

AC 31/05/2017

Item Number 4.2

UNIVERSITY OF MUMBAI



Bachelor of Pharmacy

First Year B. Pharm. (Semester I,II,III & IV),
Revised course (REV- 2016)
from Academic Year 2016 -17

(As per Choice Based Credit and Grading System with
effect from the academic year 2016–2017)

From Co-ordinator's Desk:-

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meetings unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's), give freedom to affiliated Institutes to add few (PEO's) course objectives course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry should to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes. Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Credit grading based system was implemented for First Year of B. Pharmacy from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year B. Pharmacy in the academic year 2017-2018, for Third Year and Final Year B. Pharmacy in the academic years 2018-2019, 2019-2020, respectively.

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B. Pharm. Choice Based Credit and Grading System (CBCGS)[2016-17]

**Scheme Examination Semesters I to VIII
&
Syllabus Semesters I to IV**

[REVISED 2016]

**EXAMINATION SCHEME FOR THE CHOICE BASED CREDIT AND GRADING SYSTEM
(CBCGS) (2016-17)**

SEMESTER I

Course Code	Name	Credits	Hr/Wk	Weightage Internal	Weightage End Semester Exam	Total Marks
BPH_C_101_T	General Chemistry	4	4	20	80	100
BPH_C_102_T	Dispensing and Community Pharmacy	4	4	20	80	100
BPH_C_103_T	Anatomy, Physiology & Pathophysiology I	4	4	20	80	100
BPH_C_104_T	Biochemistry I	4	4	20	80	100
BPH_C_105_T	Communication Skills and Ethics (NUES)	3	3	20	80	100
	TOTAL Theory	19	19	100	400	500
BPH_C_106_L	General Chemistry Lab	2	4	10	40	50
BPH_C_107_L	Dispensing and Community Pharmacy Lab	2	4	10	40	50
BPH_C_108_L	Anatomy, Physiology & Pathophysiology Lab	2	4	10	40	50
	TOTAL Lab	6	12	30	120	150
	TOTAL SEM I	25	31	130	520	650

SEMESTER II

Course Code	Name	Credits	Hr/Wk	Weightage Internal	Weightage End Semester Exam	Total Marks
BPH_C_201_T	Anatomy, Physiology & Pathophysiology II	4	4	20	80	100
BPH_C_202_T	Biochemistry II	4	4	20	80	100
BPH_C_203_T	Pharmacognosy I	4	4	20	80	100
BPH_C_204_T	Hospital Pharmacy and Drug Store Management	4	4	20	80	100
BPH_C_205_T	Environmental Science	3	3	20	80	100
	TOTAL Theory	19	19	100	400	500
BPH_C_206_L	Pharmacognosy Lab I	2	4	10	40	50
BPH_C_207_L	Biochemistry Lab	2	4	10	40	50
BPH_C_208_L	Computer Lab	2	4	10	40	50
	TOTAL Lab	6	12	30	120	150
	TOTAL SEM II	25	31	130	520	650

NO REMEDIAL FOR LATERAL ENTRY AS SEM I AND II SUBJECTS ARE COVERED IN DIPLOMA SYLLABUS

SEMESTER III

Course Code	Name	Credits	Hr/Wk	Weightage Internal	Weightage End Semester Exam	Total Marks
BPH_C_301_T	Organic Chemistry I	4	4	20	80	100
BPH_C_302_T	Physical Pharmacy I	4	4	20	80	100
BPH_C_303_T	Anatomy, Physiology & Pathophysiology III	4	4	20	80	100
BPH_C_304_T	Pharmaceutical Analysis I	3	3	20	80	100
BPH_C_305_T	Pharmaceutical Engineering	3	3	20	80	100
	TOTAL Theory	18	18	100	400	500
BPH_C_306_L	Organic Chemistry Lab I	2	4	10	40	50
BPH_C_307_L	Physical Pharmacy Lab I	2	4	10	40	50
BPH_C_308_L	Pharmaceutical Analysis Lab I	2	4	10	40	50
	TOTAL Lab	6	12	30	120	150
	TOTAL SEM III	24	30	130	520	650

SEMESTER IV

Course Code	Name	Credits	Hr/Wk	Weightage Internal	Weightage End Semester Exam	Total Marks
BPH_C_401_T	Organic Chemistry II	4	4	20	80	100
BPH_C_402_T	Physical Pharmacy II	4	4	20	80	100
BPH_C_403_T	Pharmaceutics I	3	3	20	80	100
BPH_C_404_T	Pharmacology I	4	4	20	80	100
BPH_C_405_T	Microbiology	3	3	20	80	100
BPH_C_406_T	Mathematics and Statistics	3	3	20	80	100
	TOTAL Theory	21	21	120	480	600
BPH_C_407_L	Physical Pharmacy Lab II	2	4	10	40	50
BPH_C_408_L	Pharmaceutics Lab I	2	4	10	40	50
BPH_C_409_L	Pharmacology Lab I	2	4	10	40	50
	TOTAL Lab	6	12	30	120	150
	TOTAL SEM IV	27	33	150	600	750

SEMESTER V

Course Code	Name	Credits	Hr/Wk	Weightage Internal	Weightage End Semester Exam	Total Marks
BPH_C_501_T	Organic Chemistry III	4	4	20	80	100
BPH_C_502_T	Pharmaceutics II	4	4	20	80	100
BPH_C_503_T	Pharmaceutical Biotechnology	4	4	20	80	100
BPH_C_504_T	Pharmacology II	4	4	20	80	100
BPH_E_5xx_T	Choice Based Course I	2	2	10	40	50
BPH_E_5xx_T	Choice Based Course II	2	2	10	40	50
	TOTAL Theory	20	20	100	400	500
BPH_C_505_L	Organic Chemistry Lab II	2	4	10	40	50
BPH_C_506_L	Pharmaceutics Lab II	2	4	10	40	50
BPH_C_507_L	Experimental Techniques in Microbiology and Biotechnology Lab	2	4	10	40	50
	TOTAL Lab	6	12	30	120	150
	TOTAL SEM V	26	32	130	520	650

SEMESTER VI

Course Code	Name	Credits	Hr/Wk	Weightage Internal	Weightage End Semester Exam	Total Marks
BPH_C_601_T	Pharmaceutical Chemistry I	4	4	20	80	100
BPH_C_602_T	Pharmaceutics III	4	4	20	80	100
BPH_C_603_T	Pharmaceutical Analysis II	4	4	20	80	100
BPH_C_604_T	Pharmacognosy II	4	4	20	80	100
BPH_E_6xx_T	Choice Based Course III	4	4	20	80	100
BPH_E_6xx_T	Choice Based Course IV	2	2	10	40	50
	TOTAL Theory	22	22	110	440	550
BPH_C_605_L	Pharmaceutical Chemistry Lab I	2	4	10	40	50
BPH_C_606_L	Pharmaceutics Lab III	2	4	10	40	50
BPH_C_607_L	Pharmaceutical Analysis Lab II	2	4	10	40	50
	TOTAL Lab	6	12	30	120	150
	TOTAL SEM VI	28	34	140	560	700

SEMESTER VII

Course Code	Name	Credits	Hr/Wk	Weightage Internal	Weightage End Semester Exam	Total Marks
BPH_C_701_T	Pharmaceutical Chemistry II	4	4	20	80	100
BPH_C_702_T	Pharmacognosy III	4	4	20	80	100
BPH_C_703_T	Pharmaceutical Analysis III	4	4	20	80	100
BPH_C_704_T	Pharmacology III	4	4	20	80	100
BPH_C_705_T	Pharmaceutical Jurisprudence	3	3	20	80	100
BPH_E_7xx_T	Choice Based Course V	2	2	10	40	50
	TOTAL Theory	21	21	110	440	550
BPH_C_706_L	Pharmacognosy Lab II	2	4	10	40	50
BPH_C_707_L	Pharmaceutical Analysis Lab III	2	4	10	40	50
BPH_C_708_L	Pharmacology Lab II	2	4	10	40	50
	TOTAL Lab	6	12	30	120	150
	TOTAL SEM VII	27	33	140	560	700

SEMESTER VIII

Course Code	Name	Credits	Hr/Wk	Weightage Internal	Weightage End Semester Exam	Total Marks
BPH_C_801_T	Pharmaceutical Chemistry III	4	4	20	80	100
BPH_C_802_T	Pharmaceutics IV	4	4	20	80	100
BPH_E_8xx_T	Choice Based Course VI	4	4	20	80	100
BPH_E_8xx_T	Choice Based Course VII	4	4	20	80	100
	TOTAL Theory	16	16	80	320	400
BPH_C_803_L	Pharmaceutical Chemistry Lab II	2	4	10	40	50
BPH_C_804_L	Pharmaceutics Lab IV	2	4	10	40	50
BPH_E_805_D	Project	6	12	-	200	200
	TOTAL Lab	10	20	20	280	300
	TOTAL SEM VIII	26	36	100	600	700

SYLLABUS FOR F. Y. B. Pharm.

SEMESTER-I

BPH_C_101_T – General Chemistry – (4 Hr/Wk)

Course Objectives

On completion of following theory topics, learner should be able to understand basic concepts of bonding, principles of chemical reaction and catalytic reaction, role of inorganic reagents as medicinal compounds.

Course Outcomes

The learner should be able to:

- 1) Draw and explain the structures of various molecules or ions based on the concept of ionic and covalent bonding
- 2) Explain the Rate Law of a Chemical Reaction and Apply the knowledge of principles like Hammonds postulate, Reactivity and Selectivity Microscopic reversibility to predict the nature of reaction and product formation rate
- 3) Differentiate the types of catalytic reactions and explain the role of catalyst
- 4) Classify Gastrointestinal Agents, Topical Agents, Saline Cathartics, Expectorants, Emetics, Antidotes and explain their mode of action. Describe sclerosing agents and complexing agents
- 5) Classify electrolytes/ elements and elaborate their physiological role. Explain use of physiological ions in replacement therapy, acid-base balance and combination therapy.
- 6) Explain the basic concepts of radiochemistry and biological effects of radiation; describe diagnostics and therapeutic uses of radiopharmaceuticals.

No.	Details	Hours
1	Review of basic bonding concepts	10
1.1	Quantum numbers, atomic orbitals, electron configuration, electronic diagrams, polar covalent bonds, electronegativity group, electronegativities, electrostatic potential surfaces, inductive effects, bond dipoles, molecular dipoles.	4
1.2	Lewis structures, formal charge.	3
1.3	VSEPR, hybridization involving s, p and d orbitals, hybridization effects	3
2	Kinetics and reaction mechanism	7
2.1	Energy surfaces, reaction coordinate diagrams, activated complex/transition state rate and rate constants, reaction order and rate laws	2
2.2	Kinetic isotope effects	2
2.3	Hammond Postulate, reactivity vs selectivity, Curtin-Hammett Principle, microscopic reversibility, kinetic vs thermodynamic control	3
3	Catalysis:	7
3.1	General principles of catalysis, Forms of catalysis – electrophilic catalysis, acid- base catalysis, nucleophilic catalysis, covalent catalysis, phase transfer catalysis.	4
3.2	Bronsted Acid-base catalysis, correlation of reaction rates with acidity functions.	3
4	Gastrointestinal Agents	4
4.1	Acidifying agents	1
4.2	Antacids:Sodium bicarbonate, aluminum hydroxide, calcium carbonate, tribasic calcium phosphate, magnesium hydroxide, magnesium trisilicate and combination antacid preparations.	1
4.3	Protectives and Adsorbents:Introduction; bismuth subnitrate, bismuth subcarbonate, kaolin, attapulgit and activated charcoal	1
4.4	Cathartics	1
5	Topical Agents	4
5.1	Protective Topical Agents: Definition; talc, insoluble zinc compounds (zinc oxide, calamine, zinc stearate), titanium dioxide.	1
5.2	Antimicrobials and Astringents: Antimicrobial terminology, mechanism of action Antimicrobial Astringent Products: Oxidative antimicrobial agents; (hydrogen peroxide, zinc peroxide, sodium carbonate, potassium permanganate, sodium hypochlorite, iodine preparation and compounds)	1
5.3	Protein Precipitant Antimicrobial Agents: Silver nitrate, mild silver protein and related products, ammoniated mercury, mercuric chloride, sulphur and sulphur compounds, sublimed sulphur and precipitated sulphur, boric acid and sodium borate, antimony potassium tartrate.	1

5.4	Astringents: Official compounds of aluminium and zinc	1
6	Complexing and chelating agents used in therapy, poisons and antidotes	2
7	Miscellaneous inorganic pharmaceutical agents:	2
7.1	Sclerosing agents, expectorants, emetics.	1
7.2	Antioxidants: Theory and principle, selection of antioxidants, official antioxidants (hypophosphorous acid, sodium bisulphite, sodium thiosulphate, sodium nitrite and nitrogen).	1
8	Inorganic Radio Pharmaceuticals: Properties of α , β and γ radiation, biological effect of radiation, half-life, clinical application of radiopharmaceuticals (Chromium-51, Iodine-125 and 131, Technetium-99, Iron-59, Cobalt-57 and 60 and Gold-198)	4
9	Major Intra & Extracellular Electrolytes	5
9.1	Major physiological ions (Role and condition related to change in concentration of following ions: chloride, phosphate, bicarbonate, sodium, potassium, calcium, magnesium)	2
9.2	Electrolytes used in replacement therapy: Sodium replacement (sodium chloride), potassium replacement (potassium chloride), calcium replacement (calcium chloride, calcium gluconate)	1
9.3	Physiological acid base balance: Acids and Bases: Buffers (Pharmaceutical and Physiological) Electrolytes used in acid base therapy (sodium acetate, sodium bicarbonate, sodium biphosphate, sodium citrate, sodium lactate, ammonium chloride). Electrolyte combination therapy.	2
10	Essential and Trace Elements: Iron and haematinics Copper, zinc, molybdenum, selenium and sulphur. Official iodine products (iodine, potassium iodide, sodium iodide).	3
TOTAL		48

Note: Only Uses of pharmaceutical agents mentioned to be covered. Monographs not to be discussed.

Books:

Latest Edition of all books to be referred.

