style="list-style-type: none"> Crystal forms and crystal habits, Theory of crystallization-Supersaturation-Mier's theory of supersaturation, Nucleation, Crystal growth. 	2
6.2	<ul style="list-style-type: none"> Crystallizers- Classification, Tank crystallizers, Agitated tank crystallizers, Swenson Walker crystallizer, Vacuum crystallizer and its modifications, Krystal or Oslo crystallizer. 	3
6.3	<ul style="list-style-type: none"> Factors affecting crystallization and Caking of crystals 	1
7	Evaporation:	4
7.1	<ul style="list-style-type: none"> Introduction, factors influencing rate of evaporation, including scale formation, Evaporators classification- Pan evaporators, Tubular evaporators (Horizontal tube evaporator, Vertical tube evaporators- short tube vertical evaporator, Multiple effect evaporator, Long tube evaporators -Climbing film evaporator, Falling film evaporator, Forced circulation evaporator,) Wiped film evaporator , Centrifugal rotary evaporator. 	2
7.2	<ul style="list-style-type: none"> Evaporator accessories- condensers, vacuum pumps, expansion and bucket traps, entrainment separators 	2
8	Distillation:	6
8.1	<ul style="list-style-type: none"> Revision of Vapour-liquid equilibrium, Distillation methods- Equilibrium distillation, Simple distillation 	1
8.2	<ul style="list-style-type: none"> Fractional distillation- Theory of batch fractionation, Columns (only construction and working) Bubble cap, sieve plate columns, packed columns. Concept of plate efficiency and HETP (no detailed theories and derivations). 	3
8.3	<ul style="list-style-type: none"> Distillation under reduced pressure- Theory of molecular distillation and 	2

	equipments. Falling film and centrifugal molecular distillation still, applications. Azeotropic and Extractive distillation- Theory and applications. Steam distillation- Theory and applications	
9	Refrigeration: <ul style="list-style-type: none"> Refrigeration –equipment and concept of refrigeration load, concepts of brine systems and absorption systems. 	1
10	Materials of construction and Corrosion:	5
10.1	<ul style="list-style-type: none"> Classification into metals and non-metals. Ferrous and its alloys-cast iron, mild steel and stainless steel. Copper and its alloys. Nickel and its alloys. Aluminium and its alloys. Plastics- Classification into thermoplastics and thermosetting plastics, properties and applications of polyvinyl chloride, polyethylene, polypropylene, polystyrene, polyester, ABS, phenolic and epoxy plastics, fluorocarbon plastics, chlorinated plastics and polycarbonated plastics. 	2
10.2	Corrosion: <ul style="list-style-type: none"> Mechanism and types of corrosion. Factors influencing rate of corrosion. Methods of combating corrosion. 	3
11	Industrial Hazards and safety regulations: <ul style="list-style-type: none"> Mechanical hazards and prevention. Electrical hazards and prevention Chemical hazards and prevention Fire hazards and extinguishers 	2
	Total	38

BOOKS (Latest editions of all books to be referred)

1. K. Sambamurthy, Pharmaceutical Engineering, New age international (P) Limited Publishers, 1998.
2. Dr. A. R. Paradkar, Introduction to Pharmaceutical Engineering, 10th Edition, Nirali Parakashan, 2007.
3. James Swarbrick & James C. Boylon, Encyclopedia of Pharmaceutical Technology, Marcel Dekker, INC, New York, 1994.
4. Walter I. Badger & Julius T. Bancher, Introduction to Chemical Engineering, Mc Graw Hill Inc, 1995.
5. M. E. Aulton, Ed, Pharmaceutics-The Science of Dosage Form Design, Churchill Livingstone Medical Division Of Longman Group UK Ltd, 2002.
6. S. J. Carter, Cooper and Gunn's Tutorial Pharmacy, 6th Edition, CBS Publishers & Distributors, New Delhi, 2005.
7. Robert H. Perry, Don W. Green, Perry's Chemical Engineers Handbook, 7th Edition, Don W. Green, James O. Maloney, McGraw Hill, 1997.
8. G. K. Jani, Pharmaceutical Engineering, Vallabh Prakashan.

Anatomy, Physiology and Pathophysiology- III**3 hrs/week**

Unit	Topics	Hours
1.	Reproductive system <ul style="list-style-type: none"> - Anatomical and Physiological considerations of male and female reproductive system - Reproductive and endocrine functions of testes and ovaries - Menstrual cycle 	4
2.	Pathophysiology of following diseases <ul style="list-style-type: none"> - Infertility - Sexually transmitted diseases (STD) - Dysmenorrhea 	2
3.	Cardiovascular System <ul style="list-style-type: none"> - Functional anatomy of heart - conducting system of heart - cardiac cycle, Electrocardiogram (ECG) -Physiology of blood circulation - Functional anatomy of blood vessels - Blood pressure and factors regulating blood pressure - Baroreceptors, chemoreceptors, vasomotor center - Humoral and neuronal control of blood pressure and circulation 	8
4.	Pathophysiology of following diseases <ul style="list-style-type: none"> - Hypertension - Congestive Cardiac Failure - Cardiac Arrhythmia - Angina Pectoris - Ischemic Heart Disease - Arteriosclerosis/Atherosclerosis 	4
5.	Urinary system <ul style="list-style-type: none"> - Anatomy and Physiology of Urinary System - Formation of urine - water balance, electrolyte balance & acid – base balance 	5
6.	Formation of body fluids and fluid compartments.	3
7.	Pathophysiology of following diseases <ul style="list-style-type: none"> - Renal failure - Glomerulonephritis - Renal calculi / kidney stones - Urinary Tract Infections (UTI) 	3
8.	Digestive System <ul style="list-style-type: none"> - Anatomy and physiology of digestive system - Digestion and absorption of carbohydrates, proteins and fats 	6
9.	Pathophysiology of following diseases <ul style="list-style-type: none"> - Peptic ulceration - Zollinger – Ellison’s Syndrome -Inflammatory Bowel Disease (Ulcerative colitis, Crohn’s disease) - Cholecystitis & Cholelithiasis - Jaundice - Hepatitis - Pancreatitis - Achalasia - Reflux esophagitis 	3
	Total	38

Books Latest editions of the following books to be referred

1. Ross & Wilson

Anatomy & Physiology in Health & Illness by Anne Waugh and Allison Grant, Published by Churchill Livingstone

2. Gerard J. Tortora & Bryan Derrickson, Principals of Anatomy & Physiology, Published by John Wiley and Sons, Inc.

3. A. C. Guyton & J. E. Hall, Textbook of Medical Physiology, Published in India by Prism Books Ltd. on arrangement with W. B. Saunders Company, USA.

