

1.1.1 T PHARMACEUTICS- I (Theory)

(3 hrs / week)

Learning Objective :

On completion of following theory topics & laboratory experiments, learner should be able to :

A. Knowledge :

1. describe the history of pharmacy, development of pharmacy profession and industry in India.
2. describe various routes of drug administration, concept of dosage forms, unit operations involved in preparation of these dosage forms.
3. describes alternative system of medicines.
4. explain the factors which influence the design of pharmaceutical dosage forms and the need for accuracy and thoroughness in manufacture of pharmaceutical products.
5. analyze and compare the difference between various dosage and routes of administrations.
6. summarize the factors influencing formulation of various dosage form like solution.
7. predict the choice of route of administration based on dosage form.
8. define preformulation, describe various preformulation parameters and define additives with its examples.

B. Skills :

1. state the correct use of various equipments in Pharmaceutics laboratory relevant to practical's.
2. explain formulation, evaluation and labeling of aromatic water, glycerides, syrups, elixirs and powder preparations.
3. perform pharmaceutical calculations to determine evaluation parameters like density, viscosity, specific gravity, angle of repose, Carr's index, Hausner ratio of preparations.
4. describe use of ingredients in formulation and category of formulation.
5. use equipments and apparatus needed for the preparation as per SOP.
6. compare various monophasic preparations depending upon their formulation.
7. select the suitable packaging material (container-closure) for the preparation.
8. classify the various dosage forms by using different criteria.
9. draw the labels in neat way including all the component/parts.

10. perform pharmaceutical calculations.
11. summarize the principles of formulation and evaluation.
12. predict the special requirements of preparations regarding the use, handling, storage conditions.

Topic No.	Name of the topic and contents	Hrs.
1	Introduction to pharmaceuticals. Introduction to pharmaceuticals and its various branches like physical pharmacy, dispensing practices, formulation development, pharmaceutical engineering etc and scope of each. History of pharmacy profession and industry in India. Pharmacy code of ethics and pharmacy as career	4
2	Pharmacopoeia and other compendia Special emphasis on IP, BP, USP including history, development and latest edition. Introduction to European Pharmacopoeia, Martindale, Merck Index, Martindale, BPC and Ayurvedic Pharmacopoeia, Materia medica.	4
3	Alternative systems of medicines Introduction to history and general principles of ayurveda, homeopathy, siddha and unani.	4
4	Introduction to drug and dosage forms Definition of drug and new drug as per regulatory aspects, sources of drugs. Concept of dosage form, rationale for development of dosage form, classification of the basis of nature, routes of administration.	6
5	Excipients Concept of excipients. Definitions and classification with examples. Special emphasis on colours, flavours and preservatives used in formulations.	7
6	Pre-formulation. Concept of pre-formulation, aspects of bulk drug characterization, solubility and stability studies. Importance of each aspect in formulation development.	7
7	Solutions Definition and types. Formulation ingredients. Types of water used in pharmaceutical solutions, Evaluation, in process control and finished Product controls. Formulation - syrups, elixirs, aromatic water, linctuses, ENT preparations and paints, mouth washes, enema	10
8	Concept of quality control and quality assurance	3

1.1.1 P PHARMACEUTICS- I (Practical)

(3 hrs / week)

Guidelines

- 1) Wherever possible, formulations should be prepared as per pharmacopoeia.
- 2) Students are expected to find corresponding marketed preparations along with the contents, name of the manufacturer, study the label and note the shelf life period.
- 3) Evaluation parameters for liquids include organoleptic properties like colour, odour, appearance, pH, weight/ml. Powder evaluation includes organoleptic properties, bulk and tapped density, angle of repose and compare against standard reference values. Assays and long term evaluations are not expected.
- 4) Semester examination should include a major and a minor experiment.

Experiments

- 1) **The concept of referencing and study of a standard style of referencing like Vancouver.**
- 2) **Aromatic waters**
Chloroform water, anise water, dill water and gripe water.
- 3) **Monophasic liquids**
Magnesium Citrate Oral Solution USP, Aqueous Iodine Solution IP, Tincture of Iodine, Cresol with Soap Solution IP, Surgical Chlorinated Soda Solution.
- 4) **Glycerites and throat paints**
Borax Glycerine IP, Tannic Acid Glycerine IP
- 5) **Syrups and elixirs**
Simple Syrup IP, Medicated syrup, Aromatic Elixir USP
- 6) **Powders**
Oral rehydration salt, talcum powder, tooth powder

Recommended Books:

- 1) L V Allen, N G Popovich, H C Ansel, Ansel's Pharmaceutical dosage forms & Drug Delivery Systems, 9th edition, 2nd Indian reprint, 2011, Published by Lippincott Williams and Wilkins, Wolters Kluwer (India) Pvt. Ltd., New Delhi.
- 2) M E Aulton, K Taylor, Pharmaceutics: The Science of Dosage Form Design, 2nd edition. Edited by M E Aulton, Published by Churchill Livingstone, 2001.
- 3) Remington: The Science and Practice of Pharmacy, Volumes 1-2, 22nd edition, 2012, Edited by Allen L V, Adeboye A, Shane P D, Linda A F, Jointly published by Pharmaceutical Press and Philadelphia College of Pharmacy at University of the Sciences.
- 4) Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig, The Theory and Practice of Industrial Pharmacy. 3rd edition, 1986, CBS publishers and Distributors, New Delhi.

- 5) Modern Pharmaceutics, 4th edition, revised and expanded, 2009, Edited by G S Banker and C T Rhodes, Published by Informa Healthcare USA Inc. New York.
- 6) A R Paradkar, Introduction to Pharmaceutical Engineering, 10th edition, 2007, Published by Nirali Prakashan, Pune.
- 7) Atmaram Pawar and R S Gaud, Modern Dispensing Pharmacy, 3rd edition reprint, 2010, Career Publications.
- 8) Indian Pharmacopoeia, 2010, Volumes I, II & III, Published by The Indian Pharmacopoeia Commission, Ghaziabad, Government of India, Ministry of Health & Family Welfare.
- 9) British Pharmacopoeia, 2009, Volumes I-IV and Veterinary, Published by British Pharmacopoeia Commission, the Stationary Office on behalf of Medicines and Healthcare products Regulatory Agency (MHRA), United Kingdom.
- 10) United States Pharmacopoeia 35 - National Formulary 30 by United States Pharmacopoeia Convention, Volumes I-3.

1.1.2 T MODERN DISPENSING PRACTICES (Theory) (3 hrs / week)

Learning Objective :

On completion of following theory topics & laboratory experiments, learner should be able to :

A. Knowledge :

1. review basic requirements in the compounding and dispensing of pharmaceutical products
2. state the parts of a typical medication container label.
3. apply basic mathematical calculations in the compounding and dispensing.
4. calculate the dose according to need of patient by using various formulas.
5. generate accurate and appropriate drug information and report health care professionals regarding ADR, Idosyncrasy, Pharmacovigilance.
6. provide consultation to patients and other health care professionals regarding various diseases.
7. Counsel patient for prescription drug, OTC products and cosmetics.
8. read, interpret, and translate into english any prescription or medication order written in latin or other.
9. judge a prescription for completeness and legality with respect to incomplete or missing information.
10. Identify the type of incompatibility and explain the methods to remove these incompatibilities.

B. Skills :

1. select proper containers for packaging of pharmaceutical preparations.
2. list commonly prescribed drugs by generic name, trade names, common therapeutic use and usual dose.
3. describe the advantages and disadvantages of various solid, liquid and semisolid dosage forms.
4. demonstrate a working knowledge of drug dosages, routes of administration, and dosage forms.
5. demonstrate skill in the operation of common pharmaceutical measuring, weighing and compounding devices.
6. identify and differentiate between various solid and liquid dosage forms for oral and topical use.
7. summarize pharmaceutical/medical terminology, abbreviations and symbols commonly used in the prescribing, dispensing, and charting of medications in the pharmacy.
8. predict specific uses for various solid and liquid dosage forms for oral and topical use.