- 1) Eric V Anslyn and Dennis A Dougherty, Modern Physical Organic Chemistry, John Wiley.
- 2) Inorganic medicinal and pharmaceutical chemistry, J. H. Block, E. B. Roche, T. O. Soine, and C. O. Wilson. Lea &Febiger, Philadelphia, PA.
- 3) Modern Inorganic Pharmaceutical Chemistry, Clarence A. Discher. Wiley, New York.
- 4) Remington: the science and practice of pharmacy, Beringer, P. Lippincott Williams & Wilkins.
- 5) Inorganic Pharmaceutical Chemistry, Bothara, K. G., Nirali Prakashan.
- 6) Inorganic Pharmaceutical Chemistry, A. S. Dhake, H. P. Tipnis, Career Publication.

BPH_C_102_T – Dispensing and Community Pharmacy – (4 Hr/Wk)

Course Objectives

On completion of the theory topics, the learner should have had an understanding of the concept of drug versus dosage forms, basic calculations relating to the practice of dispensing, prescriptions and their types and their compounding and the role of a community pharmacy in healthcare

Course Outcomes

The learner should be able to:

1. Define and identify various dosage forms
2. Solve problems relating to pharmaceutical calculations
3. Have knowledge of different prescription types
4. Identify and comprehend different steps involved in dispensing of formulations
5. Understand principles involved in compounding of different dosage forms
6. Identify physical and chemical incompatibilities among different active ingredients and formulations
7. Understand the organization of community pharmacy, provide optimal patient care under the direct personal interaction/ counseling

No.	Details	Hours
1	Concept of formulation: Definition of drug and dosage form Introduction to routes of administration Classification of dosage form and their applications	4
2	Introduction to compounding and dispensing.	1
3	Prescription: Prescription and its parts. Types of prescriptions. Pricing and recording of prescriptions.	2
4	General dispensing: Fundamentals of compounding and dispensing including good practices. Containers and closures/packaging for dispensed products. Storage and stability of dispensed products. Labeling of dispensed preparations. Dispensing of proprietary medicines.	5
5	Pharmaceutical Calculations: Reduction and enlargement of formulae, formula by weight(w/v, w/w, v/v), in parts Calculations based on expressions of concentration and dilution (percentage, parts, alligation), proof strength. Posology.	4
6	General compounding of Products (includes excipients used and compounding procedure): Solutions, suspensions, emulsions and creams, ointments and pastes, gels, suppository and pessaries, powders, granules. and capsules	10
	<i>Self-Study: Compounding of dosage forms such as lozenges, pastilles, pills, tablet triturates.</i>	5
7	Incompatibilities: Physical Incompatibilities, Chemical Incompatibilities.	3
8	Community Pharmacy: Definition and scope Pharmacy and health care system in India Roles and responsibilities of community pharmacist	2
9	Health education: WHO Definition of health, and health promotion Health screening services- definition, importance, methods for screening	3
	<i>Self-Study: Commonly occurring Communicable Diseases, causative agents, Balance diet, treatment & prevention of deficiency disorders, Family planning – role of pharmacist</i>	3
10	Pharmaceutical care: Definition and Principles of Pharmaceutical care, definition and outcomes of patient counseling	2
11	OTC Medication	2
12	Pharmaceutical ethics: Principle and Significance of professional ethics, code of ethics for a pharmacist	2
	TOTAL	48

Books:

- Cooper and Gunn's 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, Churchill Livingstone, 1998.]
- Pharmaceutical Practice; Edited by A.J. Winfield and R.M.E. Richards, Third Edition, Churchill Livingstone, 2004.
- Husa's Pharmaceutical Dispensing, Edited by Eric Martin, Sixth Edition, Mack Publishing Company, 1996.
- Pharmaceutical Calculations, A.C. Ansel and M.J.Stoklosa, Lippincott Williams and Wilkins, 2006.
- Pharmaceutical Calculations – Bradley, Gustafson and Stoklosa, Third Edition, Lea and Febiger, 1957.
- Parmar N.S. Health Education and Community Pharmacy, 18th ed. India: CBS Publishers & Distributors; 2008.
- Merchant S.H. and Dr. J.S.Quadry. A Textbook of Hospital Pharmacy, 4th ed. Ahmadabad: B.S. Shah Prakakshan; 2001

BPH_C_103_T - Anatomy, Physiology and Pathophysiology – I (4 Hr/Wk)

Course Objectives

To familiarize the learner with the anatomical organization and physiology of the human body and the pathophysiology of some disease states

Course Outcomes

The learner should be able to:

1. Outline and categorize the various body structural levels (cells, tissues, organs, and systems) and recall the structure, composition and functions of plasma membrane and methods of movement of substances across plasma membrane.
2. Explain anatomy, physiology of lymphatic system, recall & interpret the types of hypersensitivity reactions, and make use of the knowledge of the pathophysiology of AIDS and autoimmune diseases.
3. Tell the composition and functions of blood, explain the process of hemostasis and blood coagulation as well as recall & apply the knowledge of pathophysiology of common haematological disorders.
4. Comprehend the mechanisms of inflammation and repair.
5. Recall the anatomy of skeletal, cardiac and smooth muscle, explain the transmission at the neuromuscular junction and energy metabolism in the muscle as well as the mechanism of skeletal muscle contraction and demonstrate various types of skeletal muscle contractions.

No.	Details	Hours
1.	Brief introduction to human body and organization of human body	1
2.	Structural and functional characteristics of following tissues 1) Epithelial 2) Connective 3) Nervous 4) Muscle	2
3.	Detailed structure of cell membrane and trans-membrane movement of substances	2
4.	Components and functions of lymphatic system • Lymphatic organs and tissues • Organization of lymph vessels • Formation and flow of lymph	4
5.	Pathophysiology of following diseases • AIDS • Autoimmune diseases (Rheumatoid arthritis, Grave's disease, Myasthenia Gravis, Rheumatic fever) • Hypersensitivity and types of hypersensitivity reactions.	6
7.	Haematology • Composition of blood • Functions of blood elements • Erythropoiesis and life cycle of RBC. • Synthesis of Haemoglobin • Leucopoiesis • Immunity: Basics and Types • Coagulation of blood • Blood groups	10
8.	Pathophysiology of following diseases • Anaemias – Types of anaemias • Polycythemia : Physiological and polycythemia vera • Leucopenia • Leukocytosis • Thrombocytopenia • Leukemia	5
6.	Basic mechanism involved in the process of inflammation and repair. • Alteration in vascular permeability and blood flow. • Migration of WBC • Acute and chronic inflammation • Brief outline of the process of repair.	7

9.	Structure and properties of following muscles • Cardiac muscles • Smooth muscles • Skeletal muscles • Neuromuscular transmission and contraction of skeletal muscle • Energy metabolism in the muscle • Types of muscle contractions • Muscle tone	11
	TOTAL	48

Books:

Latest editions of the following books can 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, Principles 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 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, Textbook of Pathology, Published by Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi

BPH_C_104_T - Biochemistry I (4 Hr/Wk)

Course Objectives

At the end of the theory lectures, the learner should be familiar with the basic building blocks of the biomolecules and the biomacromolecules themselves in a biological system, understand the role of vitamins as cofactors in enzyme reactions and be aware of the principles of thermodynamics as they apply to biosystems.

Course Outcomes

The learner should be able to:

1. List and identify the commonly occurring carbohydrates, amino acids and fatty acids
2. Describe higher order structures like oligo- and poly-saccharides/peptides and membrane lipids
3. Classify the different vitamins in terms of their aqueous solubility and the biochemical reactions/role they are involved in.
4. Define the laws of thermodynamics and explain the concepts of Gibbs free energy, favorable and unfavorable reactions and role of ATP and NADH as energy carriers
5. Describe the process of digestion, absorption, storage and retrieval of different cellular nutrients

No.	Details	Hours
1.	Introduction to Carbohydrates: Introduction to common monosaccharides ranging from trioses to hexoses Introduction to common disaccharides sucrose, cellobiose, maltose, lactose Introduction to common polysaccharides starch and glycogen Introduction to Proteins: Introduction to amino acids, their classification, three letter and one letter codes Introduction to hierarchy of protein structures Introduction to Lipids: Introduction to common saturated and unsaturated fatty acids Introduction to triacyl glycerol, phospholipids, sphingolipids Introduction to Nucleic acids: Introduction to nitrogen bases, nucleosides and nucleotides Introduction to the structure of DNA (helices), melting and annealing of DNA, melting temperature and introduction to higher order packaging of DNA Introduction to the concept of glycoproteins, proteoglycans, lipopolysaccharides, glycolipids, lipoproteins, proteolipids, nucleoproteins, with examples.	22
2.	Vitamins Vitamins as co-enzymes and their significance. Biochemical roles of all the vitamins with details of the mechanisms of their functions. (riboflavin, thiamine, pyridoxal, nicotinamide, biotin, folic acid, ascorbic acid, pantothenic acid,	15

	cyanocobalamine, inositol, vitamins A, D, E, K)	
3.	Biochemical Energetics Introduction to the concept of free energy, standard free energy, transformed free energy. Thermodynamically favorable or unfavorable reactions. Spontaneous versus thermodynamically favorable reactions. Oxidations as a source of energy in biological systems. ATP, NADH and FADH ₂ as energy carriers. Introduction to the concepts of anabolism and catabolism. Convergence of metabolic pathways and divergence of anabolic pathways	8
4.	Digestion Digestion of food and absorption of food (carbohydrates, lipids and carbohydrates). Fate of absorbed nutrients and the relationship with regard to immediate use, storage, release and interconversion. Role of liver, muscle, adipose tissue, brain and special features of rbc's.	3
	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 Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams and Wilkins, USA
6. Foye's Principles of Medicinal Chemistry, Lippincott Williams and Wilkins, USA.

BPH_C_105_T - Communication Skills and Ethics (3 Hr/Wk)

Course Objectives

To teach the learner the importance of English language, the vocabulary and grammar for effective scientific and non-scientific communication and inculcate the importance of Life Skills and Ethics in fulfilling the role as a pharmacist, healthcare provider and a world citizen.

Course Outcomes

The learner should be able to:

1. List and identify verbs and the passive voice
2. Apply skills learnt to confidently stand in a group discussion
3. Apply skills learnt to communicate effectively – technically/businesswise
4. Appreciate and imbibe the importance of ethics, human values, honesty and integrity

No.	Details	Hours
1.	Introduction on language and communication: Review of grammar and vocabulary, Effective use of dictionary, Phonetics, Meaning and importance of communication, Objectives of Communication. Need for Communication. Types of communication. Written & Verbal communication. Formal and informal communication, upward and downward communication. Non-Verbal, Body Language and Graphic Language. Barriers to effective communication and how to overcome them; brevity, clarity and appropriateness in communication.	5
2.	Technical Communication: Nature, Origin and Development, Factors involved in Technical Communication (Audience, Purpose, Format & Style), Forms of Technical Communication, Five C's of Technical Communication (Clear, Correct, Concise, Consistent, Comprehensive), Difference between Technical Communication & General Communication	2
3.	Business communication: Objectives & Functions of Business Communication, Importance of written business correspondence, Types of Business correspondence: Enquiry, Order letter, Complaint letter, Adjustment letter, Official letters, electronic communication, Routine Letters and Goodwill Messages, Office Drafting: Circular, Notice, and Memo. Telephone Communication and Cell Phone etiquettes Assignment: Drafting of the above types of business correspondence	3
4.	Career Skills: Interview skills, Applying for job, Cover letters, Resume and Effective	4

	Profiling, group discussion, letter writing, e-mail writing and Netiquettes, Academic Application Drafting, Report writing–preparing rough draft, editing and preparing final report, Presentation Skills: (i) How to make a Power Point presentation (ii) Body language during presentation Assignment: Oral presentations by the students, followed by discussion Mock Interview: Each student to face an interview and to demonstrate the above taught skills	
5	Life Skills – Goal-setting; Self-esteem and Self-Confidence; Problem Solving; Decision Making; Time Management; Stress Management; Positive Thinking; Assertiveness; Teamwork; Interpersonal Relationships; Coping with Life Stresses; Suicidal Tendencies; Peer Pressure; Substance Abuse and Addiction. Basic Listening Skills: Introduction, Self-Awareness, Active Listening, Becoming an Active Listener, Listening in Difficult Situations	4
6.	Effective and Ethical Communication at work: Flow of communication in organizations, Communication Skills & Success at work, How to overcome typical barriers of Communication and ethical response to office gossip	2
7.	Introduction to Ethics and Human Values: Definition – Good Behaviour, Conduct and Character; Importance, Respects for Elders, Use and Relevance in Present-day Society, Individual and Society – Desirable Basic Human Characters - Honesty, Truthfulness, Respect, Punctuality, Responsibility, Courtesy, Discipline, Kindness, courage, Character, Forgiveness, Friendship, Compassion, Consideration, Contentedness, Simplicity, Empathy, Avoiding Greed; Family responsibilities, The 3 Cs of ethics – clarity, courage and creativity,	3
8.	Professional Ethics: Need and Importance – Goals, Dignity of Labour dimensions of ethics; ethics in private and public relationships, Ethical Values in Different Professions – Management, Business, Teaching, Civil Services, Politics, Medicine, Policing, Judiciary.	2
9.	Ethical Practice in Pharmaceutical Industry: Safety norms, quality norms, clinical trials, packaging, labelling, pricing, distribution, disposal of past-expiry products, advertising, use of medical channels for promotional activities, IPR, Role of R&D, profitability and its linkage to R&D	2
10.	Ethics in Media and Technology – Impact on Youth; Cyber Ethics and Etiquette; Mobile Phones, Social Networking; Correct and Judicious Use	1
11.	Leadership and Ethics: What is Ethical Leadership? Principles & commandments of ethical leadership, Characteristics of Ethical leader, Ethical decision making	2
12	Group Projects/ Field Work	6
	Total	36

Group Projects: (6 Hrs)

Students could go on a local field trip and submit an account in about 5 pages. Students can be divided into groups of 5 and one written account can be submitted per group. Different groups can undertake different projects so that the logistics are manageable and there is also sharing of experiences/ideas. Students are advised to prepare a list of questions before hand so that they are more focused.