4. McNaught & Callander, Illustrated Physiology by B. R. Mackenna & R. Callander, Published by by Churchill Livingstone

5. Kaplan, Jack, Opheim, Toivola, Lyon, Clinical Chemistry: Interpretation & Techniques

6. Praful B. Godkar, Textbook of Medical Laboratory Technology, Published by Bhalani Publishing House, Mumbai, India

8. Harsh Mohan, Text book of Pathology, Published by Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi

Mathematics**3 hrs/week**

Unit	Topics	Hours
1	Differential Calculus	05
1.1	Successive Derivatives	
1.2	Lebnitz's Rule fourth derivative	
1.3	Lagrange's and Rolle's Mean Value Theorems (Statements only)	
1.4	Taylor's and Maclaurin's Series (No proof) with application	
2	Partial Differentiation	05
2.1	Functions of two or three variables	
2.2	Change of variables	
2.3	Application to errors, maxima and minima	
3	Integral Calculus	07
3.1	Integration by parts	
3.2	Properties of definite integrals and reduction formulae	
3.3	Determination of the length of the curve, area and volume	
4	Differential Equations	07
4.1	Formation of differential equations	
4.2	Solution of first-order and first-degree equations	
4.3	Linear differential equations of higher order with constant coefficients	
4.4	Simple applications to chemical reactions and biopharmaceutics	
5	Determinants and Matrices	07
5.1	Properties of determinants and applications	
5.2	Solution of simultaneous equations with three variables by Cramer's method	
5.3	Types of matrices, inverse of matrix, rank of a matrix, eigen value and eigen vectors	
5.4	Caley Hamilton Theorem	
6.0	Numerical Methods	06
6.1	Finite difference operators (δ and E)	
6.2	Interpolation of equal and unequal intervals – Newton's method and Lagrange method	
6.3	Numerical integration – Trapezoidal rule, Simpson's $1/3^{\text{rd}}$ and $3/8^{\text{th}}$ rules	
	TOTAL	37

Books – Latest Editions to be adopted

1. Mathematics for Pharmacy Students (Vol. 1), Gujar, K. N., Bhavale Ashok, Career Publications.
2. Differential Calculus; Nareyan, S., S. Chand Publication
3. Applied Mathematics – I, Baphana R. M., Techmax Publication.
4. Textbook of Applied Mathematics, Vols. I and II, Wartikar, P. N. Pune Vidyarthi Griha Prakashan.
5. Integral Calculus, Shanti Narayan, S. Chand Publication.
6. A Textbook of Matrices, Shantinayakan, S. Chand Publication.

Practicals

Organic Chemistry Lab. – I

4 hrs/week

- 1) Laboratory safety measures to be taken for:
 - a. Fire and burns
 - b. Spillage
 - c. Inhalation of toxic fumes
 - d. Dress code in a laboratory
 - e. First aid measures to be taken in cases of accidents
 - f. Use of fume hood, eye shower, body shower.
- 2) Organic spotting: Minimum eight samples of mono-functional groups and two samples of bifunctional groups to be taken.
- 3) Theoretical aspects of physical constant determination, and detection of functional groups.

Books

1. A laboratory hand book of Organic qualitative analysis and separations, V.S. Kulkarni, S.P.Pathak, D. Ramchandra & Co., Pune
2. Text book of organic practical chemistry, V.S. Kulkarni, S.P.Pathak, D. Ramchandra & Co., Pune.
3. R. L. Shriner, R. C. Fuson and D. Y. Curtin, The systematic Identification of Organic compounds, 6th Ed., Wiley, New York, 1980
4. A. I. Vogel, A textbook of practical organic chemistry, 4th edition, Wiley New York, 1978
5. Comprehensive Practical Organic Chemistry: Qualitative Analysis, V.K. Ahluwalia, S. Dhingra, Universities Press (India) Limited, 2000
6. Comprehensive Practical Organic Chemistry: Preparation and Quantitative analysis, V.K. Ahluwalia, Renu Aggarwal, Universitites Press (India) Limited, 2000

Biochemistry Lab.

4 hrs/week

1. Qualitative tests for carbohydrates and confirmatory tests by osazone formation
2. Qualitative test and simple color reactions for amino acids and proteins. Precipitation reactions of proteins.
3. Chromatographic separation of amino acids.
4. Quantitative estimation of glucose (Willstater's and Lane & Eynon's methods). Estimation of sucrose. Colorimetric estimation of glucose.
5. Quantitative estimation of proteins by Biuret method and Folin method (one titrimetry and one by colorimetry)
6. Estimation of enzyme activity – ptyline (amylase) in saliva and alkaline phosphatase (including plotting of data to determine K_m and V_{max} for any one of these enzymes)
7. Quantitative estimation of properties of lipids – acid value, iodine value, saponification value.
8. Quantitative estimation of RNA and DNA.
9. Demonstrations of estimation of blood glucose, SGOT or SGPT using commercial kits (suggest that students should volunteer for fasting and post prandial glucose determinations)
10. Demonstration of isolation of DNA.

Books

1. An Introduction to Practical Biochemistry – Plummer D.T., Tata Mcgraw Hill, N Delhi, India
2. Laboratory Manual In Biochemisty, Jayaraman J, Wiley Easter, N Delhi. India