Topic No.	Name of the topic and contents	Hrs.
1.	Meaning of compounding and dispensing Fundamental operations in compounding and dispensing, containers, closures for dispensed products, labeling of dispensed medicines, storage and stability of medicines.	4
2.	Prescription and its parts Types, parts of prescription Responding to prescription, pricing of prescription.	3
3.	Good compounding and dispensing practices Personnel, house keeping, building. Documentations – Introduction to prescription filling, drug profile, PMR, Purchase records, Stock records.	6
4.	Pharmaceutical calculations Alligations, percentage calculations, molarity, normality, millimoles, milliequivalence calculations, Isotonic solutions, proof spirit, improvisation and dilution of dosage forms.	8
5.	Posology Meaning, factors affecting dose, calculation of doses for infants and children.	3
6.	Incompatibilities in prescription Study of various types of incompatibilities: physical, chemical and therapeutic. Methods to remove these incompatibilities.	6

7.	Community Pharmacy	
	1) Organization, structure and design of retail and wholesale drug. Legal requirements for establishment and maintenance of drug stores. Drug information service, Reporting of ADR, Idiosyncratic cases, Brief introduction to Pharma-co vigilance	5
	2) Steps in Patient counseling. Patient counseling for prescription drugs, OTC and Cosmetics products. Patient counseling in diseases like Asthma, Tuberculosis, Hypertension, Diabetes	6
	3) Role of pharmacists in community healthcare and education; Family planning, HIV/AIDS, Vaccination .Introduction to concepts of Self-medication, Rational drug use	4

1.1.2 P MODERN DISPENSING PRACTICES (Practical)
(3 hrs / week)

Experiments

- 1 Analysis of prescription : Give two prescriptions and ask student to report error , missing part in the prescription and prescription of patient medication record .
- 2 To compound and dispense given prescription(any two)
 - a) Zinc Sulphate & Zinc chloride Mouthwash, Potassium Permanganate gargle.
 - b) Pediatric Kaolin Mixture, Magnesium Trisilicate Mixture.
 - c) Castor oil emulsion, white liniment.
 - d) Zinc –starch & talc dusting powder.
 - e) Methyl salicylate ointment, Whitfield ointment
- 3 Incompatibility identification & correlation of following incompatibilities in prescriptions:
 - a) Physical- suspension, emulsion, eutectic mixture.
 - b) Chemical- explosive mixture, caffeine citrate.
 - c) Therapeutic - study of prescription containing therapeutic incompatible ingredients & correction of the same.
- 4 Pharmaceuticals calculations:
 - a) Preparation of isotonic solution
 - b) Experiment based on allegation method
 - c) Experiment based on dilution method
- 5 Posology : calculation of dose based on
 - a) Age – two case study.

- b) Surface area- two case study.
 - c) Body weight- two case study.
- 6 Pharmacist counseling
- a) OTC
 - b) Cosmetics
 - c) Inhaler

Recommended books:

- 1) Cooper and Gunn's Dispensing for Pharmaceutical Students, 12th edition, Edited by S J Carter, CBS Publishers and Distributors.
- 2) Atmaram Pawar and R S Gaud, Modern Dispensing Pharmacy, 3rd edition reprint, 2010, Career Publications.
- 3) N K Jain & G D Gupta, Modern Dispensing Pharmacy, 2nd edition, 2009, Pharma Book Syndicate, Hyderabad.
- 4) B M Mithal, A Text Book of Pharmaceutical Formulation, 6th edition, 13th reprint, 2010, Vallabh Prakashan, Delhi.
- 5) M L Shroff , Professional Pharmacy, 1st edition, Part I-III, Five Star Enterprises, Calcutta.
- 6) Bentley's Textbook of Pharmaceutics, 8th edition, 1996, Edited by E A Rawlins, All India Traveller Book Seller, New Delhi.
- 7) Indian Pharmacopoeia, 2010, Volumes I, II & III, Published by The Indian Pharmacopoeia Commission, Ghaziabad, Government of India, Ministry of Health & Family Welfare.

1.1.3 T PHARMACEUTICAL INORGANIC CHEMISTRY (Theory)

(3 hrs / week)

Learning Outcomes:

On successful completion of theory topics and laboratory experiments, the learner should be able to:

Knowledge:

1. highlight applicability and Gain a better understanding the relevance and significance of Inorganic chemistry to pharmaceutical sciences.
2. differentiate various pharmacopoeias currently in use and discuss the contents of official monographs in pharmacopoeias.
3. understand meaning of impure and pure chemical compound and describe official methods of control like limit tests and qualitative tests.
4. Clarify properties of water, methods of purification, types of water and official quality control tests.

5. classify gastrointestinal tract agent with mechanism of action and their preparation, properties, storage, assay, uses, marketed formulations of compounds used.
6. explain important functions of extracellular and intracellular ions in the body and extrapolate the knowledge regarding various therapies for disorders associated.
7. discuss the biological importance of trace elements and know the method of preparation, properties, storage, assay, marketed formulations of their official compounds.
8. illustrate importance of topical agents and discuss their method of preparation, properties, storage, assay, uses and marketed formulations.
9. classify the dental products and know the method of preparation, properties, storage, assay and uses with marketed formulations of inorganic compounds used in dental products.
10. list the important inorganic gases and specify the role, storage, and their methods of manufacturing.
11. define and elaborate the details of various inorganic medicinal agents like expectorants, antidepressant, antidotes, cytotoxic agents, etc.

Skills:

1. explain method of manufacturing, physical/chemical properties, assay, storage and uses of important inorganic substances used for pharmaceutical purpose.
2. prepare and calculate theoretical, practical and percentage yield of inorganic pharmaceutical compounds
3. perform qualitative analysis for detection of acidic and basic radicals from given inorganic binary mixture and apply them for unknown sample.
4. identify impurities from pharmaceutical substances by performing limit tests
5. perform titration, determine the end point, take observations and calculate the result and conclusion.
6. predict swelling power, acid neutralizing capacity, adsorption property of various inorganic compounds.

Sr	Topics	Hr
1	Introduction to pharmaceutical inorganic chemistry, Different Pharmacopoeia and contents of individual monographs. Indian Pharmacopoeia – History and detail study of different volumes along with general notices, new inclusion/exclusion of compound monograph.	4
2	Sources of contamination in pharmaceuticals and methods to control: Various limit tests including chloride, sulphate, arsenic, lead, iron and heavy metals as per IP. Limits of insoluble matter, soluble matter, non-volatile matter, residue on ignition and ash values. Qualitative tests for alkali and alkaline earth metals.	5