Some suggestions of locations include: Government hospital or dispensary , old age home, Pension Office, Local wholesale market, Industry, Cancer care centre, Orphanage, Homes for mentally challenged, etc

Books:

1. The right word at the right time A guide to the English language and how to use it, Alison John, The reader's Digest
2. Study writing, Hamplyons Liz & Ben Heasley, Cambridge University Press.
3. Basic Business Communication, Lesiker Raymond.V and Maire E Hatley, New York, Tata McGraw Hill
4. Business Ethics- A Global and Managerial Perspective, David J. Fritzsche, Tata McGraw Hill
5. Values and Ethics in Organizations – Theory and Practice, S.K.Chakraborty, Oxford University Press (OUP)
6. Ethics Omnibus, S.K.Chakraborty, Oxford University Press (OUP)
7. KK Ramchandran Business communication (Macmilan)
8. Basic communication skills for Technology, Andreja. J. Ruther Ford, 2nd Edition, Pearson Education, 2011
9. Communication skills, Sanjay Kumar, Pushpalata, 1st Edition, Oxford Press, 2011

10. Organizational Behaviour, Stephen .P. Robbins, 1st Edition, Pearson,2013
11. Brilliant- Communication skills, Gill Hasson, 1st Edition, Pearson Life.
12. Personality development and soft skills, Barun K Mitra, 1st Edition,Oxford Press, 2011

BPH_C_106_L – General Chemistry – Lab (4 Hr/Wk)

Course Objective

On completion of general chemistry Lab, learner should be able to prepare, purify and examine inorganic pharmaceutical agents.

Course Outcomes

The learner should be able to:

- 1) Analyze inorganic mixtures qualitatively by semi-micro methods.
- 2) Identify different inorganic impurities in inorganic medicinal agents by performing Pharmacopoeial test. .
- 3) Prepare and purify inorganic pharmaceuticals

Practicals:

- 1) The background and systematic qualitative analysis of inorganic mixtures of up to four radicals. Six mixtures to be analyzed, preferably by semi-micro methods.
- 2) Identification tests for pharmacopoeial inorganic pharmaceuticals and qualitative tests for cations and anions should be covered (any two)
- 3) Limit Test for Impurities in Pharmaceutical Compounds: Chloride, Sulphate and Iron
- 4) Preparation of Selected Inorganic Pharmaceuticals: Potash alum and ferrous oxalate.
- 5) Purification of Selected Inorganic Pharmaceuticals: Copper sulphate and ferrous sulphate.

References

- 1) Svehla G. Vogel's Textbook of Micro and Semimicro-Qualitative Inorganic Analysis. Orient Longman, Hyderabad. Latest Edition.
- 2) Indian Pharmacopoeia. The Indian Pharmacopoeia Commission, Central Indian Pharmacopoeia Laboratory, Govt. of India. Ministry of Health and Family Welfare, Ghaziabad. Latest Edition.

BPH_C_107_L - Dispensing and Community Pharmacy – (4 Hr/Wk)

Course Objectives

The train the learner in the requirements of a dispensing pharmacist and teach pharmacist-patient interactions at the professional level.

Course Outcomes

The learner should be able to:

1. Read prescriptions, identify commonly used Latin terms in Pharmacy practice
2. Calculate the quantities of active ingredients and excipients required for compounding the required quantity of formulation (expansion and reduction of formula)
3. Compound, label and dispense extemporaneous formulations
4. Understand patient counseling and patient education methods

No.	Details
1	Solutions: 1. Potassium Permanganate Solution 2. Paediatric Ferrous Sulphate Oral Solution BP 1988
2	Suspensions: 1. Paediatric Chalk Mixture BP 1988 2. Kaolin Mixture BP 1988
3	Emulsions: 1. Arachis Oil Emulsion 2. Calciferol Emulsion 3. Medicated cream
4	Ointment/paste: 1. Zinc and Castor Oil Ointment BP 1988 / Calamine Ointment IP 2010/Compound Zinc Paste BP 1988
5	Jelly: 1. Lubricating jelly
6	Powders: 1. Bulk Powder: Compound Magnesium trisilicate Oral Powder BP 1988 /Zinc, Starch and Talc Dusting Powder BPC 1973 2. Divided Powder : HyoscineHydrobromide Powder

7	Granules: 1. Isapguhl Granules 2. Effervescent Granules
8	Capsules: 1. Chlordiazepoxide capsules BP
9	Suppositories: 1. Compound Bismuth Subgallate Suppositories BP 1980
10	Incompatibility: 1. Eutectic mixture
11	Community Pharmacy project1: Disease state education flip charts, Video library development, Patient Education
12	Community Pharmacy project2: Presentations on patient counseling with reference to indications, mechanism of action, contraindications and drug interactions of a particular drug.

Patient Education: Training for blood glucose meters • Inhaler and other device use (placebo inhaler cartridge) • Smoking cessation products • Have students offer BP readings to patients picking up anti-hypertensive medications • Have students offer blood glucose logs and a review of medications to patients picking up diabetes medications

Video library development: Have the student develop a video library from which patients could check out videos. The student could gather videos, organize them, and create marketing for the library to advertise it to patients.

Disease state education flip charts: Have the student develop a flip chart (that fits into a standard 3-ring binder) that can be used to educate a patient on a disease state. This standardizes the education that is given to each patient

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.
8. Parmar N.S. Health Education and Community Pharmacy, 18th ed. India: CBS Publishers & Distributors; 2008.
9. Merchant S.H. and Dr. J.S.Quadry. A textbook of hospital pharmacy, 4th ed. Ahmadabad: B.S. Shah Prakakshan; 2001
10. Parthasarathi G, Karin Nyfort-Hansen, Milap C Nahata. A textbook of Clinical Pharmacy Practice- essential concepts and skills, 1 st ed. Chennai: Orient Longman Private Limited; 2004

BPH_C_108_L - Anatomy, Physiology and Pathophysiology – Lab I (4 Hr/Wk)

Course Objectives

To familiarize the learner with the diagnostic methods for determination of the pathology of some disease states

Course Outcomes

The learner should be able to:

1. Perform RBC count, WBC count, Differential Leukocyte count, ESR, PCV, Bleeding time, clotting time and interpret the results and correlate with clinical conditions and record/measure blood pressure.
2. Identify and locate the bones in human skeleton.
3. Identify and describe the various body tissues and organs based on the structure and organisation of cells.
4. List the common diagnostic and biochemical tests performed in various clinical conditions and make use of it in diagnosis and prognosis of the diseases.

No.	Details
1.	HEMATOLOGY 1. Red Blood Cell (RBC) Count 2. Total Leukocyte Count 3. Differential Leukocyte (WBC) Count 4. Hemoglobin content of blood 5. Bleeding / Clotting Time 6. Blood groups 7. Erythrocyte Sedimentation Rate (ESR) / Hematocrit (Demonstration)

2.	Study of human skeleton
3.	Microscopic study of permanent slides Tissues : - Columnar, Cuboidal, Squamous, Ciliated Epithelium - Cardiac / Skeletal / Smooth muscle - Ovary, Testis, Liver, Pancreas, Thyroid, Tongue, Stomach, Intestine, Kidney, Lung, Spinal Cord, Cerebrum, Artery, Vein
4.	Measurement of blood pressure
5.	Tutorial / Discussion on some common investigational procedures used in diagnosis of diseases with the help of charts / slides Name and Importance of following tests : 1. Electroencephalogram (EEG) in diagnosis of Epilepsy 2. Use of Positron emission tomography (PET) Computed tomography scan (CT Scan), Single photon emission computed tomography (SPECT) in diagnosis. 3. Use of flow cytometry as a diagnostic tool. 4. Electrocardiogram (ECG) in diagnosis of cardiac arrhythmia 5. Liver Function Tests – - Serum Bilirubin, - serum glutamate oxaloacetate transaminase (SGOT) - serum glutamate pyruvate transaminase (SGPT) - Urine Bilirubin, - Urine Urobilinogen, 6. Kidney Function Tests - Serum Creatinine, - Serum Urea, Uric Acid - Blood Urea Nitrogen (BUN) 7. Blood Glucose 8. Serum Cholesterol / Triglycerides 9. Serum Alkaline phosphatase (ALT) 10. Serum Acid phosphatase (APT) 11. Serum Lipase 12. Serum Amylase 13. Serum Calcium 14. Serum lactate dehydrogenase (LDH) 15. Thyroid Function Tests – T ₃ , T ₄ 16. Prothrombin time (PT) 17. Partial thromboplastin time (PTT) 18. Activated partial thromboplastin time (APTT) 19. Diagnostic tests for infectious diseases like - Malaria - Tuberculosis - Dengue - H1N1 swine flu - Typhoid

Books:

1. McNaught & Callander, Illustrated Physiology by B. R. Mackenna & R. Callander, Published by by Churchill Livingstone
2. Kaplan, Jack, Opheim, Toivola, Lyon, Clinical Chemistry: Interpretation & Techniques, Published by Elseviers Publications
3. Praful B. Godkar, Textbook of Medical Laboratory Technology, Published by Bhalani Publishing House, Mumbai, India
4. C. L. Ghai, Text book of Practical Physiology, Published by Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi

SEMESTER-II

BPH_C_201_T - Anatomy, Physiology and Pathophysiology – II (4 Hr/Wk)

Course Objectives

To familiarize the learner with the anatomical organization and physiology of the different systems of the human body. To introduce the learner to cancer and the causes of cancer.

Course Outcomes

The learner should be able to:

1. Explain the types of and mechanisms of cellular injuries and cellular adaptation.
2. Compare and contrast between benign and malignant tumours, Classify malignant tumours and explain the etiology and pathogenesis of cancer.
3. Discuss the biological effects of radiations.
4. Explain the anatomy and physiology of the respiratory system, endocrine system, nervous system and the sensory organs.
5. Comprehend the aetiology, pathogenesis, signs, and symptoms of common diseases/disorders of respiratory system, endocrine system and nervous system.

No.	Details	Hours
1.	Principles of cell injury and adaptation • Causes of cell injury • Pathogenesis and morphology of cell injury. • Cellular adaptation • Cellular atrophy and hypertrophy.	4
2.	- Disturbances of growth of cells • Differences between benign and malignant tumor • Classification of malignant tumors • Etiology and pathogenesis of cancer- Invasion, metastasis and patterns of spread of cancer.	3
3.	Biological effects of radiation • Nuclear radiation • U.V. radiation. • X-ray and other radiations.	3
4.	Anatomy and Physiology of Respiratory System • Exchange of gases • External and internal respiration • Mechanism and regulation of respiration • Lung volumes and lung capacities	4
5.	Pathophysiology of following diseases • Asthma • Pneumonia • Bronchitis • Emphysema • Respiratory Acidosis and Alkalosis	4
6.	Endocrine System Anatomy and physiology of following endocrine glands : • Pituitary • Thyroid & Parathyroid • Adrenal • Pancreas	8
7.	Pathophysiology of hypo and hyper secretion of above endocrine glands and related diseases	4
8.	Nervous System Neurons, Neurotransmitter and neurotransmission Anatomy and physiology of : • Central Nervous System (CNS) - Autonomic Nervous System (ANS) - Cranial and spinal nerves	8

	- Sensory and Motor pathways	
9.	Pathophysiology of following diseases • Epilepsy • Parkinsonism • Alzheimer's Disease • Cerebral Hypoxia • Stroke (Cerebrovascular disease) • Anxiety & Depression • Mania and Schizophrenia	4
10.	Structure and Function of following sensory organs • Eye • Ear • Tongue • Nose • Skin	6
	TOTAL	48

Books:

Latest editions of the following books can 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 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

BPH_C_202_T – Biochemistry II (4 Hr/Wk)

Course Objectives

To teach the learner the different pathways of intermediary metabolism, their interplay, metabolism based disorders and drugs to treat the same.

Course Outcomes

The learner should be able to:

1. Discuss carbohydrate metabolism with respect to different pathways, structures of intermediates, enzymes and cofactors involved, energy requirements/yields, regulation and drugs affecting metabolism
2. Discuss lipid metabolism with respect to different pathways, structures of intermediates, enzymes and cofactors involved, energy requirements/yields, regulation and drugs affecting metabolism
3. Discuss nucleic metabolism with respect to different pathways, structures of intermediates, enzymes and cofactors involved, energy requirements/yields, regulation and drugs affecting metabolism

No.	Details	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.	20
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.	08
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	08
2	Lipid metabolism discussed with respect to the structures of intermediates, enzymes and cofactors involved, energy yield/requirements and regulation.	18

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	08
2.2	Acetate mevalonate pathway to cholesterol biosynthesis,	04
2.3	Biosynthesis of fatty acids, prostaglandins, leukotrienes and phospholipids.	04
2.4	Examples of drugs modulating lipid/cholesterol metabolism.	02
3	Nucleic Acid Metabolism discussed with respect to the structures of intermediates, enzymes and cofactors, energy yield/requirements and regulation	10
3.1	Discussion of biosynthesis of purines.	04
3.2	Discussion of biosynthesis of pyrimidines.	02
3.3	Salvage pathways for nucleic acid metabolism. Examples of drugs modulating purine/pyrimidine biosynthesis.	04
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.

BPH_C_203_T – Pharmacognosy I (4 Hr/Wk)

Course Objectives

This subject highlights the understanding of natural drugs, their cultivation and preparation, phytochemistry and their derivatives used in Allopathic and Complementary Systems of Medicine.

Course Outcomes

The learner should be able to:

1	Outline the Alternative and complementary systems of medicine, classify drugs of natural origin
2	Describe Primary and secondary plant metabolites their biosynthesis, evaluation and therapeutic application
3	Understand the morphological and Microscopic features of medicinal plants
4	Elaborate commercial production, collection, preparation, storage and factors affecting cultivation of medicinal plants
5	Describe chemistry, source, preparation, evaluation of carbohydrate containing crude drugs and their commercial utility as Pharmaceutical Aids and Medicines
6	Describe the source, composition, preparation and applications of fibers, minerals, important protein and enzymes of natural origin.