Dispensing Lab

4 hrs/week

Dosage form	Representative preparations
1. Solutions	<ol style="list-style-type: none"> Potassium Permanganate Solution Zinc Chloride and Zinc sulphate Mouthwash BPC 1973 Sodium Bicarbonate Ear Drops BP Paediatric Ferrous Sulphate Oral Solution BP 1988
2. Suspensions	<ol style="list-style-type: none"> Menthol and Eucalyptus oil inhalation Paediatric Chalk Mixture BP 1988 Kaolin Mixture BP 1988
3. Emulsions And Creams	<ol style="list-style-type: none"> Arachis Oil Emulsion Calciferol Emulsion Aqueous Calamine cream IP 2010 Medicated cream Buffered Cream BP 1988
4. Ointment	<ol style="list-style-type: none"> Zinc and Castor Oil Ointment BP 1988 / Calamine Ointment IP 2010
5. Gel	<ol style="list-style-type: none"> Lubricating Jelly
6. Paste	<ol style="list-style-type: none"> Compound Zinc Paste BP 1988/ Zinc and Salicylic Acid paste BP 1988 Kaolin Poultice BP 1988
7. Powder	<ol style="list-style-type: none"> Bulk Powder : Compound Magnesium trisilicate Oral Powder BP 1988 / Zinc, Starch and Talc Dusting Powder BPC 1973 Divided Powder : Hyoscine Hydrobromide Powder Siedlitz Powder
8. Granules	<ol style="list-style-type: none"> Isapgahl Granules Effervescent Granules
9. Tablet triturate	<ol style="list-style-type: none"> Boric acid / Riboflavin tablet triturate
10. Capsule	<ol style="list-style-type: none"> Chlordiazepoxide capsules BP
11. Pills	<ol style="list-style-type: none"> Compound Rhubarb Pills BPC 1960 / Potassium Permanganate Pills
12. Pastilles	<ol style="list-style-type: none"> Medicated Pastille
13. Lozenge	<ol style="list-style-type: none"> Brompton Cough Lozenge BPC 1973 / Compound Bismuth Carbonate Lozenge BPC 1973
14. Suppository	<ol style="list-style-type: none"> Compound Bismuth Subgallate Suppositories BP 1980
15. Incompatibility	<ol style="list-style-type: none"> Eutectic Mixture

Books

- Relevant editions of IP, BP, BPC
- Cooper and Gunns Dispensing for Pharmaceutical Students, Edns. 11 and 12; Edited by S.J.Carter, Indian Edition, CBS Publishers, Delhi.
- Pharmaceutical Practice; Edited by D.M.Collet and M.E.Aulton; Churchill Livingstone, ELBS Edition, 1991.
- Pharmaceutical Practice Edited by A.J.Winfield and R.M.E. Richards, Second Edition (1998), Third Edition (2004) Churchill Livingstone.

Unit	Topics	Hours
1.	Functional Group Chemistry and Molecular Rearrangements	
1.1	<p>Aldehydes and Ketones Methods of preparation :Dry distillation of anhydrides, Oxidation of primary and secondary alcohol, Oxidation of methylbenzene, Reduction of acid chlorides, from Reaction of acid chloride with organocopper. Oxidation with $\text{Ag}(\text{NH}_3)_2$, KMnO_4, $\text{K}_2\text{Cr}_2\text{O}_7$, NaOH/I_2, Reduction with H_2/Pt or Ni or Pd, LiAlH_4, NaBH_4, Clemmensen & Wolf Kishner Reduction, reduction. Nucleophilic additions like Cyanohydrin, Acetal formation, Grignard, Derivatives of ammonia, NaHSO_3, organolithium compounds. Condensations with discussion of mechanism of aldol (Acid and Base catalyzed), Mixed aldol, crossed aldol, nitroaldol, retroaldol, Claisen-Schmidt, Halogenation of ketones, Perkin, Knoevenagel, Doebner-Knoevenagel, Reformatsky, Michael, Benzilic acid alkylations, Dakin oxidation, Benzoin Condensation, Wittig with Ph_3P, Wolff, Bayer-Villiger Oxidation, Diazomethane reaction, Stobbes, Willgerodt, Favorskii, Cannizzaro reduction. Problems related to above reactions.</p>	7
1.2	<p>Amines Methods of preparation : From alkyl halides, Reduction of nitro compounds with Metal/HCl and $\text{Na}_2\text{S}_2/\text{NH}_4\text{S}_6$, Reduction of amides, Reduction of cyanides, Reduction of oximes, Reductive amination, Leuckart method, Gabriel-phthalimide method, discussion and Mechanism of Curtius, Lossen, Schmidt rearrangement. Discussion on physical properties Reactions of amines : With acid, with alkyl halides, conversion to amides, Schotten-Baumann technique, ring substitution in aromatic amines, Hoffman elimination from alkylation ammonium, salts. Mechanism of Steven & Sommelet alkylations, Diazotization with mechanism and its application including Sandmeyer reaction mechanism and Gomberg reaction mechanism Problems related to above reactions.</p>	6
1.3	<p>Carboxylic acids Methods of alkylation: Oxidation of alcohols, Oxidation of alkylbenzene, from alkylation reagent, hydrolysis of nitriles, malonic ester synthesis of carboxylic acid with alkylation Reactions with Base, with SOCl_2, PCl_3, PCl_5, SO_2Cl_2, with alcohol, Conversions to amides, Reduction, Hell-Volhard-Zelinsky reaction Condensation reactions like Dieckmann condensation with mechanism. Problems related to all reactions</p>	3
1.4	<p>Amides Methods of preparation of amides, imides Reactions of amides: Hoffmann and Beckmann alkylations and its mechanism including transformations. Identification test like diazotization after acidic hydrolysis</p>	2
1.5	<p>Esters Methods of preparation Reactions: Basic and acidic hydrolysis of esters with mechanism, conversions to amides, transesterification, reaction with Grignard & organolithium, catalytic hydrogenation of esters, reduction with LiAlH_4, Claisen condensation, mixed Claisen, crossed Claisen Problems related to above reactions.</p>	2
1.6	Alcohols	2

	Physical Properties, Preparation of alcohols using Grignard synthesis, Aldol Condensation, Reduction of acids, esters carbonyl compounds. Reactions: HX, PX ₃ , with metal, esterification, oxidation, Pinacol-Pinacolone rearrangement. Problems related to above reactions.	
1.7	Phenols Physical Properties. Preparation of Phenols: Hydrolysis of diazonium salts, from aryl sulphonates. Reactions: Ester formation, Electrophilic substitution reaction-Nitration, sulponation, alkylations, Freidel-crafts alkylation, nitrosation, Fries rearrangement, Kolbe-Schmidt reaction, Reimmer-Tiemman reaction, Schotten- Baumann reaction	2
1.8	Ethers Physical Properties, Preparation Willimason's synthesis, alkoxymercuration-demercuration, Industrial sources of ethers. Reaction with HX and Wittig reaction	1
2.	Polycyclic aromatic compounds: naphthalene,anthracene and phenanthrene: preparations and reactions (Reactions of derivatives not included) Methods of preparation of polycyclic aromatic compounds- : Fittig reaction, Friedel-Crafts reaction, Elbs reaction, Pschorr synthesis, Haworth synthesis for naphthalene and phenanthrene, Stobbe condensation, Bardhan-Sengupta synthesis, Bogert-Cook synthesis, resonance and nomenclature, Reactions of naphthalene- oxidation	3
3.	Stereochemistry Conformation of ethane, Butane, Cyclohexane Types of strains: Angle strain, Transannular strain, Bayer strain, Pitzer strain stability, optical activity and conformational analysis of mono and disubstituted cyclohexanes (1,2/1,3/1,4 disubstituted with -OH, -X, t-butyl, -COOH like groups)	6
4.	Redox Reactions Reagents used in Oxidation : perbenzoic acid, CF ₃ CO ₃ H, V ₂ O ₅ , lead tetracetate, Al-isopropoxide and reactions using these reagents. Reagents used in Reduction : NaBH ₄ , LiAlH ₄ , SnCl ₂ , Na/alcohol, Na/Liq. NH ₃ , Raney Ni, Na dithionate and reactions using these reagents, Birch reduction	4
	Total	38