3	Water: Water as universal pharmaceutical vehicle. Hardness of water, methods to remove hardness of water, different official waters and official control tests for water.	3
4	Gastrointestinal agents: Acidifying agents: Dilute hydrochloric acid Antacids: Classification of antacids, Aluminium Hydroxide Gel, Aluminium Phosphate, Basic Aluminium carbonate, Calcium Carbonate, Magnesium carbonate, Magnesium Hydroxide, Magnesium Trisilicate, Sodium Bicarbonate, Combination of Antacids. Protectives and adsorbents: Bismuth compounds, bismuthsubcarbonate, Kaolin, Activated charcoal, pectin. Saline cathartics: Sodium phosphate, Sodium potassium tartarate, Magnesium carbonate, magnesium sulphate.	6
5	Electrolytes: Extra and intracellular ions: Chlorides, Phosphate, Bicarbonate, Na, K, Ca, Mg. Electrolytes used for replacement therapy, Calculation of mEq/l, mOsmol/l of electrolytes, physiological acid base balance. Electrolyte used in acid-base therapy, Electrolytes combination therapy. Sodium chloride injection, Ringer solution lactated, Ringer injections, sodium acetate, potassium bicarbonate, sodium citrate, sodium lactate, ammonium chloride, oral rehydration salts.	6
6	Essential and trace elements: Absorption, distribution, physiological role. Official compound of Fe, Cu, Zn, I, Fe: Ferrous sulfate, Iron sorbitex injection, ferric ammonium citrate, ferric chloride, Cu: Copper sulfate, Iodine, Potassium iodide, Sodium iodide, Zn-Zinc sulphate.	5
7	Topical agents: General introduction and mode of action Protectives: Talc, zinc oxide, Calamine, Zinc stearate, Titanium dioxide, aluminum compounds. Antimicrobials and astringents: Hydrogen peroxide solution, Sodium perborate, Zinc peroxide, Potassium permanganate, Sodium hypochlorite, Iodine solution, Boric acid, Selenium sulfide, Zinc sulfate.	6
8	Dental products: Dentifrices, Anti-caries agents.	2
9	Gases and vapours: Important inorganic gases used in Pharmacy Oxygen, Nitrogen, Nitrous oxide ,Carbon dioxide, Helium, Ammonia and their compounds as per I.P.	3

10	Miscellaneous agents: Expectorants: Ammonium chloride, potassium iodide Radioopaque medium: Barium sulphate Antidotes: sodium nitrite, Sodium thiosulphate Antidepressant: Lithium carbonate Cytotoxic agents: Cisplatin	5
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Note: For official compounds formula, methods of preparation, general properties, storage and uses should be discussed.

1.1.3 P PHARMACEUTICAL INORGANIC CHEMISTRY (Practical)

(3 hrs / week)

Experiments

1. Preparation of compounds followed by its identification tests as per I. P.
 - a. Ferrous sulphate
 - b. Magnesium sulphate
 - c. Copper sulphate
 - d. Sodium citrate
 - e. Aluminium hydroxide gel
2. The backgrounds and systematic qualitative analysis of Inorganic mixture of up to 4 radicals. (minimum three)
3. Identification tests for pharmacopoeial inorganic pharmaceuticals and qualitative tests for cations and anions should be covered (minimum three).
4. Determination of swelling power of bentonite, Acid neutralizing capacity Aluminium hydroxide gel, Ammonium salts in Potash alum, Adsorption property in Heavy Kaolin and presence of iodate in KI.
5. Limit tests for following as per I.P. procedures.
 - a. Chloride
 - b. Sulphate
 - c. Iron
 - d. Arsenic
 - e. Heavy metals

Recommended books:

1. Inorganic, Medicinal and Pharmaceutical Chemistry by J. H. Block, E. B. Roche, Indian edition, Varghese Publication.
2. Modern Inorganic Pharmaceutical Chemistry by C. A. Dicher.
3. Concise Inorganic Chemistry – J. D. Lee.

4. Bentley & Driver's Text Book of Pharmaceutical Chemistry Revised by L. M. Atherden, 8th edition, Oxford Medical Publications.
5. Indian Pharmacopoeia 2010.
6. Remington The Science and Practice of Pharmacy by Remington, 20th edition, Lipincott, William and Wilkins.
7. Advanced Inorganic Chemistry, 18th Edition, Cotton & Wilkinson (Wiley Eastern Ltd., Delhi).
8. Vogel's Text Book of Quantitative Analysis, 5th Ed.
9. Vogel's Quantitative Inorganic Analysis.
10. Wilson & Gisvold's Principles of Organic and Medicinal Chemistry
11. Harkishan Singh & A. K. Kapoor – Principles of Inorganic Chemistry

1.1.4 T PHARMACEUTICAL ORGANIC CHEMISTRY (Theory)

(3 hrs / week)

Learning objectives: on completion of following theory topics & laboratory experiments, learner should be able to:

A) Knowledge:

1. illuminate relevance & significance of Organic Chemistry to Pharmaceutical Sciences.
2. clarify basic principles concepts of organic chemistry.
3. explain basic functional groups & IUPAC Nomenclature of Organic Compounds.
4. clarify Isomerism & apply that knowledge in understanding the Structure Property Relationship.
5. clarify different reagents in Organic Reactions.
6. explain different Reaction Intermediates & their application in reaction mechanism.
7. explain the factors affecting strength of acid & base.
8. comprehend & explain how Addition & Elimination Reactions are performed with respect to Alkenes and alkynes.
9. explain meaning of term 'Aromaticity' & different reaction involve in the formation of aromatic compounds.

B) Skill:

1. explain correct use of various equipments & Safety measures in Pharmaceutical Chemistry laboratory.
2. calibration of thermometer in technically correct way & Explain the simple laboratory techniques.
3. explain significance of qualitative Analysis of organic compounds & synthesis of derivatives.
4. explain how to synthesize different organic compounds along with reaction & Mechanism.

Sr	Topics	Hr
1	<p>Basic principles and concepts of organic chemistry: Atomic and molecular orbitals, hybridization of atomic orbitals of carbon, nitrogen and oxygen to form molecular orbitals, covalent bond, electro negativity, bond fission, hydrogen bonding, theory of reaction mechanism, bond energy, inductive effect, steric effect, electromeric, mesomeric effect and resonance, hyperconjugation, concept of tautomerism and types</p>	4
2	<p>Classification of organic compounds on the basis of functional group and elemental composition as</p> <ol style="list-style-type: none"> 1. Compounds containing carbon and hydrogen atoms only : hydrocarbons (alkanes, alkenes alkynes, aromatic hydrocarbons, aryl-alkyl hydrocarbons, alicyclic hydrocarbons) 2. Compounds containing carbon, hydrogen and oxygen atoms only (alcohols, phenols, ethers and epoxides, carbonyl compounds, carboxylic acids, esters, anhydrides) 3. Compounds containing carbon, hydrogen and nitrogen atoms only (amines and imine, nitriles, hydrazines, nitro compounds) 4. Compounds containing carbon, hydrogen, and halogens with oxygen (alkyl halides, aryl halides, acyl halides) 5. Compounds containing carbon, hydrogen, oxygen and nitrogen atoms only (amides , imides, aldoxime and ketoxime) 6. Compounds containing carbon, hydrogen and sulphur with/without nitrogen, oxygen and halogen. Sulphonic acids, sulphonylhalides <p>At least five mono-functional examples of each class including aromatic and aliphatic compounds should be covered with their common names)</p> <p>IUPAC nomenclature of all classes of compounds; nomenclature of mono- substituted and poly-substituted compounds should be covered. (Recent rules of IUPAC should be referred).</p>	6
3	<p>Structure-property relationship: Dipole moment, polarity of molecules, intermolecular and intramolecular forces of attraction (hydrogen bonding, <i>van der waal's</i>), and effects of these on physical properties of molecules as physical state, physical constant (melting point and boiling point), and solubility.</p> <p>Isomerism</p> <ol style="list-style-type: none"> i. Introduction to principles of stereochemistry: enantiomerism and diastereomerism, <i>meso</i>-compounds, assigning configurations (<i>R</i> and <i>S</i>), geometric isomerism (<i>cis</i>, <i>trans</i>, <i>Z</i> and <i>E</i>) 	4