No.	Details	Hours
1.	Introduction, development, present status, significance and future scope of pharmacognosy. Alternative and Complementary systems of medicine Ayurveda, Unani, Siddha, Homeopathy, Chinese medicine and Aromatherapy. Self study: Examples of sources of DONO • Examples of drugs used in different traditional systems of medicine.	2 1
2	Classification of drugs: Alphabetical, morphological, taxonomical, pharmacological and chemical	1
3	Techniques in microscopy of powdered drugs covering use of mountants, clearing agents, chemomicroscopic reagents, micrometer, quantitative microscopy	2
4	Plant description, morphology, cell differentiation and ergastic cell contents: Study of plant parts, cell and tissue, underground or subterranean drugs, roots, rhizomes, corms, bulb, tubers, stolon, runners, and suckers; Leaves: Simple and compound, stomata, stomata number, stomatal index, palisade - ratio, hydathodes and water pores, epidermal trichomes, calcium oxalate crystals, vein-islet number, vein termination number; Inflorescence and flowers; Fruits; Seeds; Barks, and wood. Unorganised drugs: Dried latex, dried juices, dried extracts, gums and mucilages, resins.	7

5	Introduction, classification with examples and important biological activities of following groups of plant constituents: Carbohydrates; Alkaloids, Glycosides, saponins, steroids and triterpenoids Flavonoids, lignans, coumarins, tannins and polyphenolic compounds, Lipids and volatile oils; Gums, mucilages, resins and resin combinations with examples. Details of Phytochemical test for the evaluation of each class	12
6	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.	4
7	Study of plant, animal & mineral fibres with respect to their classification, sources, production, chemistry, commercial utility and significance in Pharmaceutical Industry for the following: Absorbent & nonabsorbent cotton, jute, flax, hemp, asbestos, glass wool, silk, wool, rayon, viscose	3
8	Systematic pharmacognostic study of following a) Carbohydrates and derived products: agar, guar gum acacia, Honey, Isabgol, pectin, Starch, sterculia chitin, xanthan gum, tamarind kernel powder (TKP) and Tragacanth. b) Lipids: Bees wax, Castor oil, Arachis oil, Cocoa butter, Shea butter, Cod~liver oil, Hydnocarpus oil, Kokum butter, Lard, Linseed oil, Rice Bran oil, Wheat germ oil, Shark liver oil and Wool fat	7
9	Proteins and Enzymes Study of Proteins and Enzymes with respect to sources, preparation and uses - protein hydrolysates, gelatin, casein, thyroid hormones, proteolytic enzymes (Papain, bromelain, serratiopeptidase, urokinase, streptokinase, pepsin). Study of plant lectins with respect to sources, composition and applications for Abrin, ricin. Self study: • Marketed formulations containing serratiopeptidase and their applications	4 1
10	Biological source, chemical constituents and uses of the following: Chirata, Shatavari, Kalmegh, Karela, Punarnava, Guggul, Tinospora. Self study: Brahmi, Neem, Tulsi, Amla,	2 1
11	Self study: Minerals: Kiselghur, Chalk, Talc, and Bentonite.	1
	TOTAL	48

Books

1. Trease D. & Evans W. C.: Text Book of Pharmacognosy: W. B. Saunders.
2. Tyler V.E., Brady L.R. & Robbers J. E.: Pharmacognosy; LeaFeibger, USA.
3. Wallis T. E.; Text Book of Pharmacognosy; CBS Publishers, Delhi.
4. Kokate C.K., Purohit A. P. & Gokhale S. B.: Pharmacognosy; Nirali Publications, Pune.
5. Harbone J. B.: Phytochemical Methods: A guide to modern techniques Analysis: Chapman & Hall, London.
6. Bruneton J.: Pharmacognosy, Phytochemistry, Medicinal Plants: Intercept Limited.
7. Vasudevan T.N. & Laddha K.S.: A Textbook of Pharmacognosy, Vrinda Publication House, Jalgaon.
8. The Indian Pharmacopeia: The Controller of Publication; Delhi.
9. Brain K.R. & Turner T. D.: The Practical Evaluation of Phytopharmaceuticals: Wright, Scientica, Bristol.

BPH_C_204_T – Hospital Pharmacy and Drug Store Management (4 Hr/Wk)

Course Objectives

To introduce the learner to the organization and functioning of a retail pharmacy and a hospital pharmacy.

Course Outcomes

The learner should be able to:

1. Appreciate the difference in the functions, layout, legal requirements, organization, drug procurement, storage and dispensing of medicines in a retail versus hospital pharmacy setting.
2. Appreciate the importance of documentation in the functioning of a pharmacy
3. Understand the importance of a hospital level formulation and compounding of parenterals.
4. Understand the importance and functioning of the hospital sterile supply services department
5. Appreciate the dangers/detection/reporting of fraudulent pharmacy practices
6. Appreciate the concept of Rational Drug Therapy

Unit No.	Sub-unit	TOPICS	DURATION (HOURS)
1	1.1	Hospitals: Definition, Organization Structure, Classification, Functions	2
	1.2	Hospital Pharmacy: Definition, Organization structure, Location, Layout and staff requirements and responsibilities and functions of hospital pharmacists.	2
	1.3	Budget of Hospital Pharmacy: Preparation and Implementation	2
2.	2.1	Drug Distribution Systems in Hospitals: Dispensing of drugs to inpatients, types of drug distribution systems, charging policy and labeling, Dispensing of drugs to ambulatory patients, and Dispensing of Controlled Substances including Hospital Control Procedures	4
3	3.1	Pharmacy and Therapeutics Committee (PTC): Objective, composition, Functions, Role of PTC in Drug Safety, Adverse Drug Reaction Monitoring and Emergency Drug Lists.	3
4	4.1	Hospital formulary: Definition, Advantages and Disadvantages, contents of hospital formulary, Differentiation of hospital formulary and Drug list, Preparation and revision, and addition and deletion of drug from hospital formulary.	3
	4.2	<i>Medication errors and ASHP Guidelines to prevent errors, Infection control in hospitals (Self Study)</i>	2
5	5.1	<i>Drug Utilization Review(Self Study)</i>	2
	5.2	<i>Safe Use of Medications in Hospitals(Self Study)</i>	2
	5.3	Handling of radiopharmaceuticals in hospitals	2
6	6.1	Central Sterile Supply Services Introduction to sterilization, basic techniques used for sterilization of hospital supplies	2
	6.2	Advantages, Plan, Location, Layout	4
	6.3	Sterilization of surgical dressings – methods of packing, loading and prevention of wetting of dressings. Sterilization of rubber gloves, syringes, needles, catheters, tubing, surgical instruments, mattresses, utensils and bedpans and other accessories	
	6.4	Manufacturing and Bulk compounding of large volume parenterals, Total Parenteral Nutrition and Intravenous additives.	2
7	7.1	Planning of retail pharmacy and entrepreneurship	2
	7.2	<i>(Self-study) Forms of Business Organization: Sole Proprietor, Partnership, Hindu Undivided Family, Joint Stock Company and Co-operative Society</i>	2
	7.3	<i>Channels of Distribution for Pharmaceuticals: Wholesaler, Retailer</i>	1
8	8.1	Setting Up and management of a Drug Store- Legal Aspects and Registrations	2
	8.2	Selection of site, Space layout, Location Analysis and Layout design and staff	2
	8.3	Materials- Coding, stocking, maintenance of various registers,	1
	8.4	Use of Computers: Business and health care soft wares	1
	8.5	Sales promotion and window display	2
9	9.1	Purchasing and Inventory control in drug store: Purchasing procedure in retail trade	1
	9.2	Definition of inventory control, various methods of Inventory Control (Want Book, Systematic Want Book, Open to Buy budgeting, ABC,VED, EOQ analysis),	1
10	10.1	Risk management, Insurance policies and Frauds in retail practice	1
TOTAL			48

Books:

1. Hospital Pharmacy, W. E. Hassan, Edition, Lea and Febiger, Philadelphia.
2. A text – book of Hospital Pharmacy, S.H. Merchant and Dr. J.S. Quadry, B.S. Shah Prakashan, Ahmedabad.
3. Hospital Pharmacy, Dr. H. P. Tipnis and Dr. Amrita Bajaj, Career Publication, Maharashtra.
4. Gennaro Alfonso R, Remington – The Science and Practice of Pharmacy”, Lippincott Williams and Wilkins.
5. Principles and methods of Pharmacy Management, Smith, Lea and Febiger, Philadelphia.
6. Drug store management, Nolen and Maynard. McGraw Hill.
7. Drug Store and Business Management, A. P. Battasse, Unique Publication.
8. Text book of Forensic Pharmacy, N. K. Jain, Vallabh Prakashan.

BPH_C_205_T - Environmental Science (3 Hr/Wk)

Course Objectives

1.	To study the importance of environmental science and environmental studies
2.	To know the importance of key to the future of mankind.
3.	To study continuing problems of pollution, loss of forest, solid waste disposal, degradation of environment, issues like economic productivity and national security
4.	Study of Global warming, the depletion of ozone layer and loss of biodiversity have made everyone aware of environmental issues.

Course Outcomes

The learner should be able to:

1. Describe the basics of Environmental sciences like need and purpose of study the subject, Ecology, food chain and ecological pyramids, sustainable development
 2. Outline, Environmental Legislation, role of different ministries and environment control boards
 3. Classify and compare different sources of energies
 4. Relate technology to control pollution and economic benefits thereof, infer, the concept of green building, carbon credit and disaster management
- Realize the environment related moral responsibilities and identify Legal (environmental) aspects for becoming entrepreneur in future

No.	Details	Hours
1.	Multidisciplinary Nature of Environmental Studies: • Scope and Importance • Need for Public Awareness • Depleting Nature of Environmental resources such as Soil, Water, Minerals, and Forests. • Global Environmental Crisis related to Population, Water, Sanitation and Land. • Ecosystem: Concept, Classification, Structure of Ecosystem, overview of Food chain, Food web and Ecological Pyramid	5
2.	Sustainable Development • Concept of sustainable development • Social, Economical and Environmental aspect of sustainable development. • Control Measures: 3R (Reuse, Recovery, Recycle), Appropriate Technology, Environmental education, Resource utilization as per the carrying capacity.	5
3.	Environmental Pollution: • Air Pollution: Sources, Effects of air pollution with respect to Global Warming, Ozone layer Depletion, Acid Rain, Photochemical smog, Two Control Measures, Bag house Filter, Venturi scrubber. Case Study: Bhopal Gas Tragedy • Water Pollution: Sources and Treatment, Concept of waste waters - Domestic & Industrial and treatment. Case Study: Minamata Disease. • Land Pollution: Solid waste, Solid waste Management by Land filling, Composting. • Noise Pollution; Sources and Effects • E-Pollution: Sources and Effects.	11
4.	Environmental Legislation: • Overview • Ministry of Environment and Forests (MoE&F). Organizational structure of MoE&F. • Functions and powers of Central Control Pollution Board. • Functions and powers of State Control Pollution Board. • Environmental Clearance, Consent and Authorization Mechanism. • Environmental Protection Act • Any two case studies pertaining to Environmental Legislation.	5
5.	Renewable sources of Energy: • Limitations of conventional sources of Energy.	5

	• Various renewable energy sources. • Solar Energy: Principle, Working of Flat plate collector & Photovoltaic cell. • Wind Energy: Principle, Wind Turbines. • Hydel Energy: Principle, Hydropower generation. • Geothermal Energy: Introduction, Steam Power Plant	
6.	Environment and Technology • Role of Technology in Environment and health • Concept of Green Buildings, Indoor air pollution • Carbon Credit: Introduction, General concept. • Disaster Management: Two Events: Tsunami, Earthquakes, Techniques of Disaster Management • Case Study: Earthquake in Japan	5
	TOTAL	36

Books:

1. Hazardous Waste Incineration, Brunner R.C., McGraw Hill Inc
2. Global Biodiversity Assessment, Heywood V.H and Waston R.T., Cambridge Univ. Press
3. Environmental Science systems & Solutions, Mckinney M.L. and School R.M., Web enhanced edition.
4. Fundamentals of Ecology, Odum E.P., W.B. Saunders Co. USA.
5. Textbook of Environmental studies by Erach Bharucha, University Press.
6. Environmental Studies by R. Rajagopalan, Oxford University Press.
7. Essentials of Environmental Studies by Kurian Joseph & Nagendran, Pearson Education
8. Renewable Energy by Godfrey Boyle, Oxford Publications.
9. Perspective Of Environmental Studies, by Kaushik and Kaushik, New Age International
10. Environmental Studies by. Anandita Basak, Pearson Education
11. Textbook of Environmental Studies by Dave and Katewa, Cengage Learning
12. Environmental Studies by Benny Joseph, Tata McGraw Hill

BPH_C_206_L – Pharmacognosy Lab I (4 Hr/Wk)

Course Objectives

This subject highlights the morphological, microscopic and phytochemical evaluation of natural drugs used in Allopathic as well as Complementary Systems of Medicine.

Course Outcomes

The learner should be able to:

1	Carry out quantitative microscopy for leaf constants
2	Determine different extractive and ash values as per pharmacopoeial requirements
3	Identify diagnostic features of plants such as calcium-oxalate, starch and trichomes
4	Differentiate between different plant parts based on morphological and microscopic evaluation
5	Identify fibers and carbohydrates based on chemical evaluation

No.	Experiments
1.	Quantitative microscopy (Estimation of Leaf constants i.e. Stomatal Index, Vein islet number and Vein termination number, Palisade ratio)
2	Determination of alcohol soluble and water soluble extractives, Total ash value and acid insoluble ash and water soluble ash value for any one crude drug as per IP.
3	Study of different types of starch grains, calcium oxalate crystals, Trichomes and stomata
4	Identification of Fibres based on chemical tests as covered in theory. Tests for detection of honey, starch, tragacanth, acacia, guar gum, agar
5	Microscopical Studies of basic tissues a) Stem: Ephedra b) Leaves: Vasaka, Senna c) Roots: Rauwolfia d) Bark: Cinchona e) Seed: Nux vomica, Linseed f) Fruits: Fennel

Books:

1. Trease D. & Evans W. C.: Textbook of Pharmacognosy: W. B. Saunders.

2. Tyler V.E., Brady L.R. & Robbers J. E.: Pharmacognosy; Lea Febiger, USA.
3. Wallis T. E.; Textbook of Pharmacognosy; CBS Publishers, Delhi.
4. Kokate C.K., Purohit A. P. & Gokhale S. B.: Pharmacognosy; Nirali Publications, Pune.
5. Harborne J. B.: Phytochemical Methods: A guide to modern techniques Analysis: Chapman & Hall, London.
6. Bruneton J.: Pharmacognosy, Phytochemistry, Medicinal Plants: Intercept Limited.
7. Vasudevan T.N. & Laddha K.S.: A Textbook of Pharmacognosy, Vrinda Publication House, Jalgaon.
8. The Indian Pharmacopoeia: The Controller of Publication; Delhi.
9. Brain K.R. & Turner T. D.: The Practical Evaluation of Phytopharmaceuticals: Wright, Scientica, Bristol.