Books (Latest Editions to be adopted)

1. Organic Chemistry by R.T. Morrison and R.N.Boyd, 6th edition,Prentice Hall Publications
2. Organic Chemistry by Pine, Stanley H.; Hendrickson, James B.; Cram, Donald J.; Hammond, George S., 4th edition. The Macgraw hill publications
3. Organic Chemistry by I.L. Finar, Vol 1& 2, 6th edition, Pearson Education
4. Advanced Organic Chemistry: Reactions, Mechanisms, Structures by Jerry March, John Wiley and sons
5. Organic Chemistry, Part A: Structures and Mechanism, Part B: Reactions and Synthesis, Francis and Carry, Richard J Sundberg. Springer publications
6. A Guidebook to Mechanism in Organic Chemistry, 6th edition, Peter Sykes, Pearson Education
7. Name Reactions: A Collection of Detailed Reaction Mechanisms. Jie Jack Liji Jack Lee, Springer publications
8. Organic Chemistry, 9th Ed, T. W. Graham Solomons, Craig Fryhle. John Wiley & Sons
9. a) Stereochemistry: Conformation and Mechanism, b) Organic Reactions And Their Mechanisms. By P. S. Kalsi. New age International
10. Organic Chemistry through Solved Problems, *Goutam Brahmachari*. Edition, Morgan & Claypool
11. Organic Name Reactions: A Unified Approach. *Goutam Brahmachari*. Alpha Science publications

Pharmaceutical Analysis – I

3 hrs/week

Unit	Topics	Hours
1	Introduction to Pharmaceutical Analysis	4
1.1	<ul style="list-style-type: none"> • Scope of Pharmaceutical Analysis, Classification of Quantitative Analytical techniques (Instrumental and Non-Instrumental). • Introduction to pharmacopoeial monograph - Drug and formulation (As API-Aspirin, Calcium gluconate and Dried aluminium hydroxide gel. formulation-Soluble Aspirin tablets and Calcium gluconate injection). 	2
1.2	<ul style="list-style-type: none"> • Types Of Errors – Determinate and indeterminate: Causes of errors and ways to minimize them. • Concept and numerical of –Mean, Median, Standard deviation, relative standard deviation, Absolute and relative errors, precision, accuracy, significant figures. 	2
2	Aqueous acid-base titrations.	7
2.1	<ul style="list-style-type: none"> • Theoretical terms: Titrimetric analysis, Titrant, Titrand, Theoretical end point or equivalence point, end point of titration, Titration error, Conditions for titrimetric analysis, Classification of reactions for titrimetric analysis, <i>Expression of concentration of Standard solutions</i>-Molarity-(Analytical and equilibrium molarity), Molality, percent concentration, ppm, ppb, Normality, Primary and Secondary standards. • Law Of Mass Action, Equilibrium Constant, Application Of Law of Mass Action to solutions Of Weak Electrolytes, pH, pKa, pKb, hydrolysis of salts (weak base-strong acid, weak acid-strong base, weak acid, weak base), Buffer solutions, Buffer Capacity. 	2
2.2	<ul style="list-style-type: none"> • Neutralisation curves-(strong acid by strong base, weak acid by strong base, weak base by strong acid, and weak acid by weak base). • Neutralisation indicators-different theories (Ostwald's theory, Resonance theory), Mixed indicators, concept of range of indicators, Choice of indicators. 	2
2.3	<ul style="list-style-type: none"> • Methods of titration –Direct titration, back titration and need, blank determination use, significance (One Example for each type) and concepts of factor calculation for assay. • Problems related to calculation of- pH and its numericals with respect to neutralisation curve, Strength of Electrolytes (molarity, normality, and milliequivalence), and assay. • Applications. 	3
3	Non-aqueous titrations	2
3.0	<ul style="list-style-type: none"> • Theoretical considerations-Need, Types of non-aqueous solvents (aprotic, protophilic, protogenic, amphiprotic), Characteristics of solvents for non-aqueous titrations (acid-base character, dielectric constant, leveling and differentiating effect), Indicators for non-aqueous titrations, Determination of Bases and Acids (solvent, titrants and indicator used). • Applications. 	2
4	Complexometric titrations	3

	<ul style="list-style-type: none"> • Terms-Complex, complexing agents (Complexones), Chelate, Ligand, Dentate and types, Co-ordination number, Chelating agent, Sequestering agent, Metal – Ligand complex. • Aspects in complex formation with respect to Disodium Edetate- Dissociation constant, pH, Stability, colouration, titrability of polyvalent metal ions, pM indicators, presence of auxiliary complexing agent, and general structure of complexes formed with di-, tri-, and tetravalent metal ions. • Complexometric titrations: Direct method, back titration, Replacement titration, Titration of mixture of metal ions, masking agent (auxiliary ligand) and demasking agents, and Titration curve w. r. t Disodium Edetate. • Applications: Determination of individual cations (aluminium by back titration, nickel by direct titration), determination of mixture of lead, zinc and magnesium in a sample, and assay of calcium gluconate injection. 	3
5	Oxidation – Reduction Titrations	6
5.1	<ul style="list-style-type: none"> • Terms: Oxidation –Reduction, Oxidising and reducing Agents, Standard Reduction Potential, Nernst Equation, redox titration curve and Equivalence point potential. 	1
5.2	<ul style="list-style-type: none"> • Theory, indicators, and titrants for : Permanganometry and Cerrimetry, • Applications- Assay of hydrogen peroxide solution (Permanganometry), Assay of Ascorbic acid tablets/ Dried Ferrous sulphate, Paracetamol (Cerrimetry). 	2
5.3	<ul style="list-style-type: none"> • Theory, indicators, and titrants for : Iodometry, Iodimetry, Potassium dichromate, potassium iodate titrations, and Potassium bromate titrations. • Applications-Assay of hydrogen peroxide solution, Assay of Ascorbic acid API (Iodimetry), Assay of KMnO_4 (Back Iodometry), Assay of Potassium iodide (Iodate titration). 	2
5.4	<ul style="list-style-type: none"> • Balancing Of Redox Equation-half cell reaction and net reaction. 	1
6	Precipitation Titration	3
6.1	<ul style="list-style-type: none"> • Theoretical considerations-Common Ion Effect, Solubility Product, Factors affecting solubility of precipitates, Fractional precipitation. 	1
6.2	<ul style="list-style-type: none"> • Types Of Precipitation Titration (Argentometric, Non– Argentometric), Argentometric Titration methods -Mohr's method, Volhard's Method and Adsorption Indicator Method. • Applications: Standardisation of silver nitrate, Assay of NaCl and KCl. 	2
7	Gravimetry	3
7.1	<ul style="list-style-type: none"> • Theory mass as measurement signal and precipitation equilibria, Unit operations in gravimetric analysis, Organic and inorganic precipitants, precipitation from homogeneous solution. • Problems associated with gravimetric analysis and methods to overcome (co-precipitation and reprecipitation, Ostwald's ripening, degree of supersaturation or von Weimarn ratio, solubility of precipitate, peptisation). 	2
7.2	<ul style="list-style-type: none"> • Applications-Assay of Nickel by dimethylglyoxime, Assay of aluminium by oxine reagent, Assay of Ba^{+2} as BaSO_4. • Numerical related to gravimetric factor. 	1
8	Miscellaneous methods	2