2	Classes of reactions and classes of reagents including electrophiles, nucleophiles and radicals.	2
3	Reaction intermediates – carbocations, carbanions, carbenes, free radicals, nitrene and nitrenium ions.	2
4	Acidity and basicity, application of inductive, steric, hyperconjugation and resonance effects on acidity and basicity.	2
5	Alkanes: properties and reactions of alkanes, mechanism and kinetics of halogenation.	3
6	Alkenes and alkynes: preparation and reactions, E1, E2 and E1cB elimination–mechanism and stereochemistry, Saytzeff and Hoffman rules. Addition Reaction of Alkenes – Mechanism, regioselectivity (Markonikov & anti markonikov) in addition of hydrogen, halogen, hydrogen halide, halohydrin formation, oxymercuration–demercuration, hydroboration–oxidation, hydroxylation, allylic substitution (using NBS) and ozonolysis. Conjugated Dienes–Structure, electrophilic addition of dienes: 1, 2 & 1, 4 – addition, Diels – Alder reaction. Alkynes: General methods of preparation and reactions.	10
7	Benzene and aromaticity: Huckel rules, resonance in benzene and derivatives. Mechanism of Electrophilic aromatic substitution: Halogenation, Nitration sulphonation and Friedel Crafts reaction, orientation and reactivity in monosubstituted benzene. Mechanism of nucleophilic aromatic substitution. Addition – elimination and elimination – addition (reactions involving benzyne intermediates)	12

1.1.4 P PHARMACEUTICAL ORGANIC CHEMISTRY (Practical)

(3 hrs / week)

Experiments

1. Safety measures in laboratory.
2. Introduction to laboratory techniques: calibration of thermometer, melting point, boiling point, distillation, and recrystallization.
3. Systematic qualitative analysis of organic compounds and preparation of their derivatives. Organic compounds of all types of functional groups such as
 - a. Benzoic acid
 - b. Aniline
 - c. α/β -Naphthol
 - d. Anthracene
 - e. Diphenylamine

- f. Acetoaminophen
 - g. p-Toludine
 - h. Thiourea
4. Synthesis of acetanilide
 5. Synthesis of phenyl benzoate
 6. Synthesis of para nitro acetanilide
 7. Synthesis of 2,4,6- tribromoaniline.
 8. Synthesis of para bromo acetanilide
 9. Synthesis of 9,10- anthraquinone

Recommended books:

1. Organic Chemistry by Morrison & Boyd, 6th edition, Pearson Education.
2. Organic Chemistry by Pine, 5th edition, TATA McGraw Hill.
3. Advanced Organic Chemistry: Reaction, Mechanism and Structure by Jerry March 4th edition, A Wiley-Interscience Publication.
4. Advanced General Organic Chemistry a Modern Approach by Sachin Kumar Gosh, Reprinted 2007, New Central Book Agency (P) Ltd, Calcutta.
5. Fundamental of Organic Chemistry by T.W. Graham, Wiley- International, New York.
6. Vogl's Text Book of Practical Organic Chemistry- Brian Furniss, Antony Hannaford, Peter Smith, Austrin (Eds), 5th edition, ELBS Publication, Singapore, 1997.
7. Introduction to Organic laboratory Techniques – a Contemporary Approach by Donald L. Pavia, Gary M. Camp man, Georange S. Kriz (Eds), 2nd edition, C.B.S. College Publishing, USA, 1982.
8. Organic Syntheses by A. H. Blatt (Ed), 6th edition, Vol. 1-10, 1950, John Wiley & sons, London.
9. Advanced Organic Chemistry by Bahl & Bahl, S Chand Publication.
10. Organic Chemistry by I. A. Finar, ELBS Publication.
11. A Guidebook to Mechanism in Organic Chemistry by Peter Sykes Longman Scientific and Technical, Sixth Edition, 1985.
12. Organic Chemistry by Garaham Solomon, Tenth Edition, Wiley India Pvt. Ltd, 2009.
13. Organic Chemistry by John McMurry, Fifth Edition, Brooks/Cole Thomson Learning, 1999.
14. Advanced Organic Chemistry by Francis A. Carey, Part A: Structure and Mechanism, Springer, 2007.
15. Writing Reaction Mechanisms in Organic Chemistry by Audrey Miller, Second Edition, Elsevier Science & Technology Books, 1999.
16. Organic Reactions by Werner E. Bachmann, Volume I, John Wiley and Sons. INC, 1942.

17. Advanced Organic Chemistry Reaction Mechanisms by Reinhard Bruckner, Elsevier, 2002
18. Organic Reactions Stereochemistry and Mechanisms by Kalsi P. S., Forth Edition, New Age International Limited, 2006.
19. Advanced Organic Chemistry, Reactions and Mechanisms by Singh M. S., Second Edition, Dorking Kindersley Pvt. Limited, 2008.
20. Organic Reactions, Mechanisms with Problems by Tyagi Rajpal, First Edition, Discovery Publishing House, 2005.

1.1.5 T HUMAN ANATOMY & PHYSIOLOGY –I (Theory)
(3 hrs / week)

Learning objectives: on completion of following theory topics & laboratory experiments, learner should be able to:

A) Knowledge:

1. explain the relevance and significance of Human Anatomy and Physiology to Pharmaceutical Sciences.
2. explain basic terminologies used in anatomy and physiology as well as prefixes & suffixes used to identify body parts and directional terms.
3. clarify the progression of structural levels (cells, tissues, organs, and systems) contributes to the body's order, there function and stability.
4. explain the anatomy & physiology of skeletal & smooth muscle.
5. explain Composition and functions of blood component & Hemostasis and Blood Coagulation.
6. demonstrate how all parts of the human body contribute to the maintenance of homeostasis.
7. clarify the anatomy, physiology & disorders of cardiovascular system, lymphatic system and digestive system.
8. explain WHO Definition of health and health promotion.

B) Skill:

1. explain the construction, working, care and handling of various materials, instruments, glassware's and equipments required for understanding the practical.
2. explain the precautions taken by student while doing the practical in the laboratory.
3. demonstrate the simple laboratory techniques.

4. clarify significance of bleeding time, clotting time, detection of blood group, haemoglobin detection, W.B. C. count, R.B. C. count of blood sample and blood pressure determination.
5. demonstrate human cardiovascular system and digestive system.
6. enrich the practical knowledge students should take to visit the Hospitals/Medical College/Blood Bank.

Topic No	Name of the topic and contents	Hrs
1	<p>Introduction: Definition and scope of anatomy, physiology and related topics. Basic terminologies used in anatomy and physiology. Functional organization of human body and control of the “Internal Environment”.</p>	03
2	<p>Cell and Tissues: Structure of cell, its components and their functions. Genetic control of protein synthesis, cell function and cell reproduction. Structure and functions of plasma membrane. Various transport mechanisms across membrane. Structure, functions, characterization and subtypes of following class of tissues: Epithelial, Connective, Muscle, Nervous tissues</p>	07
3	<p>Muscular system: Anatomy & physiology of skeletal & smooth muscle, neurotransmission, Excitation and contraction of smooth and skeletal muscle, energy metabolism and muscle tone.</p>	03
4	<p>The Blood Cell, Immunity and Blood Coagulation: Composition and functions of blood. Nature, types and function of plasma proteins. Red Blood Cell, Anemia and Polycythemia Resistance of the body to infections.... i) WBCs and Inflammation ii) Immunity and Allergy Innate immunity. Blood types: Transfusion, Tissue and organ transplantation. Hemostasis and Blood Coagulation.</p>	10
5	<p>Lymph and lymphatic system: Composition, formation, circulation and functions of lymph. Structure of lymph node. Anatomy, physiology and functions of spleen. Disorders of lymphatic system.</p>	03
6	<p>Cardiovascular system: Anatomy of heart and blood vessels. Cardiac muscle, the heart as pump and function of heart valves.(cardiac cycle and ECG) Rhythmical excitation of heart.</p>	10