BPH_C_207_L - Biochemistry Lab (4 Hr/Wk)

Course Objectives

To teach the learner the methods for the detection and estimation of different biomolecules

Course Outcomes

The learners should be able to understand the principles and methods for the estimation of:

1. Carbohydrates
2. Amino acids and proteins
3. Fats and Lipids
4. Nucleic acids
5. Enzyme kinetic parameters
6. Enzyme activity as diagnostic markers

EXPERIMENTS

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 Biochemistry, Jayaraman J, Wiley Easter, N Delhi. India

BPH_C_208_L - Computer Lab (4 Hr/Wk)

Course Objectives

To Introduce the learner to the importance of computers – hardware and software – and their potential applications to the pharmacy profession

Course Outcomes

The learner should be able to:

1. Describe the components of a PC
2. Compare the different operating systems
3. Record simple programs using BASIC and C programming languages
4. Apply knowledge gained for use of computers in pharmacy

No.	Details	Hours
1.	Introduction to Computers.	2
2.	History of Computer development and respective generation: Abacus, Napier's Bones, Slide rule, Pascal's Calculator. General use of computers in everyday life.	5

	Computer Classification: Mainframe, Mini and Micro Computers, comparison of Analog & Digital Computers, Hardware and Software. Calculator and Computer	
3.1	Operating Systems: Introduction to types of operating systems, UNIX, MS-DOS, etc. RAM, ROM, Virtual Memory etc	4
3.2	Students should learn on Windows and Linux OS based systems use of basic Windows and Linux commands	4
4.1	Type of Languages: Conventional languages; their advantages, limitations; C, Pascal, FORTRAN, Programming of these languages	4
4.2	Students should be taught some programming in BASIC and C	4
5.1	Introduction to Computer Networks: Architecture of seven layers of communications	4
5.2	Students should be taken to a computer lab with has a network and shown the basic connections and operation of different types of networks.	3
6.1	Introduction to Data Structure: Like Queues, list, trees, Binary trees algorithms, Flow chart, Structured Systems, Analysis and development, Ingress-SQL, Gateways etc. Statistics, methodologies. Basic Language: Constants and Variables: Character set, constants, variables, Naming the variables getting data into memory, LET, INPUT, READ. DATA, Print Statement Expressions: Arithmetic expression, Hierarchy of operations, Rules of Arithmetic, Evaluation of expressions, Relational expressions, Logical operations, Library functions Printer Control: Comma and semicolon control, the TAB function, PRINT, LPRINT Functions and Subroutines: User defined functions, subroutines, subscripted variables The above concepts should be introduced practically to students with examples, while working on a computer system.	8
6.2		
7.	Computer Graphics:	5
8.	Computer applications in pharmaceutical area and in clinical studies	5

Books:

1. Basic Electronics and Computer Applications, Rajiv Khanna, New Age International Publishers
2. Fundamentals of Computers, V. Rajaraman, Prentice Hall of India Pvt. Ltd.
3. Schaums Outline Series, Theory and Problems of Introduction to Computer Science, Francis Scheid, McGraw Hill Book Co.

SYLLABUS FOR S. Y. B. Pharm.

SEMESTER-III

BPH_C_301_T – Organic Chemistry I – (4 Hr/Wk)

Course Objectives

1. To introduce the system of naming organic compounds generally encountered in Pharmacy profession
2. To introduce the learner to the structural features of organic compounds with respect to 2D and 3D features, resonance forms, tautomerism, conjugation, and aromaticity.
3. To introduce the learner to the properties of compounds as dictated by their structures especially the functional groups.
4. To introduce the learner to concepts of reaction kinetics, first/second/zero order rates and equilibrium phenomenon.

Course Outcomes

The learner should be able to:

1. Assign IUPAC and stereochemical nomenclature of compounds containing multiple functional groups
2. Predict aromatic character, resonance and tautomerism of compounds
3. Explain the reactivity of compounds based on physicochemical properties
4. Understand the factors affecting equilibria, rates and reaction mechanisms
5. Explain the influence of structure on physicochemical properties and its application to various aspects of pharmaceuticals

No.	Details	Hours
1	Structure	
1.1	Nomenclature of mono/polyfunctional compounds (trivial and IUPAC) (Heterocycles to be excluded).	4
1.2	Hybridization states of C, O and N.	1
1.3	Atomic orbitals, Molecular orbitals of sp^3 (ethane), sp^2 (ethene), and sp (acetylene) and C attached to heteroatoms with lone pairs. HOMO and LUMO of ethene and the C=O group.	2
1.4	Basic concepts of electronegativity, hydrogen bonding, inductive effect, dipole moment, log P with examples of monofunctional compounds.	2
1.5	Concept of aromaticity: Huckel's rule, identification of aromatic, non-aromatic and anti-aromatic systems based on planarity, conjugation and Huckel's rule.	2
1.6	Resonance in aliphatic and aromatic systems: Rules of resonance and stability of the resonance structures. Tautomerism of keto-enol and imine-enamine systems. Hyperconjugation.	2
1.7	Stereochemistry: Concept of configuration and chirality, axes of symmetry, plane of symmetry, center of symmetry. Representation of molecules using projection formulae - Fischer, Wedge, Sawhorse and Newmann. Geometric Isomerism: Methods of determination of configuration of geometric isomers. Optical isomerism: Enantiomers and diastereomers. Nomenclature of stereoisomers including E and Z, D and L and R and S designations. Conformations of ethane, butane, cyclohexane with their energy profile diagrams. Conformational analysis of mono- and di-substituted cyclohexanes. Types of strains: Angle strain (Baeyer Strain), transannular strain (Prelog Strain), torsional strain (Pitzer strain).	6
2	Ionization, acidity, basicity and pK_a (excluding heterocyclic compounds).	6
3	Geometry, stability and properties of the following reactive intermediates: carbocations, carbanions, carbenes and carbon radicals. Electrophiles and nucleophiles (including charged and neutral species). Concept of leaving groups, alkyl shifts and migratory aptitude.	6
4	Equilibria, rates and mechanisms.	7
5	Mechanism of SN^1 , SN^2 , E1 and E2 reactions. Factors affecting substitution and elimination reactions. Comparison of substitution and elimination reactions.	4
6	Reactivity of the following functional groups: Alkenes, alkynes, alcohols, phenols, alkyl halides, ethers, aldehydes, ketones, carboxylic	4

	acid and derivatives, amines. (Molecular orbital diagrams for nucleophilic addition to carbonyl group and electrophilic addition to alkene).	
7	Influence of the physicochemical properties of the above mentioned functional groups on the following aspects: receptor binding, formulation and degradation.	2
	TOTAL	48

Books:

1. Organic Chemistry, Jonathan Clayden, Nick Greeves, and Stuart Warren, Oxford University Press.
2. Organic Chemistry, Stanley H. Pine, James B. Hendrickson, Donald J. Cram, and George S. Hammond, McGraw-Hill Book Co.
3. Organic Chemistry, John E McMurry, Brooks/Cole Cengage Learning.
4. Textbook of Organic Chemistry, P. S. Kalsi, MacMillan India Limited.

BPH_C_302_T – Physical Pharmacy I – (4 Hr/Wk)

Course Objectives

The objective of the course is to train the learner for understanding the basic physical principles underlying pre-formulation testing, formulation development and finished product testing of drug delivery systems.

Course Outcomes

The learner should be able to:

1. Understand the various physical phenomena involved in designing of various formulations.
2. Determine various physical parameters of drugs and formulations
3. Predict and anticipate in-process problems based on raw materials and manufacturing methods.
4. Apply the knowledge of physical phenomena in selecting raw materials, including drug, inactive ingredients of appropriate quality leading to stable formulations.

No.	Details	Hours
1.	States of matter	11
1.1	Binding Forces between molecules	1
1.2	Gaseous state: Ideal and Real gases, ideal gas equation and van der waal's equation (No derivation), Critical Phenomena	2
1.3	Liquid state: Liquefaction of gases, aerosols, vapor pressure, latent heat, boiling point	2
1.4	Solid state: Amorphous solids, crystalline solids: crystal lattice and unit cell, crystal defects, polymorphism, melting point, pharmaceutical significance of polymorphs and amorphous solids	4
1.5	Liquid crystalline state and supercritical fluid state: Properties and pharmaceutical significance	2
2	Physical properties of Drug Molecules	7
2.1	Additive, constitutive and colligative properties with examples; Concept of tonicity in pharmacy, methods to adjust isotonicity;	3
2.2	Dipole moment, Dielectric constant and significance to pharmacy	1
2.3	Refractive index and molar refraction, Principle and working of Abbe's refractometer and Application of molar refraction to determine structures	1
2.4	Optical rotation, Specific rotation, measurement of optical rotation and its applications	2
3	Solubility and distribution phenomena	9
3.1	Solvent – solute interactions, Ideal and real solutions, Raoult's law, deviation from Raoult's law, Azeotropic mixtures.	2
3.2	Phase equilibria and Phase rule (one, two and three component systems)	1
3.3	Solubility of gases in liquids, Henry's law and applications	1
3.4	Solubility of liquids in liquids, miscible and partially miscible liquids, critical solution temperature and applications.	2
3.5	Solubility of solids in liquids, solubility parameters	2
3.6	Distribution law, its limitations, modification for weak electrolytes (No derivation) and applications	1
4	Ionic equilibria and buffers	6

4.1	Strong electrolytes and weak electrolytes, dissociation of weak electrolytes, dissociation constant pH, Sorensen's pH scale, pH determination (glass electrode) Applications of buffers, buffer equation (Henderson- Hasselbalch equation), buffer capacity, buffers in pharmaceutical and biological systems	2
4.2		1
4.3		3
5	Interfacial phenomena	9
5.1	Surface tension, Interfacial tension, Surface free energy	1
5.2	Measurement of surface and interfacial tension-capillary rise method, drop number method, Drop weight method, Du Nuoy tensiometer method	1
5.3	Spreading of liquids, Spreading coefficient, Surface active agents, Hydrophilic-Lipophilic balance, soluble monolayers	3
5.4	Adsorption at solid interfaces, Adsorption isotherms, Freundlich adsorption isotherm, Langmuir adsorption isotherm	3
5.5	Wetting, wetting agents and contact angle	1
6	Rheology	6
6.1	Definition: Rheology, viscosity, Newton's law of flow, viscosity coefficients for Newtonian fluids	1
6.2	Non- newtonian systems: Plastic, pseudoplastic and dilatant, thixotropy and its significance	2
6.3	Measurement of flow for newtonian and non-newtonian systems	2
6.4	Deformation of solids: Introduction to Elastic, plastic, viscoelastic and fragmentation	1
TOTAL		48

Books:

Refer to latest editions

1. P. J. Sinko, 'Martin's Physical Pharmacy and Pharmaceutical Sciences' Fifth edition, Lippincott Williams and Wilkins, Indian Edition distributed by B.I. Publications Pvt. Ltd, 2006.
2. Pharmaceutical Dosage Forms And Drug Delivery Systems, Howard C. Ansel, Nicholas G. Popovich, Loyd V.
3. Pharmaceutics: The Science Of Dosage Form Design, Michael E. Aulton
4. Bahl and Tuli, 'Essentials of Physical Chemistry' S. Chand and Company Ltd. Ramnagar, New Delhi-110055.
5. Essentials of Physical Pharmacy, C.V.S Subrahmanyum, Vallabh Prakashan
6. Textbook of Physical Pharmaceutics, C.V.S Subrahmanyum, Vallabh Prakashan

BPH_C_303_T – Anatomy Physiology and Pathophysiology III – (4 Hr/Wk)

Course Objectives

1. To teach about anatomy and physiology of reproductive, cardiovascular, urinary and gastrointestinal system.
2. To teach pathophysiology of common diseases associated with reproductive, cardiovascular, urinary and gastrointestinal system.

Course Outcomes

The learner should be able to:

TOPIC	COURSE OUTCOMES	BLOOM'S LEVEL
T1,T3, T5,T8	Explain the anatomy, and physiology of the reproductive system, cardiovascular system, urinary system and digestive system and know the concept, significance and application of ECG	2
T2,T4, T7, T9	Comprehend the etiology, pathogenesis, signs and symptoms of common diseases of the reproductive system, cardiovascular system, urinary system and digestive system	2
T5, T6	State the relevance of various body fluid compartments, electrolyte distribution and acid-base balance.	1

No.	Details	Hours
1	Reproductive system - Anatomical and Physiological considerations of male and female reproductive system	6

	- Reproductive and endocrine functions of testes and ovaries - Menstrual cycle	
2	Pathophysiology of following diseases - Infertility - Sexually transmitted diseases (STD) - Dysmenorrhea	3
3	Cardiovascular System - 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 centre - Humoral and neuronal control of blood pressure and circulation	9
4	Pathophysiology of following diseases - Hypertension - Congestive Cardiac Failure - Cardiac Arrhythmia - Angina Pectoris - Ischemic Heart Disease - Arteriosclerosis/Atherosclerosis	5
5	Urinary system - Anatomy and Physiology of Urinary System - Formation of urine - water balance, electrolyte balance & acid – base balance	6
6	Formation of body fluids and fluid compartments.	4
7	Pathophysiology of following diseases - Renal failure - Glomerulonephritis - Renal calculi / kidney stones - Urinary Tract Infections (UTI)	4
8	Digestive System - Anatomy and physiology of digestive system - Digestion and absorption of carbohydrates, proteins and fats	7
9	Pathophysiology of following diseases - Peptic ulceration - Zollinger – Ellison’s Syndrome - Inflammatory Bowel Disease (Ulcerative colitis, Crohn’s disease) - Cholecystitis & Cholelithiasis - Jaundice - Hepatitis - Pancreatitis - Achalasia - Reflux esophagitis	4
	Total	48

Books:

1. Ross & Wilson, Anatomy & Physiology in Health & Illness by Anne Waugh and Allison Grant, Published by Churchill Livingstone
2. Gerard J. Tortora & Bryan Derrickson, Principles of Anatomy & Physiology, Published by John Wiley and Sons, Inc.
3. 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 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
7. Harsh Mohan, Textbook of Pathology, Published by Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.

Course Objectives

1. To introduce the learner to the scope and importance of sample preparation and analytical procedures, pharmacopoeial methods of analysis, and errors associated with analytical procedures.
2. To introduce the learner to the different titrimetric analytic methods like acid-base titrations, complexometric titrations, etc.
3. To introduce the learner to gravimetric and electro-analytical methods of analysis.

Course Outcomes

The learner should be able to:

1. Explain the role of pharmaceutical analysis in the field of pharmacy and industry and delineate between qualitative- quantitative, manual, automatic and electrochemical methods of analysis.
2. Describe volumetric, gravimetric, electrochemical and solvent extraction methods of analysis.
3. Solve numerical problems related to volumetric, gravimetric and solvent extraction methods of analysis and apply simple statistics to numerical data.