8.0	<ul style="list-style-type: none"> • Oxygen flask combustion method-technique, apparatus, principle and determination of organically bound halogens, sulphur and phosphorus, Application- Diloxanide furoate. • Nitrite titrations- Concept of external indicator and application- Assay of Sulphacetamide sodium • Determination of nitrogen (Kjeldahl method)-Technique (direct and indirect method), reagents & apparatus used, reaction & factor calculation and numerical for estimation of nitrogen. Application-Assay of Urea (API) 	
9	Electro Analytical Techniques:	6
9.1	Polarography- <ul style="list-style-type: none"> • Apparatus-Construction and working of Dropping mercury electrode (DME), advantages and disadvantages of DME. • Theory-Current-Voltage curve (Polarogram), supporting electrolyte, Oxygen wave, polarographic maxima, Ilkovic equation, factors affecting limiting current, half wave potential. • Applications-In brief. • Pulse polarography-Normal pulse polarography and Differential pulse polarography and square wave polarography). 	2
9.2	<ul style="list-style-type: none"> • Amperometry-DME cell, four types of end points in amperometric titrations, advantages, general applications and Biamperometric titrations. • Aquametry by Karl Fischer titration: principle, composition and stability of KFR, standardization of KFR as per I.P, determination of water in a sample-e.g.Amoxyccillin trihydrate. 	2
9.3	<ul style="list-style-type: none"> • Coulometry and High Frequency Titration-Faraday's first law of electrolysis, Current vs Time plot, Cells for coulometric titration and generation of titrant, Types of coulometric methods (potentiostatic and amperostatic), primary and secondary coulometric titrations, advantages of coulometric titrations, and applications in brief. 	1
9.4	<ul style="list-style-type: none"> • Electrogravimetry- Theory of electrolysis – constant current electrolysis and constant potential electrolysis, theory of electrogravimetry- Ohm's Law, Faraday's second law of electrolysis, Terminology: polarization, overvoltage, current density, current efficiency, decomposition potential, polarized electrode, types of polarization-concentration and kinetic, apparatus for electrogravimetric determinations, characteristics of the deposit, factors affecting physical properties of the deposit, applications in brief. 	1
10	Liquid-Liquid Extraction	2
10.0	<ul style="list-style-type: none"> • Terms: Nernst Distribution law and partition coefficient, Distribution coefficient, Distribution Ratio, Percent extraction or extraction efficiency, Separability factor. • Types-Single extraction (Batch), Multiple extractions, Countercurrent Distribution and Continuous. • Factors influencing solvent extraction, Emulsion formation problem in extraction and ways to minimise. • Applications. 	2
10.1	<ul style="list-style-type: none"> • Problems based on distribution coefficient. 	
Total		38

Reference books and textbooks (Please refer latest editions if available)	
1	Practical Pharmaceutical Chemistry by Beckett, A H & Stenlake, J B , 2005, 4 th edition, Part I and II, CBS Publishers and Distributors, India.
2	A Textbook of Pharmaceutical Analysis by Kenneth A Connors, 2002, 3 rd edition, John Wiley and Sons, Canada.

3	Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, 1992, 5 th edition, Saunders College Publishing, USA.
4	Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West, F. James Holler, 1991, 7 th edition, Saunders College Publishing, USA.
5	Analytical Chemistry by Gary D. Christian, 6 th edition, John Wiley & Sons, Singapore.
6	Vogel's textbook of quantitative chemical analysis by Mendham J, R.C. Denney, J.D. Barnes, M. Thomas, 2002, 6 th edition, Pearson Education Ltd.
7	Pharmaceutical Drug Analysis by Ashutosh Kar, 2005, 2 nd edition, New Age International (P) Ltd Publishers, India.
8	Instrumental Methods of Analysis by Dr. Supriya S. Mahajan, 2010, 1 st edition, Popular Prakashan Pvt Ltd, India.
9	Instrumental methods of chemical analysis (Analytical Chemistry) by Gurudeep R. Chatwal and Sham.K.Anand, 2008, 5 th revised and enlarged edition, Himalaya Publishing House Pvt Ltd.
10	Indian Pharmacopoeia.
11	Instrumental Method of Analysis by Willard H.H.L. Merrit & John A. Dean, 1986, 6 th edition, CBS Publishers & Distributors, New Delhi.
12	Pharmaceutical Analysis –A textbook for pharmacy students and pharmaceutical chemists by David G Watson, second edition, Pub: Elsevier, Churchill Livingstone
13	Undergraduate instrumental analysis by J.W. Robinson, E.M. Skelly Frame and G.M. Frame II, Pub. Marcel Dekker, 2009
14	Analytical Chemistry, A modern approach to analytical science, second edition, R. Kellnar, J.M.Mermet, M.Otto, M. Valcarcel, H.M.Widner, Pub: WILEY-VCH
15	Analytical chemistry by Open learning Pub: John Wiley and sons Classical methods Vol. 1 by and Chris Doran Classical methods Vol.2 by John Mendham and Derek Cooper Principles of electroanalytical methods by Tom Riley and Colin Tomlinson Polarography and other voltammetric methods by Tom Riley and Arthur Watson