	<p>Circulation (pulmonary, coronary, systemic and portal). Blood pressure (cardiac output, venous return and their regulation). Renin- angiotensin- aldosterone system. Disorders of cardiovascular system - hypertension, hypotension, arteriosclerosis, angina, myocardial infarction, congestive heart failure, circulatory shock and cardiac arrhythmias (definitions only).</p>	
7	<p>Digestive system: Anatomy and physiology of different parts of digestive system (salivary glands, stomach, liver, pancreas, small intestine, large intestine). Secretory functions of alimentary tract. Neuro humoral control of digestive tract. Disorders of digestive system (definitions only)</p>	07
8	<p>Health Education: WHO Definition of health and health promotion. Family planning: different devices for family planning Classification of food requirements: Balanced diet, nutritional deficiency disorders, their treatment and prevention.</p>	02

Recommended Books:

1. Chatterjee, C.C., Human Physiology. Medical Allied Agency, Kolkata.
2. Ganong, W.F., Review of Medical Physiology. Prentice-Hall International, London.
3. Guyton, A.C., Textbook of Medical Physiology. W. B. Saunders Co., Philadelphia, USA.
4. Tortora, G.J. and Grabowski, S.R., 2005. Principles of Anatomy and Physiology. Harper Collins College Publishers, New York.
5. Vander, A.J., Sherman, J.H. and Luciano, D.S., Human Physiology. McGraw-Hill Publishing Co., USA.
6. Waugh, A. and Grant, A., Ross and Wilson's Anatomy and Physiology in Health and Illness. Churchill-Livingstone, London.
7. West, J.B., Best and Taylor's Physiological Basis of Medical Practice. Williams and Wilkins, Baltimore, USA.
8. Warwick, R. and Williams, P., Gray's Anatomy. Longman, London.
9. Chaudhari S K. Concise Medical Physiology. New Central Book Agency (P) Ltd., Calcutta.
10. Godkar P.B and Godkar D.P., Textbook of Medical Laboratory Technology. Bhalani Publishing House, Mumbai.
11. Joshi V.D. Practical Physiology. Vora Medical Publications, Mumbai.
12. DiFiore-Mariano S.H., Atlas of Human Histology. Lea and Febiger, Philadelphia.

13. Garg K., Bahel I. and Kaul M., A Textbook of Histology. CBS Publishers and Distributors, New Delhi.
14. Goyal, R.K., Patel, N.M. and Shah, S.A., Practical Anatomy, Physiology and Biochemistry. B. S. Shah Prakashan, Ahmedabad.
15. Ranade, V.G., Joshi, P.N. and Pradhan, S., Textbook of Practical Physiology. Pune Vidyarthi Griha Prakashan, Pune.
16. Singh, I., BD., Chaurasia's Human Anatomy. CBS Publisher and Distributors, New Delhi.
17. Singh, I., Textbook of Human Histology. Jaypee brothers Medical Publishers, New Delhi.
18. Upasani, C.D. and Undale, V., Human Anatomy and Physiology. Tech-Max Publications, Pune.
19. Mukherjee, K.L., Medical Laboratory Technology. Tata McGraw Hill Publishing Company Ltd. New Delhi.
20. Beck, W.S., Human Desigh: Molecular, Cellular and Systemic Physiology. Harcourt Brace Jovanovich Inc. New York.

1.1.5 P HUMAN ANATOMY & PHYSIOLOGY –I (Practical)

(3 hrs / week)

Experiments

- 1 To study the microscope (types, uses, care and handling of microscopes)
- 2 Histological study of important tissues (epithelial, connective, muscular and nervous tissue)
- 3 To determine RBC count
- 4 To determine WBC count
- 5 To determine hemoglobin content of blood sample using hemometer
- 6 To determine blood group
- 7 To determine clotting time.
- 8 To determine bleeding time.
- 9 To study of human cardiovascular system with the help of chart, model and histological slides.
- 10 To measure blood pressure, body temperature, pulse rate of healthy volunteer (Manual and digital).
- 11 To record ECG, study PQRST waves and discuss the significance of ECG.
- 12 To study of human digestive system with the help of chart, model and histological slides.
- 13 Visit to Medical College and/or Hospital (Optional)
Visit to Blood Bank (Optional)

Recommended Books:

1. Godkar P.B and Godkar D.P., Textbook of Medical Laboratory Technology. Bhalani Publishing House, Mumbai.
2. Joshi V.D. Practical Physiology. Vora Medical Publications, Mumbai.
3. DiFiore-Mariano S.H., Atlas of Human Histology. Lea and Febiger, Philadelphia.
4. Mukherjee, K.L., Medical Laboratory Technology. Tata McGraw Hill Publishing Company Ltd. New Delhi.
5. Beck, W.S., Human Design: Molecular, Cellular and Systemic Physiology. Harcourt Brace Jovanovich Inc. New York.
6. Chatterjee, C.C., Human Physiology. Medical Allied Agency, Kolkata.
7. Ganong, W.F., Review of Medical Physiology. Prentice-Hall International, London.
8. Guyton, A.C., Textbook of Medical Physiology. W. B. Saunders Co., Philadelphia, USA.
9. Tortora, G.J. and Grabowski, S.R., 2005. Principles of Anatomy and Physiology. Harper Collins College Publishers, New York.
10. Vander, A.J., Sherman, J.H. and Luciano, D.S., Human Physiology. McGraw-Hill Publishing Co., USA.
11. Garg K., Bahel I. and Kaul M., A Textbook of Histology. CBS Publishers and Distributors, New Delhi.

1.1.6 T COMMUNICATION AND SOFT SKILL DEVELOPMENT (Theory)

(3 hrs / week)

Learning Objective:

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

Knowledge:

1. handle interpersonal relations & communicate effectively.
2. choose career and make appropriate decisions
3. build a repertoire of functional vocabulary and to move from the lexical level to the syntactic level.
4. comprehend the concept of communication
5. *describe* the four basic communication skills – Listening, Speaking, Reading and Writing
6. convert the conceptual understanding of communication into everyday practice
7. become aware of their thinking styles and to enable them to convert thinking into performance.
8. *make* students reflect and improve their use of body language – posture, gesture, facial expression, tone
9. identify, classify and apply relevant soft skills.
10. *illustrate* role of skills in real-life work situations with case studies, role play, etc.

11. identify the concept and components of personality, thereby to apply the acquired knowledge to themselves and to march towards excellence in their respective academic careers.
12. bring out creativity and other latent talents with proper goal setting so that self- esteem gets enhanced.
13. sharpen memory skills and other study skills, which are vital for academic excellence.
14. Identify the concept of positive thinking which will keep the students in a good stead at the time of crisis.