No.	Details	Hours
1	Introduction to Pharmaceutical Analysis	4
1.1	• Scope of Pharmaceutical Analysis, Classification of Quantitative Analytical techniques (Instrumental and Non-Instrumental). • Introduction to pharmacopoeial monograph –Significance of a pharmacopoeial monograph. (Only relevance of all the tests and principle of the assay procedures in the monographs mentioned below to be discussed). Active Pharmaceutical Ingredient (API): Aspirin, Calcium gluconate and Dried aluminium hydroxide gel. Formulations: Soluble Aspirin tablets.	2
1.2	• Types of Errors: Determinate and Indeterminate, Causes of errors and ways to minimize them. • Concept and numericals of: Mean, Median, Standard deviation, relative standard deviation, Absolute and relative errors, precision, accuracy, significant figures.	2
2	Aqueous acid-base titrations.	6
2.1	• 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, Expression of concentration of Standard solutions-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	• Neutralization curves-(strong acid versus strong base, weak acid versus strong base, weak base versus strong acid and weak acid versus weak base). • Neutralization indicators-different theories (Ostwald's theory, Resonance theory), Mixed indicators, concept of range of indicators, Choice of indicators.	2
2.3	• 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 neutralization curve, Strength of Electrolytes (molarity, normality, and milliequivalence), and assay. • Applications: Assay of benzoic acid, aspirin, sodium hydroxide.	2
3	Non-aqueous titrations	2
3.0	• 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: Assay of Sodium benzoate and Acetazolamide.	2

4	Complexometric titrations	3
	• Terms-Complex, complexing agents (Complexones), chelate, ligand, 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 with respect to 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.	
5	Oxidation – Reduction Titrations	6
5.1	• Terms: Oxidation, Reduction, oxidising and reducing agents, standard reduction potential, Nernst equation, redox titration curve and equivalence point.	1
5.2	• Theory, indicators, and titrants for : Permanganometry and Cerimetry, • Applications- Assay of hydrogen peroxide solution (Permanganometry), Assay of Ascorbic acid tablets, Dried Ferrous sulphate, Paracetamol (Cerimetry).	2
5.3	• Theory, indicators, and titrants for : Iodometry, iodimetry, potassium dichromate, potassium iodate and potassium bromate titrations. • Applications- Assay of Ascorbic acid API (Iodimetry), Assay of potassium permanganate (Iodometry), Assay of Potassium iodide (Iodate titration)	2
5.4	• Balancing of redox equation-half cell reaction and net reaction.	1
6	Precipitation Titration	3
6.1	• Theoretical considerations-Common Ion Effect, Solubility Product, Factors affecting solubility of precipitates, Fractional precipitation.	1
6.2	• Types of Precipitation Titration: Argentometric Titration methods -Mohr's method, Volhard's Method and Adsorption Indicator Method. • Applications: Standardization of silver nitrate, Assay of sodium chloride and potassium chloride.	2
7	Gravimetry	3
7.1	• 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	• Applications-Assay of Nickel by dimethylglyoxime, Assay of aluminium by oxine reagent, Assay of Ba⁺² as Barium sulphate. • Numericals related to gravimetric factor	1
8	Miscellaneous methods	2

8.1	• 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:	5
9.1	Polarography- • 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, Differential pulse polarography and square wave polarography).	2
9.2	• 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. Amoxycillin trihydrate.	1
9.3	• 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	• 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
10.1	• Terms: Nernst Distribution law and partition coefficient, Distribution coefficient, Distribution Ratio, Percent extraction or extraction efficiency, Separability factor. • Types-Single extraction (Batch), multiple extraction, Countercurrent Distribution and Continuous extraction. • Factors influencing solvent extraction, Emulsion formation problem in extraction and ways to minimize. • Examples –Assay of soluble Aspirin tablets.	2
10.2	• Problems based on distribution coefficient.	
	Total	36

Books:

1. Practical Pharmaceutical Chemistry by Beckett, A H & Stenlake, J B, 2005, 4th edition, Part I and II, CBS Publishers and Distributors, India.
2. A Textbook of Pharmaceutical Analysis by Kenneth A Connors, 2002, 3rd edition, John Wiley and Sons, Canada.
3. Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, 1992, 5th edition, Saunders College Publishing, USA.
4. Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West, F. James Holler, 1991, 7th edition, Saunders College Publishing, USA.
5. Analytical Chemistry by Gary D. Christian, 6th 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, 6th edition, Pearson Education Ltd.
7. Pharmaceutical Drug Analysis by Ashutosh Kar, 2005, 2nd edition, New Age International (P) Ltd Publishers, India.
8. Instrumental Methods of Analysis by S. S. Mahajan, 2010, 1st edition, Popular Prakashan Pvt Ltd, India.
9. Instrumental Methods of Chemical Analysis (Analytical Chemistry) by Gurudeep R. Chatwal and Sham. K. Anand, 2008, 5th revised and enlarged edition, Himalaya Publishing House Pvt Ltd.
10. Indian Pharmacopoeia, 2014 or latest edition.
11. Instrumental Method of Analysis by Willard H.H., L. L. Merritt & John A. Dean, 1986, 6th edition, CBS Publishers & Distributors, New Delhi.
12. Instrumental Method of Chemical Analysis by Ewing Galen W, 1969, 3rd edition, McGraw Hill Book Company, New York.
13. Undergraduate Instrumental Analysis by J.W. Robinson, E.M. Skelly Frame and G.M. Frame II, Pub. Marcel Dekker, 2009
14. Analytical Chemistry, 2nd edition, R. Kellnar, M. Mermet, M. Otto, M. Valcarcel, H. M. Widner.

BPH_C_305_T – Pharmaceutical Engineering – (3 Hr/Wk)

Course Objectives

To provide learner with basic understanding of unit operations and related aspects involved in pharmaceutical industry.

Course Outcomes

The learner should be able to:

1. Understand mechanics of fluid, fluid flow, and its measurements
2. Classify and describe pumps, heat measuring devices and conveyors
3. Understand basic principles involved in unit operations such as crystallization, evaporation, distillation and refrigeration and will be able to describe the equipment and accessories involved therein.
4. Summarize construction material, discuss corrosion of equipment from pharmaceutical industry point.
5. Define and categorize the different industrial hazards.

Note: Under all topics no detailed derivations are to be considered.

No.	Details	Hours
1	Fluid flow Mention of 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.	3
2	Fluid and pressure measurements Measurement of flow- Classification of flow meters, venturi meter, Orifice meter, pitot tube, rotameter and current flow meters. Pressure measurement - Classification of manometers, simple manometer, U tube manometer and modifications, Bourdon gauge.	3
3	Pumps: Positive displacement pumps-reciprocating pumps, rotary pumps. Centrifugal pumps	2
4	Heat and Mass transfer 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. Concept of interfacial mass transfer	3
5	Conveying of solids Belt conveyor, Bucket conveyor, Screw conveyor and Pneumatic conveyor.	1
6	Crystallization	4

	Crystal forms and crystal habits, Mier's theory of supersaturation, Nucleation, Crystal growth. Crystallizers- Classification, Tank crystallizers, Agitated tank crystallizers, Swenson Walker crystallizer, Vacuum crystallizer and its modifications, Krystal or Oslo crystallizer. Factors affecting crystallization and Caking of crystals	
7	Evaporation: Introduction, concept of heat transfer across the wall of evaporator, factors influencing rate of evaporation, including scale formation Evaporators classification - Pan evaporators, Tubular evaporators -Horizontal tube evaporator, Vertical tube evaporators- short tube vertical evaporator, Long tube evaporators -Climbing film evaporator, Falling film evaporator, Forced circulation evaporator, Wiped film evaporator , and Centrifugal rotary evaporator. Multiple effect evaporator-principle, operation, economy, capacity efficiency and feeding methods of evaporation. Vapor recompression- mechanical and thermal compression principle Evaporator accessories- condensers, vacuum pumps, expansion and bucket traps, entrainment separators	6
8	Distillation: Revision of Vapour-liquid equilibrium. Distillation methods- Equilibrium distillation, Simple distillation Fractional distillation- Theory of batch fractionation, Columns (only construction and working) Bubble cap, sieve plate columns, valve plate column, packed columns. Concept of plate efficiency with respect to vapor equilibrium diagram and HETP (no detailed theories and derivations). Distillation under reduced pressure- Theory and applications of molecular distillation and equipment including falling film and centrifugal molecular distillation still. Azeotropic and Extractive distillation, Steam distillation- Theory and applications.	5
9	Refrigeration: Refrigeration – equipment and concept of refrigeration load, concepts of brine systems and absorption systems.	2
10	Materials of construction and Corrosion: 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. Corrosion: Mechanism and types of corrosion. Factors influencing rate of corrosion. Methods of combating corrosion.	4
11	Industrial Hazards and safety regulations: Mechanical hazards and prevention. Electrical hazards and prevention Chemical hazards and prevention Fire hazards and extinguishers	3
	TOTAL	36

Books:

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, Pharmaceuticals-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.

BPH_C_306_L – Organic Chemistry Lab I – (4 Hr/Wk)

Course Objectives

1. To discuss the aspects of occupational safety and hazards of working in a chemistry laboratory.
2. To teach the learner the method for determination of some common and useful physical properties of organic compounds.
3. To teach the learner the method for determination of some common functional groups present in organic compounds.

Course Outcomes

The learner will be able to:

1. Practice and follow safety rules and precautionary measures in laboratory.
2. Explain theoretical aspects of physical constant determination, detection of functional groups and Log P
3. Characterize/ Identify/Spot monofunctional or bifunctional organic compounds by physical constant, elemental analysis and functional group analysis

DETAILS

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. Discussion about theoretical aspects of physical constant determination, and detection of functional groups.
3. Organic spotting: Minimum eight samples of mono-functional groups, and two samples of bi-functional groups to be taken. Elemental analysis using environmentally friendly reagents should be done for at least two of the above samples of mono-functional groups.
4. Demonstration: Determination of Log P of benzoic acid and substituted benzoic acids.

Books:

1. A Laboratory Hand Book of Organic Qualitative Analysis and Separations, V. S. Kulkarni, S. P. Pathak, D. Ramchandra & Co., Pune
2. Textbook of Organic Practical Chemistry, V.S. Kulkarni, S. P. Pathak, D. Ramchandra & Co., Pune
3. The Systematic Identification of Organic compounds, R. L. Shriner, R. C. Fuson and D. Y. Curtin, 6th Ed., Wiley, New York, 1980
4. A Textbook of Practical Organic Chemistry, A. I. Vogel, 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, Universities Press (India) Limited, 2000
7. DST Monographs

BPH_C_307_L – Physical Pharmacy Lab I – (4 Hr/Wk)

Course Objectives

The objective of the course is to teach the learner the methods for the determination of different physical parameters underlying pre-formulation testing, formulation development and finished product testing of drug delivery systems.

Course Outcomes

The learner should be able to:

1. To understand the principles and methods for the determination of various physical parameters of drugs and formulations.
2. To carry out various physical tests involved in characterization of drugs.
3. To demonstrate testing of various physical parameters involved in pre-formulation and formulation evaluation.

Experiments

1. Determination of refractive index of solid.
2. Polarimetry: Different concentrations of sugar, determination of unknown concentration and specific rotation.
3. Determination of solubility of a drug at room temperature
4. Viscosity determination of Newtonian liquids using Ostwald's viscometer and to determine the composition of an unknown binary mixture.
5. Phenol water system – Critical solution temperature and composition
6. Determination of surface tension of given liquids by drop count/ OR drop weight method and study the effect of surfactants in reducing surface tension/enhance wetting properties.
7. To determine buffer capacity at various stages of titrations of a weak acid against a strong base and hence to determine pKa of the acid.
8. Determination of partition coefficient of Iodine in CCl₄ and water/ OR benzoic acid in benzene and water
9. Adsorption of acetic acid on activated charcoal and determination of specific surface area of charcoal.

Demonstration:

10. Determination of HLB number of a surfactant by saponification method

Books:

1. Laboratory Manual of Physical Pharmaceutics, C.V.S. Subramanyam, J. Thimma settee.
2. Practical Physical Pharmacy, U. B. Hadkar, T.N. Vasudevan and K.S. Laddha,

BPH_C_308_L – Pharmaceutical Analysis Lab I– (4 Hr/Wk)

Course Objectives

1. To introduce the learner to pharmacopoeial methods of analysis.
2. To teach the learner the procedures for conducting different titrimetric analysis like acid-base titrations, complexometric titrations, etc.
3. To teach the learner gravimetric methods of analysis.

Course Outcomes

The learner should be able to:

1. Employ practice of calibration and proper handling of volumetric apparatus, electronic analytical balance and safety measures in the laboratory.
2. Demonstrate eye- hand co-ordination required for titrimetric analysis.
3. Perform and record, calculate and interpret data obtained for experiments related to volumetric, gravimetric and solvent extraction methods of analysis.
4. Conduct and evaluate various tests mentioned in a pharmacopoeial monograph

NOTE: For all the experiments, Indian Pharmacopoeia 2014/ latest edition has to be referred.

No.	Details
	Acid-Base titrations:
1.	Assay of Aspirin (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 tablets (Iodimetry).
7.	Assay of Sodium metabisulphite (Iodometry)
8.	Assay of potassium permanganate (Iodometry)
9.	Assay of Dried Ferrous sulphate/ Ferrous fumarate/ Paracetamol (Cerimetry).
10.	Assay of Potassium iodide (Iodate titration)
	Complexometric titrations:
11.	Assay of Calcium gluconate.
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:
16.	Ni ²⁺ using Dimethyl glyoxime/ Al ³⁺ as Aluminium oxinate.
17.	Ba ²⁺ as barium sulphate
	Introduction to the study of monograph:
18.	Monograph of ascorbic acid tablets/ Calcium gluconate
	Demonstration titrations:
19.	Assay of Pyridoxine hydrochloride/ Sodium benzoate using non-aqueous titration method
20.	Assay of Sodium chloride
21.	Assay of Potassium chloride

Books:

1. Indian Pharmacopoeia, 2014 or latest edition.
2. Practical Pharmaceutical Chemistry by Beckett, A H & Stenlake, J B, 2005, 4th edition, Part I and II, CBS Publishers and Distributors, India.
3. Analytical Chemistry by Gary D. Christian, 6th edition, John Wiley & Sons, Singapore.
4. Vogel's Textbook of Quantitative Chemical Analysis by Mendham J, R.C. Denney, J.D. Barnes, M. Thomas, 2002, 6th edition, Pearson Education Ltd.
5. Pharmaceutical Analysis –A Textbook for Pharmacy Students and Pharmaceutical Chemists by David G Watson.