Pharmaceutics – II

3 hrs/week

Unit	Topics	Hours
1	Disperse Systems: Suspensions and Emulsions	15
1.1	Introduction and Physicochemical principles, (Revision) surface & interfacial tension, surface free energy, Gibb's equation, concepts of thermodynamic & kinetic stability of disperse systems and challenges to formulator, Classification of disperse systems	1
1.2	A) Suspensions:- Definition, advantages and disadvantages, desirable features and pharmaceutical applications B) Emulsions:- Definition, advantages and disadvantages, pharmaceutical applications	1
1.3	Theoretical aspects of Suspensions:-Wetting phenomenon, particle-particle interactions, DLVO theory, flocculated and deflocculated systems, Schulze Hardy rule, Sedimentation in suspensions, Ostwald ripening and crystal factors, rheology	3
1.4	Theoretical aspects of Emulsions:-Need for emulsifier Emulsifiers- mechanisms, droplet stabilization, classification, Selection of emulsifiers-HLB method, Davies method, PIT method, Cloud point method	3
1.5	Preparation of suspensions:- Precipitation methods and dispersion method. Formulation additives	2
1.6	Preparation of Emulsions-Other formulation additives, rheological aspects, physical stability of emulsions, symptoms of instability.	2
1.7	Large scale manufacture of emulsions & suspensions.with layout of manufacturing area and equipments for each step Quality control tests for emulsions & suspensions- including stress testing -Examples of official formulations.	3
2	Factors influencing skin penetration-physiological and physicochemical factors, vehicles and penetration enhancers, methods to evaluate skin penetration.	6
2.1		2
2.2	Raw materials for semisolids, types of vehicles, ointment bases, pastes, gels, poultice, Formulation additives.	2
2.3	Large scale manufacture with equipments involved in each step and layout, Quality control tests, Examples of official formulations.	2
3	Suppositories:	7
3.1	Introduction, definition, advantages and disadvantages, desirable features of suppositories, factors affecting rectal absorption.	2
3.2	Suppository bases- specifications and desired features, classification and selection of suppository bases, special bases.	2
3.3	Formulation and specific problems involved in formulating suppositories, large scale manufacture with equipments involved in each step, packaging.	2
3.4	Quality control tests, Examples of official formulations.	1
4	Blood products:	6
4.1	Need, problems/hazards, blood banking procedures	1
4.2	Whole human blood, Red cell concentrate, Platelet concentrate, Plasmapheresis, plasma, serum. Fractionation of plasma, study of some fractions-clotting factors like fibrinogen, AHF, factor IX complex, prothrombin, albumin preparations, γ globulin preparations. Quality control aspects of blood products	3

4.3	Plasma substitutes (plasma volume expanders)- need, desired properties, examples- hydrolyzed gelatin based products, HETA starch, Dextran (in detail – source, preparation, official injections)	2
5	Sutures/ligatures:	4
5.1	Definition, classification, cat gut manufacturing and processing, other absorbable sutures-natural & synthetic	2
5.2	Nonabsorbable sutures- silk, linen, polyamides, polyesters, polyolefins, and metallic wires.	2
5.3	Quality control tests for sutures/ligatures	1
	Total	38

Books (Latest editions should be referred)

1. Lachman Leon, Liberman Herbert A., kaing Joseph L., "Theory and practice of Industrial Pharmacy" 3rd edition,1987, Varghese Publishing house,Mumbai.
2. Liberman Herbert A., rieger, "Pharmaceutical dosage Forms-Disperse Systems", vol 1/2/3, 2nd edition,2005, Marcel Dekker Inc., New York.
3. Allen, Loyd v V.Jr, "Remingtons- the Science and Practice of Pharmacy, Vol 1 / 2, 22nd edition, Pharmaceutical Press
4. Patrik Sinko Ed."Martin's Physical Pharmacy and Pharmaceutical Sciences", 6th edition, 2010, Lippincott Williams and Wilkins.
5. M.E. Aulton Ed.,"Pharmaceutics-The Science of Dosage Form Design"3rd edition,2007, Churchill livingstone Elsevier Ltd., UK.
6. E.A. Rawlins Ed.,"Bentley's Textbook of Pharmaceutics", 2010, Elsevier Publications.
7. S.J.Carter Ed.,"Tutorial Pharmacy-Cooper & Gunn", 6th edition,1986, CBS Publishers & distributors, India.
8. Pharmacopeias-IP, BP, USP-latest editions

Microbiology**3 hrs/week**

Unit	Topics	Hours
1	Introduction to Microbiology	2
1.1	Brief history, Scope of Microbiology-Basic & Applied, Relevance and Applications in Pharmaceutical Industry	1
1.2	Classification of Microorganisms, Prokaryotic and eukaryotic microorganisms, Microbes and the environment.	1
2	Microscopy	3
2.1	Simple microscope, Compound microscope, resolving power, magnification, angular aperture, numerical aperture, oil immersion objective.	1
2.2	Dark field microscopy, phase contrast microscopy, fluorescent microscopy, electron microscopy.	2
3	Techniques to study and characterize microorganisms	2
3.1	Staining of microorganisms-Monochrome stain; Negative staining; Differential staining (Gram staining & Acid fast staining), Capsule, Flagella, Cell wall, Spore staining; Study of motility by hanging drop technique	1
3.2	Information used to characterize and identify microorganisms (in brief) - morphological, cultural, metabolic, antigenic, pathogenic, genetic.	1
4	Bacteria	9
4.1	Morphology, Cell characteristics, Habitat, Nutritional requirements, Cultivation of bacteria, Culture media- Cultivation & Storage media, Enrichment media, Differential media, Assay media, Cultivation of aerobes and anaerobes.	5
4.2	Pure culture, Methods to isolate pure cultures, Preservation of cultures.	1
4.3	Reproduction of bacteria, Growth phases, Measurement of growth, factors affecting growth, continuous cultivation, enumeration of bacteria.	1
4.5	Overview of bacterial diseases and the pathogens causing them- Mycobacterium sp., Salmonella sp., Shigella sp., Staphylococci sp., Pseudomonas sp., Klebsiella sp., Clostridium sp	2
5	Viruses & related microorganisms	3
5.1	Morphological characteristics, Nutritional aspects, Cultivation and reproduction, HIV and Oncogenic viruses.	2
5.2	Rickettsiae and Chlamydiae- Morphological characteristics, Cultivation, Rickettsial & Chlamydial diseases.	2
6	Major groups of Eucaryotic microorganisms	7
6.1	Fungi-Morphological characteristics, Classification, Reproduction of fungi, Cultivation of fungi, Culture media	2
6.2.	Study of some important fungi-Penicillium, Aspergillus, Candida, Saccharomyces. Fungal infections-Mycoses	1
6.3	Algae - Classification, Morphological characteristics, reproduction, economic significance of algae.	2
6.4	Protozoa- Morphological characteristics and classification, reproduction, pathogenic protozoa like Amoeba, Paramecium, Trichomonas, Plasmodium	2
9	Control of Micro-organisms	10
9.1	Fundamentals of Microbial Control - Pattern of Death in a Microbial population, Conditions affecting Antimicrobial activity, Mechanisms of microbial cell damage, Survivor curves and concepts of D - value and Z- value.	1