Topic No	Name of the topic and contents	Hrs
1.	Introduction on language and communication: Meaning and importance of communication, Objectives of Communication. Need for Communication. Types of communication. Written & Verbal communication. Formal and informal communication (The grapevine), 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.	Channels of communication: language as a tool for communication. Developing effective messages: Thinking about purpose, knowing the audience, structuring the message, selecting proper channels, minimizing barriers & facilitating feedback.	4
3.	Writing: Selecting material for expository, descriptive , and argumentative pieces, business letters; formal report; summarizing and abstracting ; expressing ideas within a restricted word limit; paragraph division; the introduction and the conclusion; listing reference material; use of charts, graphs and tables ; punctuation and spelling; semantics of connectives, modifiers and modals; variety in sentences and paragraphs. Preparing Agenda and writing minutes for meetings, Case writing and Documentation	6
4.	Technical Communication: Nature, Origin and Development. Salient features. Scope & Significance. Forms of Technical Communication. Difference between Technical Communication & General writing. Objective Style vs. Literary Composition.	4
5.	Business communication: Importance of written business correspondence. General principles and essentials of good commercial correspondence. Different types of commercial correspondence & their drafting. Types of Business letters. Official letters, electronic communication process.	4
6.	Career Skills: Interview skills, Applying for job, Cover letters, Resume	3

	and Effective Profiling, group discussion, letter writing, e-mail writing and email etiquettes.	
7.	Formal written skills: Report writing – preparing rough draft, editing and preparing final report, Office Drafting: Circular, Notice, and Memo. Business correspondence: Enquiry, Order letter, Complaint letter, and Adjustment letter. Defining, Describing Objects & Giving Instructions.	4
8.	Introduction to Phonetics: Introduction to Vowels and Consonants and associated Phonetic symbols. Introduction to Accent, Intonation and Rhythm.	3
9.	Soft Skills: Empathy (Understanding of someone else point's of view) Intrapersonal skills, Interpersonal skills, Problem solving, Reflective thinking, Critical thinking, Negotiation skills, emotional intelligence.	6
10.	Modern Technology and Communication: Globalization of Business, Role of Information Technology. Tele-communication. Internet. Teleconferencing and Video-conferencing.	6
	Total	45 hours

Books Recommended:

1. M.Ashraf Rizvi Effective Technical Communication (Tata McGraw Hill Companies)
2. Bhaskaran & Horsburgh Strengthen Your English (Oxford University Press)
3. Andrea J Rutherford Basic Communication Skills for Technology (Pearson Education Asia)
4. Orient Longman English Skills for Technical Students, WBSCTE with British Council,
5. P.Elijah A hand book of English for professionals. (Pharma book syndicate)
6. Judy Garton-Sprenger B.B.C. English Stage 1 (B.B.C. English)
7. Spoken English in 3 volumes with 6 cassettes, OUP. (CIEFL)
8. T.Balasubramanian A textbook of English Phonetics for Indian Students by (Macmillan)
9. KK Ramchandran Business communication (Macmilan)
10. S R Inthira & V Saraswathi “ Enrich your English – a) Communication skills b) Academic skills “ (CIEFL & OUP)
11. Mohan Krishna & Banerji Meera. Developing communication skills (Macmillan)

1.2.1 T PHARMACEUTICS- II (Theory)

(3 hrs / week)

Learning Objective:

On completion of following theory topics, learner should be able to :

Knowledge :

1. describe the flow of materials in a manufacturing unit by studying the plant layout design
2. explain a technical knowhow of different operations in pharmaceutical manufacturing
3. identify factors and equipments that lead to enhanced filtration
4. elucidate the importance of particle size in pharmacy and suggest methods for size reduction of solids
5. describe the mechanisms of mixing, mixing equipments and suggest measures to overcome failures during mixing operation.
6. characterize powders in terms of their size and size distributions
7. handle different types of packs, materials of packaging available for liquid, powders, tablets and semisolid dosage forms
8. familiarize with good manufacturing practices
9. correlate dosage form design with biological fate of drug by expressing the absorption, distribution, metabolism and excretion of drugs.
10. explain the importance of bioavailability and bioequivalence of drugs

Topic No.	Name of the topic and contents	Hrs.
1	Packaging technology Concept of pack, primary and secondary pack. Types of packaging materials. Unit dose packaging. Packaging of liquid, powders, tablets and semisolid dosage forms. Closures. Evaluation of containers and closures of non sterile formulations as per pharmacopoeia.	8
2	Filtration and clarification Definition and applications of filtration, Factors affecting rate of filtration, types of filter media used, filter aids, filter press, leaf filter, rotary filter & hydro extractors. Clarification and its techniques.	6
3	Size reduction Importance in pharmacy, factors affecting size reduction Grinding mills of various types like Hammer mill, Multi mill, Ball mill, Edge and end runner mill, Fluid energy mill, colloidal mill	5

4	Particle size analysis and size separation Importance and methods of measurement of particle size. Pharmaceutical significance of size separation. Standards of sieves as per official books, Powder gradation, size distribution methods, techniques and equipments for size separation.	6
5	Basis of bio pharmaceuticals Bioavailability and bioequivalence. Concepts and mechanisms related to absorption, distribution, metabolism and excretion.	8
6	Introduction to good manufacturing practices	4
7	Mixing Mixing of liquids, Equipments used in manufacturing & packing of oral solution, liquid mixing- mechanism of mixing, Impeller, Propeller mixers, Paddle mixer, baffles, prevention of aeration & foam. Mixing of powders. Mechanism of powder mixing, factors affecting mixing, sigma & ribbon blender, paddle mixer, tumbler mixers , planetary mixer	6
8	Pharmaceutical plant layout designing Various department in pharmaceutical manufacturing unit. Flow chart and layout of liquid manufacturing and packaging section	2

Recommended Books:

- 1) Walter L. Badger and J.T. Banchemo, Introduction to Chemical Engineering, 7th Edition, 2002, McGraw Hill Book Co., Singapore.
- 2) A R Paradkar, Introduction to Pharmaceutical Engineering, 10th edition, 2007, Published by Nirali Prakashan, Pune.
- 3) Bentley's Textbook of Pharmaceutics, 8th edition, 1996, Edited by E A Rawlins, All India Traveller Book Seller, New Delhi.
- 4) L V Allen, N G Popovich, H C Ansel, Ansel's Pharmaceutical dosage forms & Drug Delivery Systems, 9th edition, 2nd Indian reprint, 2011, Published by Lippincott Williams and Wilkins, Wolters Kluwer (India) Pvt. Ltd., New Delhi.
- 5) Manohar A. Potdar, Pharmaceutical Facilities: Design, Layouts and Validation, 2010 PharmaMed Press An Imprint of Pharma Book Syndicate.

1.2.2 T DOSAGE FORM DESIGN (Theory)

(3 hrs / week)

Learning Objective:

On completion of following theory topics & laboratory experiments, learner should be able to :

A. *Knowledge* :

1. list reasons for the incorporation of drugs into various dosage forms
2. compare and contrast the advantages/disadvantages of various drug dosage forms
3. define solubility and solve problems related to solubility, stability and dissolution rate
4. identify factors that affect drug solubility.
5. describe approaches to optimizing drug solubility.
6. list and describe a variety of types of powders and granules.
7. describe appropriate uses of pharmaceutical powders and granules.
8. describe theoretical aspects of stabilization of emulsions and suspensions
9. describe formulation and evaluation of semisolid dosage forms such as ointments, creams, pastes, jellies and suppositories.
10. identify uses of radiochemistry in pharmaceuticals; related manufacturing and quality control aspects

B. *Skills* :

1. state the correct use of various equipments in Pharmaceutics laboratory relevant to practical's.
2. explain formulation, evaluation and labeling of powders, granules, emulsion, suspension, ointments and liquid preparations.
3. perform pharmaceutical calculations to determine evaluation parameters like density, viscosity, specific gravity, angle of repose, Carr's index, Hausner ratio of preparations.
4. describe use of ingredients in formulation and category of formulation.
5. define and describe the physical characteristics and role of formulation aids in preparation of pharmaceutical suspensions.
6. define and/or identify emulsions, emulsifying agents and describe the levels of instability to which emulsions are subject.
7. describe and/or demonstrate 3 methods of emulsion preparation.
8. describe the use buffers and preservatives in pharmaceutical solutions.
9. draw the labels in neat way including all the component/parts.
10. perform pharmaceutical calculations.
11. summarize the principles of formulation and evaluation.
12. predict the special requirements of preparations regarding the use, handling, storage conditions.