SEMESTER-IV

BPH_C_401_T – Organic Chemistry – (4 Hr/Wk)

Course Objectives

1. To introduce the learner to the synthetic methods for the introduction of different functional groups in a molecule and different methods for interconversion of some functional groups using synthetic methods.
2. To introduce the learner to the different nucleophilic reactions of carbonyl compounds and different electrophilic reactions of alkenes.
3. To introduce the learner to nucleophilic and electrophilic reactions of aromatic compounds.

Course Outcomes

The learner should be able to:

1. Outline few methods of preparation for various functional groups
2. Understand how and why the C=O group reacts with nucleophiles (using molecular orbitals and curly arrows) to give varied products
3. Predict the molecules that can be synthesized by reaction of C=C groups with electrophiles
4. Understand reactivity of aromatic systems towards electrophiles and nucleophiles

Emphasis to be placed on reaction mechanisms of the reactions from Unit 2 onwards

No.	Details	Hours	References
1.0	Preparation of following functional groups: (Only reactions to be discussed without mechanisms)	6	Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Pearson Education, 7 th Ed.
1.1	Alcohols by Grignards reagent, phenols by hydrolysis of diazonium salts		
1.2	Aldehydes & ketones by oxidation of primary & secondary alcohols, Oxidation of methyl benzenes		
1.3	Amines by reduction of nitro compounds		
1.4	Carboxylic acids by oxidation of alcohols and hydrolysis of nitriles		
2.0	Nucleophilic addition to C=O group	6	1. Organic Chemistry, Jonathan Clayden, Nick Greeves, and Stuart Warren, Oxford University Press, 2 nd Ed., Chapter 6. 2. Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Pearson Education, 7 th Ed., Chapter 12.
2.1	Nucleophilic addition to aldehydes, ketones (e.g. attack of cyanide, hydride, organolithium, Grignard reagents, water and alcohols to form hemiacetals in acidic/basic conditions)		
2.2	Cannizzaro and crossed - Cannizzaro reaction		
3.0	Nucleophilic substitution to C=O group	10	1. Organic Chemistry, Jonathan Clayden, Nick Greeves, and Stuart Warren, Oxford University Press, 2 nd Ed., Chapter 10. 2. Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Pearson Education, 7 th Ed., Chapter 14
3.1	Concept of leaving group based on stability and pK _a with reference to carboxylic acid derivatives		
3.2	Discussion of tetrahedral intermediate		
3.3	Examples to be discussed: Conversion of acid chloride to esters and amides, transesterification reaction.		
3.4	Comparison of reactivity of various carboxylic acid derivatives, Interconversion of carboxylic acid derivatives		
3.5	Acid and base catalyzed hydrolysis of esters, amides.		
3.6	Strategies of converting ketones to esters		
3.7	Nucleophilic substitution at C=O with loss of carbonyl oxygen. (Examples to be discussed: Conversion of aldehydes and ketones to imine, oxime, hydrazine, semihydrazone and semi carbazide.)		1. Organic Chemistry, Jonathan Clayden, Nick Greeves, and Stuart Warren, Oxford University Press, 2 nd Ed., Chapter 11. 2. Organic Chemistry, R. T.

			Morrison, R. N. Boyd, S. K. Bhattacharjee, Pearson Education, 7 th Ed., Chapter 12
3.8	Wittig reaction		
4.0	Electrophilic addition to alkene	8	1. Organic Chemistry, Jonathan Clayden, Nick Greeves, and Stuart Warren, Oxford University Press, 2 nd Ed., Chapter 19. 2. Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Pearson Education, 7 th Ed., Chapter 6.
4.1	Addition of bromine*, water, HBr (in presence and absence of peroxide) to alkenes, dimerization, oxymercuration-demercuration*, hydroboration-oxidation*, oxidation of alkenes to epoxide*, periodate cleavage and ozonolysis*, reaction with N-bromo succinimide. (*Stereochemical aspects to be covered)		
5.0	Enols and Enolates	6	1. Organic Chemistry, Jonathan Clayden, Nick Greeves, and Stuart Warren, Oxford University Press, 2 nd Ed., Chapter 20 (Pgs. 449-458) 2. Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Pearson Education, 7 th Ed. Organic Chemistry, Jonathan Clayden, Nick Greeves, and Stuart Warren, Oxford University Press, 2 nd Ed., Pg. 504.
5.1	Formation and stability of enols		
5.2	Aldol condensation reaction, crossed Aldol and mixed aldol reaction, Claisen and Crossed Claisen, Mannich reaction, Dieckmann reaction.		
5.3	Conjugate addition : 1,2 and 1,4 Michael addition reaction		
6.0	Electrophilic aromatic substitution	8	1. Organic Chemistry, Jonathan Clayden, Nick Greeves, and Stuart Warren, Oxford University Press, 2 nd Ed., Chapter 21. 2. Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, 7 th Ed., Pearson Education.
6.1	Nitration, sulphonation, halogenation, Friedel-Crafts alkylation and Friedel Crafts acylation.		
6.2	Kolbe reaction, Reimer-Tiemann reaction		
6.3	Orientation and reactivity of mono and di-substituted benzene towards electrophilic aromatic substitution reaction.		
7.0	Nucleophilic aromatic substitution	4	1. Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Pearson Education, 7 th Ed. Ch. 9
7.1	Mechanistic approach of nucleophilic aromatic substitution (Bimolecular displacement and benzyne formation)		
	TOTAL	48	

Books:

Already referred to in the syllabus outline

BPH_C_402_T – Physical Pharmacy II – (4 Hr/Wk)

Course Objectives

On completion of the theory lectures, the learner should be familiar with the basic concepts of chemical kinetics, drug diffusion and dissolution, biopharmaceutics, complexation, coarse and colloidal dispersions, which in turn, will help the learner in design, development and evaluation of dosage forms.

Course Outcomes

The learner should be able to:

1. Identify order of reactions, pathways of drug degradation and types of drug complexes
2. Describe Fick's laws of diffusion, mechanism of drug dissolution and absorption
3. Acquire understanding of drug complexes, protein binding and their applications
4. Gain knowledge of the basic principles of coarse and colloidal dispersions
5. Apply basic principles of drug characterization to biopharmaceutical aspects of drug delivery

No.	Details	Hours
1	Chemical kinetics and drug stability	11
1.1	Molecularity, order of a reaction, specific rate constant	2

1.2	Reaction kinetics: zero, pseudo-zero, first & second order (problems), units of basic rate constants, determination of reaction order, Energy of activation	4
1.3	Physical and chemical factors influencing the chemical degradation of pharmaceutical product: temperature, solvent, ionic strength, dielectric constant, specific & general acid base catalysis.	3
1.4	Accelerated stability testing in expiration dating of pharmaceutical dosage forms.	2
2	Dissolution and diffusion	9
2.1	Diffusion: Concept, and applications, diffusion through biological membranes, drug release	2
2.2	Fick's Laws of diffusion, Steady state diffusion, driving forces for diffusion in pharmaceutical systems, permeability	3
2.3	Measurement of diffusion	1
2.4	Concept of dissolution, dissolution mechanism	1
2.5	Noyes Whitney equation, factors affecting dissolution	1
2.6	Intrinsic Dissolution Rate, Hixson – Crowell Law, measurement of dissolution rates	1
3	Complexation and protein binding	6
3.1	Introduction, classification of complexes	2
3.2	Pharmaceutical applications of complexes	1
3.3	Method of analysis of complexes	1
3.4	Protein binding, complexation and drug action, stability constants	2
4	Coarse dispersions	8
4.1	Classification of dispersions, properties of coarse, colloidal and molecular dispersions	1
4.2	Thermodynamic and kinetic stability of dispersed systems	1
4.3	Electric Properties of Interfaces: Nernst and zeta potential, effect of electrolytes	1
4.4	Suspensions: DLVO theory, flocculated and deflocculated systems, controlled flocculation, physical stability of suspensions	3
4.5	Emulsions: Theories of emulsification, physical stability of emulsions	2
6	Colloids	7
6.1	Classification and preparation	2
6.2	Colloid properties: optical, kinetic and electrical	2
6.3	Stability of colloids and Schultz Hardy rule, Protective colloid and gold number	2
6.4	Pharmaceutical applications of colloids	1
7	Biopharmaceutics	7
7.1	Introduction to biopharmaceutics and Pharmacokinetics, concept of ADME, bioavailability	2
7.2	Mechanisms of drug absorption	1
7.3	Factors affecting drug absorption: Physicochemical, physiological and dosage form factors	3
7.4	Introduction to Biopharmaceutical Classification System of drugs	1
TOTAL		48

Books:

Refer to latest edition

1. P. J. Sinko, 'Martin's Physical Pharmacy and Pharmaceutical Sciences' Fifth edition, Lippincott Williams and Wilkins, Indian Edition distributed by B.I. Publications Pvt. Ltd, 2006.
2. Pharmaceutical Dosage Forms And Drug Delivery Systems, Howard C. Ansel, Nicholas G. Popovich, Loyd V.
3. Pharmaceutics: The Science Of Dosage Form Design, Michael E. Aulton
4. Bahl and Tuli, 'Essentials of Physical Chemistry' S. Chand and Company Ltd. Ramnagar, New Delhi-110055.
5. Essentials of Physical Pharmacy, C.V.S Subrahmanyum, Vallabh Prakashan.
6. Textbook of Physical Pharmaceutics, C.V.S Subrahmanyum, Vallabh Prakashan

BPH_C_403_T – Pharmaceutics I – (3 Hr/Wk)

Course Objectives

To furnish the students with introduction to Pharmaceutics and preliminary knowledge that is required in the field of formulation development and details of Monophasic liquids, Powders and Biological preparations.

Course Outcomes

The learner should be able to:

1. Describe the status of Pharma Industry in India and elaborate on the different official compendia, recall the various types of dosage forms, routes of administration and describe the alternate systems of medicine.
2. Explain the concepts and need for GMP & QA and preformulation.

- Summarize the packaging of pharmaceuticals
- Explain the formulation considerations, unit operations, Q.A. aspects of monophasic systems, and powders.
- Classify, describe the various biological products, viz. sutures & ligatures, blood products and plasma volume expanders.

No.	Details	Hours
1.	Introduction- Historical background of Profession of Pharmacy in India in brief Brief overview of status of Pharmaceutical Industry in India Pharmacopoeias-IP, BP & BPC, USP/NF, International Pharmacopoeia, Eur. Pharmacopeia	2
2.	Overview – Revision of dosage forms and routes of administration Introduction to alternate systems of medicine-Ayurveda, Homeopathy, Unani & Siddha Concepts of GMP & Quality Assurance in Pharma Industry Preformulation-importance and need.	2
3.	Packaging of Pharmaceuticals- General concept of package and its components-primary & ancillary packs, basic packaging materials- glass, plastics, metals, rubber and paper; types of containers and closures; quality control tests; brief on adhesives and printing inks.	2
4.	Monophasic Liquid dosage forms:Preformulation & formulation aspects General considerations of liquid dosage form design and manufacture-selection of vehicle and excipients; solubility and solubilisation techniques, dissociation and partition coefficient, polymorphism, organoleptic properties, stability with excipients. Large scale Manufacturing aspects-Unit operations and equipment used: liquid mixing, clarification and filtration, filling operations, packaging and quality control tests. Brief coverage of following monophasic dosage forms- Solutions, Aromatic waters, Syrups, Elixirs, Linctuses, Nasal & Ear drops, Paints, Sprays, Lotions & Liniments.	10
5.	Micromeritics & Powder Technology: Preformulation & formulation aspects Basics of micromeritics-Fundamental and derived properties of powders and their measurement-particle shape & size, surface area, densities, flow properties, packing properties, fluidization of powders. Large scale manufacturing aspects- Unit operations and equipment used: Size reduction, size separation, powder mixing, segregation of mixed powders; packaging & Q.C. of powders. Brief coverage of following powders-Dusting powders, Oral rehydration powders, Dry syrup formulations.	10
6.	Biological products- Sutures & ligatures- Definition, classification, cat gut manufacturing and processing, other absorbable sutures-natural & synthetic; Nonabsorbable sutures- silk, linen, polyamides, polyesters, polyolefins, and metallic wires; Quality control tests for sutures/ligatures Blood products: Need, problems/hazards, blood banking procedures 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 Plasma substitutes (plasma volume expanders)- Need, desired properties, examples- hydrolyzed gelatin based products, HETA starch, Dextran (in detail –source, preparation, official injections)	10
	Total	36

Books-

- Lachman Leon, Lieberman Herbert A, Kanig Joseph L., "The Theory and Practice of Industrial Pharmacy, Varghese Publishing House, Mumbai.
- Remington, The Science and Practice of Pharmacy, Vol I & II, B.L. Publications Pvt. Ltd.
- Martin A., Physical Pharmacy, 4th Edition, Lea & Febiger, Philadelphia, London.
- M.E. Aulton, Ed, Pharmaceutics-The Science of Dosage Form Design, Churchill Livingstone Medical Division of Longman Group, UK Ltd.
- Rawlings, Bentley's Text Book of Pharmaceutics, Bailliere Tindall, London.
- Atmaram Pawar, "Introduction to Pharmaceutics", Career Publications, Nashik
- Pharmacopoeias- IP, BP, USP

BPH_C_404_T – Pharmacology I – (4 Hr/Wk)

Course Objectives

1. To educate about general principles of Pharmacology, drug actions, routes of drug administration, pharmacodynamics and pharmacokinetics.
2. To impart knowledge on the effect of drugs on the human body and the mechanisms by which they produce biological/therapeutic/toxic effects.
3. To impart knowledge about the pharmacology of drugs acting via receptors of Autonomic nervous system.
4. To educate on the pharmacology of drugs used for cardiovascular disorders.
5. To educate on pharmacology of diuretic drugs.