	Sterility assurance and Inactivation factor.	
9.2	Sterilization methods & Equipments- Heat Sterilization methods (Moist heat, dry heat, low temperature sterilization methods), Radiation Sterilization (Ionizing and non-ionizing radiations), Filtration Sterilization, Gaseous Sterilization	4
9.3	Chemical agents used for control of microorganisms- Terminology of Chemical agents, Ideal properties, Major groups of disinfectants and antiseptics (with mechanisms and applications), Chemical sterilants, Evaluation of potency- Tube dilution & Agar plate methods, Phenol Coefficient technique	2
9.4	Introduction to Aseptic techniques (no equipments), Sterilization control and sterility assurance- Various types of sterilization indicators, Test for sterility	2
	Total	36

Books: (Latest editions should be referred)

1. M.J. Pelzer Jr., E.C.S. Chan and N.R. Krieg "Microbiology Concepts and Applications" McGraw Hill, Inc., USA, 1993.
2. M.Frobisher, R.D. Hinsdill, K.T. Crabtree and C.R. Goodheart "Fundamentals of microbiology", 9th Edn. Saunders College Publishing, Philadelphia 1968.
3. W. B. Hugo and A. D. Russel "Pharmaceutical Microbiology" 6th Edn. Blackwell science Ltd. UK, 2003.
4. R. Ananthianarayan and Ck. J. Paniker "Text Book of Microbiology", 7th edn. Orierit Longman Pvt. Ltd. Hydrabad, 2005.

Pharmacology – I**3 hrs/week**

Unit	Topics	Hours
1.	General Principles of Pharmacology <ul style="list-style-type: none"> • Introduction to Pharmacology • Routes of drug administration with special reference to their advantages and disadvantages. • Drug Absorption, Distribution, Metabolism & Excretion (ADME) 	6
2.	Mechanisms of drug action <ul style="list-style-type: none"> • Brief introduction to physiological receptors • Structural and functional families of receptors • Mechanisms of drug action: <ul style="list-style-type: none"> -Drug receptor interaction -Dose response curve (DRC) -Drug antagonism 	4
3.	Factors modifying actions of drugs	1
4.	Toxic effects of drugs on different organs and systems.	2
5.	Autonomic nervous system <ul style="list-style-type: none"> • Autonomic neurotransmission • Parasympathomimetics • Parasympatholytics • Sympathomimetics • Sympatholytics • Drugs acting on autonomic ganglia • Skeletal muscle relaxants 	12
6.	Cardiovascular system <ul style="list-style-type: none"> • Drugs used in the treatment of: <ul style="list-style-type: none"> - Congestive cardiac failure - Hypertension - Cardiac arrhythmia - Angina pectoris - Hyperlipoproteinemia 	10
7.	Diuretics	3
Total		38

Books (Latest edition of following books to be referred)

1. Goodman & Gilman's Pharmacological Basis of Therapeutics; Joel. G, Hardman Lee, E. Limbird, Alfred Goodman Gilman; 11th Ed.; The McGraw-Hill Companies, Inc; 2011.
2. Pharmacology and Pharmacotherapy; R.S. Satoskar, S.D. Bhandarkar, Nirmala N. Rege; 20th Ed.; Popular Prakashan; 2007.
3. Pharmacology; Rang and Dale; 7th Ed.; Churchill Livingstone; 2012.
4. Lippincott's illustrated reviews: Pharmacology, Lippincott-Raven; 3rd Ed.; Howland & Nycets Publishers, N.Y.; 2006.
5. Lewis Pharmacology; Crossland; 5th Ed. Churchill Livingstone.
6. Clinical Pharmacology- Lawrence, D.R and Bennet- 9th Ed.; Elsevier, N.Y. 2006.
7. Clinical Pharmacology- B.G. Katzung; 11th Ed.; Appleton & Lange Publications. 2009.
8. Pharmacology; George M. Brenner, Craig W. Stevens; 2nd Ed.; Elsevier Publishers, 2006.

Mathematics and Statistics**3 hrs/week**

Unit	Topics	Hours
1	Measurement of Central Tendency: Arithmetic Mean, median and mode	10
2	Measures of Dispersion	18
2.1	Range, quartile deviation, mean deviation and standard deviation	
2.2	Coefficients of variation, moments, skewness and kurtosis, generating moments	
2.3	Probability expectations and variance	
2.4	Binomial, Poisson and Normal Distributions	
2.5	Fitting of curves by the method of least squares $\{Y = a + bX, Y = a + bX + cX^2, Y = aX^b, Y = ab^X, Y = ac^{bX}\}$	
3	Sampling distribution for mean and proportion.	08
3.1	Test of hypothesis for specified values of mean and proportion for large samples	
3.2	Testing equality of two means and proportions	
3.3	Students "t" test for single sample and paired observation, F-test and analysis of variance, testing of attributes, Chi-square distribution.	
	Total	36

Books – Latest Editions to be adopted

1. Fundamentals of Statistics, Gupta S. C., Himalaya Publication.
2. Mathematics for Pharmacy Students (Vol. I), Gujar K. N., Bhavale Ashok, Career Publicaiton.
3. Measurement, Statistics of Computation, C Cornmich D, John Wiley and Sons.
4. Biostatistics in Pharmaceutical Industry, Buchner R. C., Marcel Decker Inc.
5. Integral Calculus, Shanti Narayan, S. Chand Publication.

Practicals
Pharmaceutical Analysis Lab. – I

4 hrs/week

NOTE: For all the experiments, the latest edition of the Indian Pharmacopoeia 2010 has to be referred, except for gravimetric analysis.