Topic No.	Name of the topic and contents	Hrs.
1	Concept of dosage form design. Conventional dosage forms with examples. Introduction to novel drug delivery systems. Concept of modified release and targeted drug delivery system.	3
2	Powders and granules Types of powders as dosage forms. Properties of powders. Importance and measurement of flow properties. Methods of mixing. Evaluation of powders. Formulation aspects of talcum powder and tooth powder. Importance and methods of granulation. Effervescent granules.	8
3	Emulsions Definition and types, theories of emulsions, formulation aspects, emulsifying agents, HLB and RHLB system, stability and evaluation of emulsions, introduction to microemulsions and self-emulsifying drug delivery system	8
4	Suspensions Definition and types. Stability of suspensions and factors affecting the same. Suspending agents. Suspensions containing poorly wetttable solids, suspensions of precipitate forming liquids. Dry suspensions for reconstitution. Evaluation of suspensions	8
5	Semisolid dosage forms Definitions and types. Formulation and evaluation aspects of ointments, creams, pastes, jellies and suppositories.	10
6	Radiopharmaceutical dosage forms Concept and units of radioactivity, manufacturing and quality control aspects of radiopharmaceutical dosage forms, therapeutic and diagnostic applications.	4
7	Dissolution and solubility Concept and expression of solubility and dissolutions. Concept and mechanism of dissolution. Factors affecting solubility and rate of dissolution. Methods of solubility enhancement.	4

1.2.2 P DOSAGE FORM DESIGN (Practical)

(3 hrs / week)

Guidelines

- 1) Wherever possible, formulations should be prepared as per pharmacopoeia.
- 2) Students are expected to find corresponding marketed preparations along with the contents, name of the manufacturer, study the label and note the shelf life period.
- 3) Evaluation parameters for liquids include organoleptic properties like colour, odour, appearance, pH, weight/ml. Powder evaluation includes organoleptic properties, bulk and

tapped density, angle of repose, Hausner's ratio, compressibility index and compare against standard reference values. Assays and long term evaluations are not expected.

- 4) Semester examination should include a major and a minor experiment.

Experiments

- 1) Visit to pilot plant of the institute.
- 2) Powders: Medicated dusting powder, ORS powder, dry syrup for reconstitution
- 3) Granules: Effervescent granules, wet granulation of lactose, granulation for aspirin tablets
- 4) Emulsions: Liquid paraffin emulsion, oily calamine lotion, emulsion by dry gum method and wet gum method.
- 5) Suspensions: Milk of magnesia, inhalation containing menthol and eucalyptus
- 6) Semisolids: Sulphur ointment, Buffered Cream BP, glycerine suppository, zinc suppository, paracetamol suppository, lubricating Jelly
- 7) Liquid formulated with solubility enhancement: Paracetamol paediatric solubilized drops,

Recommended Books:

- 1) L V Allen, N G Popovich, H C Ansel, Ansel's Pharmaceutical dosage forms & Drug Delivery Systems, 9th edition, 2nd Indian reprint, 2011, Published by Lippincott Williams and Wilkins, Wolters Kluwer (India) Pvt. Ltd., New Delhi.
- 2) M E Aulton, K Taylor, Pharmaceutics: The Science of Dosage Form Design, 2nd edition. Edited by M E Aulton, Published by Churchill Livingstone, 2001.
- 3) Remington: The Science and Practice of Pharmacy, Volumes 1-2, 22nd edition, 2012, Edited by Allen L V, Adeboye A, Shane P D, Linda A F, Jointly published by Pharmaceutical Press and Philadelphia College of Pharmacy at University of the Sciences.
- 4) Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig, The Theory and Practice of Industrial Pharmacy. 3rd edition, 1986, CBS publishers and Distributors, New Delhi.
- 5) Modern Pharmaceutics, 4th edition, revised and expanded, 2009, Edited by G S Banker and C T Rhodes, Published by Informa Healthcare USA Inc. New York.
- 6) A R Paradkar, Introduction to Pharmaceutical Engineering, 10th edition, 2007, Published by Nirali Prakashan, Pune.
- 7) Cooper and Gunn's Dispensing for Pharmaceutical Students, 12th edition, Edited by S J Carter, CBS Publishers and Distributors.
- 8) Atmaram Pawar and R S Gaud, Modern Dispensing Pharmacy, 3rd edition, reprint 2010, Career Publications.
- 9) Indian Pharmacopoeia, 2010, Volumes I, II & III, Published by The Indian Pharmacopoeia Commission, Ghaziabad, Government of India, Ministry of Health & Family Welfare.
- 10) British Pharmacopoeia, 2009, Volumes I-IV and Veterinary, Published by British Pharmacopoeia Commission, the Stationary Office on behalf of Medicines and Healthcare products Regulatory Agency (MHRA), United Kingdom.

- 11) United States Pharmacopeia 35 - National Formulary 30 by United States Pharmacopeia Convention, Volumes I-3.

1.2.3 T PHARMACEUTICAL ORGANIC CHEMISTRY II (Theory)

(3 hrs / week)

Learning Object:

On completion of following theory topic and laboratory experiment learner should able to.

Knowledge

1. explain chemistry ,method of preparation & chemical reactions of aldehyde and ketones.
2. clarify chemistry ,method of preparation & chemical reactions phenols sulphonic acid derivatives.
3. explain and clarify common and IUPAC nomenclatures of different alcohols and ethers. synthesis and general reactions of the alcohols and ethers.
4. memorize chemistry of amines, separation of amines. Outline the synthesis, chemical reactions of amines. Illustrate the use.
5. classify, synthesize of cyanide and isocyanides.
6. memorize reactions related to esters and amide.
7. explain substitution nucleophilic reactions.
8. carify the synthesis, chemical reactions of a given carboxylic acid along with mechanism.

Skill

1. explain and understand the principal behind various qualitative tests and analyze the given unknown organic compounds having different functional groups.
2. able to handle all chemicals carefully.
3. explain and understand the principal, reaction mechanism and illustrate applications of every experiment.
4. understand, explains and apply various laboratory techniques for the synthesis of organic compounds. Students should familiar with various techniques of Purification of the synthesized compound using precipitation or recrystallization.

Sr	Topics	Hr
1	Aldehydes and Ketones: Common and IUPAC nomenclature, general methods of preparation, mechanism of nucleophilic addition and condensation reactions; reactivity of aldehydes and ketones to nucleophilic addition, Acetal, amine, oximes, hydrazones, semicarbazones, enamine – preparation and uses. Addition of Grignard Reagents and hydrides, MPV reduction, Oppenaur oxidation, Aldol condensation, Cannizzarro’s reaction, Reformatsky reaction, Perkin reaction, Knoevenagel reaction, Haloform reaction and Mannich reaction.	12

2	Phenols: Nomenclature, properties, methods of preparation and general reactions.	3
3	Sulphonic acids: Preparation, properties, reactions and uses.	3
4	Alcohols and Ethers: Common and IUPAC nomenclature, properties, methods of preparation, types and general reactions.	4
5	Amines: Common and IUPAC nomenclature, chemistry of amines, separation of amines, methods of preparation, types, general reactions, preparation and use of diazonium salts.	4
6	Cyanides and isocyanides: Structure, nomenclature, preparation, physical properties and chemical reactions.	2
7	Esters and Amides: Mechanism of Claisen and Dieckmann reactions, use of acetoacetic ester and malonic ester in synthesis. Unsaturated compounds: Michael addition and addition of Grignard reagents. Ammonolysis of esters.	4
8	Alkyl halides: Methods of preparation, general reactions, kinetics, mechanism and stereochemistry of SN^1 , SN^2 and SN^i reactions, factors affecting nucleophilic substitution reactions, Substitution Vs Elimination .	6
9	Carboxylic acids (aromatic & aliphatic): Common and IUPAC nomenclature, properties, methods of preparation & reactions. Functional derivatives of carboxylic acids – Acid chlorides, anhydrides, esters & amides – IUPAC nomenclature, general methods of preparation and reactions (along with mechanism), dicarboxylic acid.	7