Course Outcomes

The learner should be able to:

TOPIC	COURSE OUTCOMES	BLOOM'S LEVEL
T1	Define the scope, general principles and applications of Pharmacology. Comprehend pharmacokinetic and pharmacodynamic principles along with ability to compare and contrast various routes of administration with advantages and disadvantages. Understand the factors modifying drug action.	1 and 2
T2	Classify receptors and elucidate their role in drug/neurotransmitter/hormone action. Understand the mechanisms of drug action.	2
T3	Explain autonomic transmission and discuss the pharmacology of drugs acting on ANS and rationalize their therapeutic applications.	2 and 3
T4, T5	Explain the pharmacology of drugs acting on cardiovascular system and as diuretics and discuss their use in associated diseases	2 and 3

No.	Details	Hours
1	General Principles of Pharmacology • Introduction to Pharmacology • Routes of drug administration with special reference to their advantages and disadvantages. • Drug Absorption, Distribution, Metabolism & Excretion (ADME) • Factors modifying action of drug	8
2	Mechanisms of drug action • Brief introduction to physiological receptors • Structural and functional families of receptors • Mechanisms of drug action: -Drug receptor interaction -Dose response curve (DRC) -Drug antagonism	8
3	Autonomic nervous system • Autonomic neurotransmission • Parasympathomimetics • Parasympatholytics • Sympathomimetics • Sympatholytics • Drugs acting on autonomic ganglia • Skeletal muscle relaxants	16
4	Cardiovascular system • Drugs used in the treatment of: - Congestive cardiac failure - Hypertension - Cardiac arrhythmia - Angina pectoris - Hyperlipoproteinemia	13
5	Diuretics	3
Total		48

Books:

1. Goodman & Gilman's Pharmacological Basis of Therapeutics; Joel. G, Hardmon Lee, E. Limbird, Alfred Goodman Gilman; 11th Ed.; The McGraw-Hill Companies, Inc; 2011.
2. Pharmacology and Pharmacotherapeutics; 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.
9. Essentials of Medical Pharmacology, K. D. Tripathi, 7th ed, Jaypee Publishers.

BPH_C_405_T – Microbiology – (3 Hr/Wk)**Course Objectives**

1. To discuss the scope, history of microbiology and applications in pharma industry, classification of microorganisms and Learn different microscopy techniques and principles of different staining techniques.
2. To understand Structural organization and multiplication of bacteria, viruses, algae, protozoa, and fungi, Nutritional requirements of bacteria and study diseases related to them ; different media used for bacterial culture; growth curve and different methods to quantify bacterial growth
3. To study physical and chemical control of microorganisms, different methods of sterilization, validation of sterilization methods
4. To learn Microbiological standardization of Pharmaceuticals: Bioassay, Microbial limit tests, Sterility testing of pharmaceutical products and preservation of pharmaceutical products

Course Outcomes

The learner should be able to:

1. Describe the classification of microorganisms and list some of the common diseases caused by them.
2. Use different microscopic techniques, staining techniques, and differential media for the identification of some common disease causing microorganisms.
3. Describe different methods for the control of growth of microorganisms and methods of preservation/sterilization of pharmaceutical products.
4. Describe the importance of microbial testing and microbial limit tests for some pharmaceutical products

No.	Details	Hours
1		5
1.1	Introduction to Microbiology, 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
1.3	Microscopy, Simple microscope, Compound microscope, resolving power, magnification, angular aperture, numerical aperture, Dark field microscopy, phase contrast microscopy, fluorescent microscopy, electron microscopy.	2
1.4	Information used to characterize and identify microorganisms (in brief) - morphological, cultural, biochemical (metabolic), antigenic, pathogenic, genetic characteristics.	1
2		15
2.1	Bacteria - Morphology, Cell characteristics, Habitat, Nutritional requirements, Cultivation of bacteria, Culture media- Cultivation & Storage media, Cultivation of aerobes and anaerobes.	3
2.2	Pure culture, Methods to isolate pure cultures, Preservation of cultures. Reproduction of bacteria, Growth phases, Measurement of growth (enumeration), factors affecting growth, continuous cultivation.	2
2.3	Overview of bacterial diseases and the pathogens causing them- Mycobacterium sp., Salmonella sp., Shigella sp., Staphylococci sp., Pseudomonas sp., Klebsiella sp., Clostridium sp, Vibrio sp.	2
2.4	Viruses & related microorganisms - Morphological characteristics, Nutritional aspects, Cultivation and reproduction, HIV and Oncogenic viruses.	2
2.5	Rickettsiae and Chlamydiae- Morphological characteristics, Cultivation, Rickettsial &	1

	Chlamydial diseases.	
2.6	Major groups of Eukaryotic microorganisms -	
	Fungi-Morphological characteristics, Classification, Reproduction of fungi, Cultivation of fungi, Culture media, Study of some important fungi- Penicillium, Aspergillus, Candida, Saccharomyces. Fungal infections-Mycoses	2
	Algae - Classification, Morphological characteristics, reproduction, economic significance of algae.	1
	Protozoa- Morphological characteristics and classification, reproduction, pathogenic protozoa like Amoeba, Paramecium, Trichomonas, Plasmodium	2
3		11
	Control of Microorganisms	
3.1	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. Inactivation factor.	2
3.2	Sterilization methods & Equipment- Heat Sterilization methods (Moist heat, dry heat, low temperature sterilization methods), Radiation Sterilization, Ionizing and non-ionizing radiations, Filtration Sterilization, Gaseous Sterilization. Evaluation of the efficiency of sterilization methods, Equipment employed in large scale sterilization, Sterility indicators.	5
3.3	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, Tissue toxicity index	4
4		5
4.1	Introduction to Aseptic techniques (no equipment) Designing of aseptic area, laminar flow equipment; study of different sources of contamination in an aseptic area and methods of prevention, clean area classification as per ISO and USFDA. General aspects-environmental cleanliness and disposal of microbial waste.	1
4.2	Sterility testing of products (solids, liquids, ophthalmic and other sterile products) according to IP, BP and USP	1
4.3	Principles and methods of different microbiological assay. Methods for standardization of antibiotics, vitamins and amino acids. Assessment of a new antibiotic and testing of antimicrobial activity of a new substance	1
4.4	Microbial limit tests : Types of spoilage, factors affecting the microbial spoilage of pharmaceutical products, sources and types of microbial contaminants, assessment of microbial contamination and spoilage.	1
4.5	Preservation of pharmaceutical products using antimicrobial agents, evaluation of microbial stability of formulations.	1
	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. Ananthanarayan and Ck. J. Panicker "Textbook of Microbiology", 7th edn. Orient Longman Pvt. Ltd. Hyderabad, 2005.

BPH_C_406_T – Mathematics and Statistics – (3 Hr/Wk)

Course Objectives

1. To teach the learner the basic principles of calculus, differentiation and integration, and determinants and matrices and their application in several other specialized pharmacy subjects.
2. To convey to the learner the importance of statistics and statistical methods in data analysis and results interpretation and as an extension in experimental design.

Course Outcomes

The learner should be able to:

1. Know the theoretical concepts of topics and their application in Pharmacy
2. Solve the different types of problems by applying theoretical concepts.
3. Appreciate the important application of mathematics and statistics in Pharmacy.

No.	Details	Hours
1	Calculus: Differentiation	5
	Introductions, Derivative of a function, Derivative of a constant, constant and a function, sum or difference of two functions, product/quotient of two functions(product/quotient formula), Derivative of x^n w.r.t x , $\log_e x$, a^n , Successive differentiation, Lagrange's and Rolle's Mean Value Theorems(Statements only), Taylors and Maclaurins Series with application.	
2	Analytical Geometry: Integration	5
	Definition, standard formulas, rules of integration, method of substitution, integration by parts, definite integration, Application(determination of the length of the curve, area and volume)	
3	Differential Equations	4
	Formation of differential equations, solution of first-order and first-degree equation, linear differential equations of higher order with constant coefficients.	
4	Determinants and Matrices	4
	Properties of determinants and application of Cramers method, types of matrices, inverse of matrix, rank of matrix.	
Statistics		
5	Measurement of Central Tendency	4
	Arithmetic Mean, median and mode	
6	Measures of Dispersion	7
	Range, quartile deviation, mean deviation and standard deviation, coefficient of variation, probability, Binomial, Poisson and Normal distribution, Fitting of curves by the method of least squares $\{Y = a + bX, Y = ab^x, Y = aX^b\}$	
7	Sampling distribution for mean and proportion	7
	Test of hypothesis for specified values of mean and proportion for large samples, Testing equality of two means and proportions, 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. Mathematics for Pharmacy Students (Vol.I), Gujar K. N., Bhavale Ashok, Career Publication.
2. Mathematics for Pharmacy Students (Vol.II), Gujar K. N., Bhavale Ashok, Career Publication.
3. Fundamentals of Statistics, Gupta S.C., Himalaya Publication.
4. Integral Calculus, Shanti Narayan, S. Chand Publication.
5. Differential Calculus, Shanti Narayan, S. Chand Publication.
6. Textbook of Applied Mathematics, Vols. I and II, Warlikar, P. N., Pune Vidyarthi Griha Prakashan.

BPH_C_407_L – Physical Pharmacy Lab II – (4 Hr/Wk)

Course Objectives

To familiarize the learner with methods to evaluate shelf life and physical stability of products and teach the learner characterization methods and protocols for determination of physical parameters.

Course Outcomes

The learner should be able to:

1. Determine reaction rate constant, order of a reaction for different reactions
2. Predict shelf life by carrying out accelerated stability studies
3. Calculate physical parameters such as stability constants, molecular weight, and critical micellar concentration

Experiments:

1. Determination of reaction rate constant, order of a reaction and relative strength of acids (first order).
2. Determination of reaction rate constant and order of a reaction (second order, $a=b$).
3. Determination of order of reaction by Ostwald isolation method
4. Accelerated stability studies
5. Determination of stability constant and donor acceptor ratio of PABA-Caffeine complex by solubility method **OR** Determination of stability constant and donor acceptor ratio of Cupric-Glycine complex by pH titration method
6. Determination of wetting property of solid by Wet point method or Flow point method
7. Determination of molecular weight of polymer using intrinsic viscosity
8. Determination of critical micellar concentration of a surfactant

Demonstration

9. Demonstration of Brookfield viscometer or any other rotational/multipoint viscometer.

Books:

1. Laboratory Manual of Physical Pharmaceutics, C.V.S. Subramanyam, J. Thimma Settee
2. Practical Physical Pharmacy, U. B. Hadkar, T.N. Vasudevan and K.S. Laddha

BPH_C_408_L – Pharmaceutics Lab I– (4 Hr/Wk)

Course Objectives

To train the learner in preparation of typical monophasic liquid and powder formulations and carry out their Q.C. tests, and acquaint them with some biological preparations available in market.

Course Outcomes

The learner should be able to:

- 1) Prepare monophasic liquid systems and powder systems, justify the components and method of preparation.
- 2) Demonstrate the properties of the developed dosage forms and biological products, comment on the quality.
- 3) Perform experiments as per GLP and record in the journals.

Experiments:

No.	Details
1	Aromatic waters - Chloroform Water IP 1966, Conc. Dill water IP 1966, Conc. Anise water IP 1973, Gripe water
2	Syrups - Syrup IP 1966, Artificial syrup, Cough Syrup-Codeine phosphate syrup-BPC
3	Linctus - Simple linctus BPC
4	Elixirs - Piperazine Citrate elixir BPC
5	Ear drops - Chloramphenicol ear drops BPC
6	Nasal Drops - Ephedrine sulphate nasal drops BPC
7	Glycerites -Glycerin of starch IP 1955, Glycerin of boric acid IP 1955, Glycerin of tannic acid IP 1966
8	Solutions -Aqueous Iodine solution IP 1966, Paracetamol solubilized paediatric drops, Cresol with soap solution IP, Magnesium Citrate oral solution NF XIV, Chlorinated soda solution, surgical-BPC, Iodine paint compound BP 1968
9	Powders -Oral rehydration salt (ORS)
10	Quality evaluations - a) Liquids for –organoleptic properties, specific gravity, pH, viscosity b) Powders for-particle size, bulk density, flow properties (flow rate & angle of repose) c) Packaging materials-simple testing of dimensions, thickness, volume etc of containers and flexible packaging materials (films, paper, laminates).
11	Biological products-Assignment a) Sutures & ligatures- survey on marketed products- one absorbable & one non-absorbable, learn about its monographic testing and labelling. b) Blood products- survey on one blood product and one plasma volume expander (marketed), and its monographic

testing.

Books:

1. Lachman Leon, Lieberman Herbert A, Kanig Joseph L., "The Theory and Practice of Industrial Pharmacy, Varghese Publishing House, Mumbai.
2. Remington, The Science and Practice of Pharmacy, Vol I & II, B.L. Publications Pvt. Ltd.
3. Martin A., Physical Pharmacy, 4th Edition, Lea & Febiger, Philadelphia, London.
4. M.E. Aulton, Ed, Pharmaceutics-The Science of Dosage Form Design, Churchill Livingstone Medical Division of Longman Group, UK Ltd.
5. Rawlings, Bentley's Textbook of Pharmaceutics, Bailliere Tindall, London.
6. Atmaram Pawar, "Introduction to Pharmaceutics", Career Publications, Nashik
7. Pharmacopoeias- IP, BP, USP

BPH_C_409_L – Pharmacology Lab I– (4 Hr/Wk)

Course Objectives

1. To impart practical (Laboratory) training in basic laboratory techniques like tissue (cock ileum) mounting and in vitro experimentation.
2. To teach plotting of dose response curve of acetylcholine in presence of antagonist and agonist.
3. To demonstrate the effect of various drugs on isolated organ (frog heart) using interactive audiovisuals.
4. To convey about ethical guidelines followed in animal experimentation.

Course Outcomes

The learner should be able to:

TOPIC	COURSE OUTCOMES	BLOOM'S LEVEL
P1	Perform <i>in vitro</i> experiment on cock ileum (tissue) to evaluate effect of drug (Ach) and its dose on response (contraction) to comprehend and infer drug effects on receptors and its outcomes.	1 and 2
P1, P4	State the principles behind plotting dose-response of drugs/agonist/antagonist and its applications. Define pA ₂ value and calculate pA ₂ value of antagonist.	1 and 3
P3	Summarize the impact of drugs on eye and GI and discuss their potential therapeutic utility.	2
P4	Observe and explain the mechanisms of action of neurotransmitters, drugs and ions on isolated frog heart.	2
P5	Knowledge of animal handling techniques and understanding of ethical guidelines governing animal experimentation.	1 and 2

No.	Details
1	Dose response curve (DRC) of Acetylcholine using suitable isolated tissue preparation (e.g. Cock ileum)
2	Demonstrations: Effect of drugs on isolated frog heart (CDs) -Adrenaline, Acetylcholine -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
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 e.g. 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:

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.