Acid-Base titrations:

- 1) Assay of Aspirin API (with special emphasis on the test for salicylic acid).
- 2) Assay of Aspirin tablets.
- 3) Estimation of Total alkalinity in a solution of Sodium Hydroxide.
- 4) Assay of Benzoic acid.

Redox titrations:

- 5) Assay of hydrogen peroxide solution (Permanganometry).
- 6) Assay of Ascorbic acid API (Iodimetry)
- 7) Assay of Sodium metabisulphite API (Iodometry)
- 8) Assay of KMnO_4 (Back Iodometry)
- 9) Assay of Ascorbic acid tablets/ Dried Ferrous sulphate/ Ferrous fumarate/ Paracetamol (Cerrimetry).
- 10) Assay of Potassium iodide (Iodate titration)

Complexometric titrations:

- 11) Assay of Calcium gluconate injection.
- 12) Assay of Zinc sulphate.
- 13) Assay of Magnesium sulphate.

Miscellaneous titrations:

- 14) Assay of Sulphacetamide sodium using external indicator.
- 15) Assay of Soluble Aspirin tablets (Solvent extraction followed by Bromometry-iodometry).

Gravimetric analysis: (Ref. Vogels' Textbook of Quantitative Chemical Analysis by Mendham J, Denney R C, Barnes J D, Thomas N, 2002, 6th Edition, Pearson Education Ltd.)

- 16) Ni^{2+} using Dimethyl glyoxime/ Al^{3+} as Al-oxinate.
- 17) Ba^{2+} as BaSO_4 .

Demonstration titrations:

- 18) Assay of Pyridoxine hydrochloride/ Sodium benzoate using non-aqueous titration method.
- 19) Assay of Sodium chloride.
- 20) Assay of Potassium chloride.

P. B. Standardization of all volumetric solutions has to be done

1. SUSPENSIONS: (a) Antacid Suspension (Aluminium Hydroxide gel I.P' 2010/ Magnesium hydroxide oral suspension I.P' 2010) (b) Paracetamol Suspension (c) Calamine Lotion I.P' 2010 (d) Microscopic evaluation, rheology and sedimentation rate studies for any one of the above suspensions.
2. EMULSIONS: (a) Liquid Paraffin Emulsion I.P ' 2010 (b) White Liniment B.P.C, 73 (c) Turpentine Liniment I.P ' 66 (d) Benzyl Benzoate Application I.P ' 2010 (e) Microscopy of any one of the above emulsion
3. OINTMENTS: (a) Simple Ointment I.P ' 66 (b) Sulphur ointment I.P ' 66 (Microscopic evaluation) (c) Emulsifying ointment I.P ' 66 (d) Compound Benzoic acid ointment I.P' 2010 in emulsifying ointment base (e) Iodine ointment, Non – staining B.P.C 68 (f) Iodine ointment, Non – staining with methyl salicylate B.P.C 68
4. CREAMS: (a) Cetrimide cream I.P' 2010
5. GELS: (a) Diclofenac sodium gel
6. PASTES: (a) Titanium dioxide paste B.P.C' 73
7. SUPPOSITORIES: (a) Indomethacin Suppositories I.P' 2010

Books

1. Relevant editions of Indian Pharmacopoeia, British Pharmaceutical Codex.
2. Lachman Leon, Liberman Herbert A., Kaing Joseph L., "Theory and practice of Industrial Pharmacy" 3rd edition, 1987, Varghese Publishing house, Mumbai.
3. Allen, Loyd V.Jr, "Remingtons- the Science and Practice of Pharmacy, Vol 1 / 2, 22nd edition, Pharmaceutical Press.

Sr. No.	Experiment
1.	Dose response curve (DRC) of Ach using suitable isolated tissue preparation (e.g. Cock ileum)
2.	Demonstrations: Effect of drugs on isolated frog heart (CDs) -Adrenaline, ACh -Atropine, propranolol -Effect of excess calcium and potassium on isolated heart -Effect of lack of calcium and potassium on isolated frog heart -Effect of digitalis on hypodynamic heart
3.	Simulated experiments (CDs) -Effect of drugs on eye -Effect of drugs on GI motility
4.	Demonstration with the help of CDs or kymograph recordings: –Effect of neostigmine on DRC of Ach –Effect of pancuronium on DRC of Ach (Give the readings to the students and ask them to plot the graphs and draw conclusions from the results eg. Identify type of antagonism existing between two drugs by studying the nature of the graphs, competitive and non competitive. Find out the potency of the drugs by studying the DRC and determining IC50 values) -Calculation of pA2 value of atropine using Ach as an agonist
5.	Tutorials -Laboratory animal handling -Care and ethics in animal experimentation

Books: Latest editions of following books to be referred.

1. Kulkarni, S.K. Handbook of Experimental Pharmacology; 3rd Ed.; Vallabh Prakashan, New Delhi. 2005.
2. Gosh M.N. Fundamentals of Experimental Pharmacology, 3rd Ed.; Hilton & Company, Calcutta. 2005.
3. S.B. Kasture A Handbook of Experiments in Pre-Clinical Pharmacology- 1st Ed. Career Publications. 2006.
4. W.I.M. Perry, Pharmacological Experiments on Isolated Preparations. 2nd Ed.; E & S Livingstone, Edinburgh & London, 1970.

Microbiology Lab

4 hrs/week

1. Study of microscope and common laboratory equipments.
2. Gram Staining
3. Monochrome staining
4. Negative staining
5. Cell wall staining
6. Spore staining
7. Capsule staining
8. Motility by hanging drop technique
9. Preparation and sterilization of nutrient broth, agar slants, plates and inoculation techniques.
10. Isolation of pure culture by pour plate and streak plate methods. Colony characterization and growth patterns in broth of cocci and bacilli.
11. Total counts by Breeds smear method
12. Growth by optical density, total plate count
13. Study of yeast, Aspergillus and Penicillum with respect to morphology
14. Observation on prepared slides of malarial parasites in blood smear, intestinal amoeba in stools.

Books

1. C. R. Kokare "Pharmaceutical Microbiology Experiments and Techniques", Career Publication, Nashik.
2. R. S. Gaud and G. D. Gupta "Practical Microbiology", Nirali prakashan, Pune.
3. C. H. Collins, Patricia M. Lyne, J. M. Grange "Microbiological Methods "7th Edn. Butterworth-Heinemann Ltd Oxford, London