1.2.3 P PHARMACEUTICAL ORGANIC CHEMISTRY II (Practical)

(3 hrs / week)

Experiments

1. Introduction to identification of Organic compound having different functional groups by qualitative analysis (This should include functional groups taught in theory such as aldehydes, ketones, phenols, carboxylic acid, alcohols and amines). **Minimum eight**
2. Synthesis of following compounds having importance as intermediates in medicinal organic chemistry involving single step reactions, Purification of the synthesized compound using precipitation or recrystallization. **Minimum Six**
 - a. Benzanilide
 - b. Aspirin
 - c. Phenyl cinnamate
 - d. Cinnamic acid
 - e. Acetophenone

- f. Benzophenone oxime
- g. Iodoform
- h. Hippuric acid
- i. Hydrazone

Recommended books:

1. Organic Chemistry by Morrison & Boyd, 6th edition, Pearson Education.
2. Organic Chemistry by Pine, 5th edition, TATA McGraw Hill.
3. Advanced Organic Chemistry: Reaction, Mechanism and Structure by Jerry March 4th edition, A Wiley-Interscience Publication.
4. Advanced General Organic Chemistry a Modern Approach by Sachin Kumar Gosh, Reprinted 2007, New Central Book Agency (P) Ltd, Calcutta.
5. Fundamental of Organic Chemistry by T.W. Graham, Wiley- International, New York.
6. Vogl's Text Book of Practical Organic Chemistry- Brian Furniss, Antony Hannaford, Peter Smith, Austrin (Eds), 5th edition, ELBS Publication, Singapore, 1997.
7. Introduction to Organic laboratory Techniques – a Contemporary Approach by Donald L. Pavia, Gary M. Camp man, Georange S. Kriz (Eds), 2nd edition, C.B.S. College Publishing, USA, 1982.
8. Organic Syntheses by A. H. Blatt (Ed), 6th edition, Vol. 1-10, 1950, John Wiley & sons, London.
9. Advanced Organic Chemistry by Bahl & Bahl, S Chand Publication.
10. Organic Chemistry by I. A. Finar, ELBS Publication.
11. A Guidebook to Mechanism in Organic Chemistry by Peter Sykes Longman Scientific and Technical, Sixth Edition, 1985.
12. Organic Chemistry by Garaham Solomon, Tenth Edition, Wiley India Pvt. Ltd, 2009.
13. Organic Chemistry by John McMurry, Fifth Edition, Brooks/Cole Thomson Learning, 1999.
14. Advanced Organic Chemistry by Francis A. Carey, Part A: Structure and Mechanism, Springer, 2007.
15. Writing Reaction Mechanisms in Organic Chemistry by Audrey Miller, Second Edition, Elsevier Science & Technology Books, 1999.
16. Organic Reactions by Werner E. Bachmann, Volume I, John Wiley and Sons. INC, 1942.
17. Advanced Organic Chemistry Reaction Mechanisms by Reinhard Bruckner, Elsevier, 2002

18. Organic Reactions Stereochemistry and Mechanisms by Kalsi P. S., Forth Edition, New Age International Limited, 2006.
19. Advanced Organic Chemistry, Reactions and Mechanisms by Singh M. S., Second Edition, Dorking Kindersley Pvt. Limited, 2008.
20. Organic Reactions, Mechanisms with Problems by Tyagi Rajpal, First Edition, Discovery Publishing House, 2005.

1.2.4 T HUMAN ANATOMY & PHYSIOLOGY –II (Theory)

(3 hrs / week)

Learning objectives: on completion of following theory topics & laboratory experiments, learner should be able to:

A) Knowledge:

1. illuminate significance of the different mechanisms that govern the normal working of various organs and systems as a whole.
2. explain Basic fundamentals structural features of neurons, mechanism of neurotransmitters along with processes of neuroconduction and neurotransmission.
3. explain detailed structure of brains parts along with role of Autonomous Nervous System involve to maintain the body's order and stability.
4. clarify various sense organs involve in our body to maintain homeostasis.
5. clarify basic organs and mechanism involve in respiration along with clinical significance and disorders of respiratory system.
6. explain the essentials of Urinary systems involve in regulation of Body functions & how all parts of the human body contribute to the maintenance of homeostasis.
7. explain and discuss the role of Endocrine system involve in regulation and functions of hormones to control overall activity of human body.
8. describe organs involve in reproductive system, genetics, and aging process each contributes to the reproduction, growth and development of a human body.

B) Skill:

5. explain correct use and handling of various materials, instruments and equipments.
6. clarify structural and microscopical aspects of various organs of human system.
7. demonstrate and aware the students related various parameters are use to check and regulate the normal functions of Human body.
8. demonstrate with the techniques for identification, counting, determination of various integral components of the body.

Topic No	Name of the topic and contents	Hrs
1	<p>Nervous system:</p> <p>i) Central Nervous System: Organization and functions of nervous system. Fundamentals of neurotransmitters, processes of neuroconduction and neurotransmission. Anatomy and physiology of brain (cerebellum, pons, medulla oblongata, thalamus, hypothalamus, and functional areas of cerebrum), extra pyramidal system, limbic system, Spinal cord (structure and reflexes), cranial nerves (names and functions).</p> <p>ii) Autonomous Nervous System: general organization of sympathetic and parasympathetic nervous system, autonomic reflexes, disorders of nervous system (definitions only)</p>	16
2	<p>Special Sense organs:</p> <p>Anatomy and physiology of ear, eye, tongue, nose and skin.</p>	06
3	<p>Respiratory system:</p> <p>Pulmonary ventilation, anatomy and functions of respiratory organs, mechanism and control of respiration, transport and exchange of gases, vital capacity, respiratory volumes and their clinical significance and disorders of respiratory system (definitions only)</p>	05
4	<p>Urinary system:</p> <p>The body fluid compartments, anatomy and physiology of urinary system, Mechanism of urine formation, importance of renin-angiotensin system, acid base, electrolyte and water balance, renal clearance tests, physiology of micturition, disorders of urinary system (definitions only)</p>	05
5	<p>Endocrine system:</p> <p>Anatomy and physiology of endocrine glands, regulation and functions of endocrine hormones-neurohumoral control, disorders of endocrine system (definitions only)</p>	08
6	<p>Reproductive system:</p> <p>Structure, function and location of the organs of male and female reproductive systems, major events of female reproductive cycle, process of spermatogenesis, oogenesis and follicular development, physiology of breast development and lactation</p>	05

Recommended Books:

1. Chatterjee, C.C., Human Physiology. Medical Allied Agency, Kolkata.
2. Ganong, W.F., Review of Medical Physiology. Prentice-Hall International, London.
3. Guyton, A.C., Textbook of Medical Physiology. W. B. Saunders Co., Philadelphia, USA.
4. Tortora, G.J. and Grabowski, S.R., 2005. Principals of Anatomy and Physiology. Harper Collins College Publishers, New York.

5. Vander, A.J., Sherman, J.H. and Luciano, D.S., Human Physiology. McGraw-Hill Publishing Co., USA.
6. Waugh, A. and Grant, A., Ross and Wilson's Anatomy and Physiology in Health and Illness. Churchill-Livingstone, London.
7. West, J.B., Best and Taylor's Physiological Basis of Medical Practice. Williams and Wilkins, Baltimore, USA.
8. Warwick, R. and Williams, P., Gray's Anatomy. Longman, London.
9. Chaudhari S K. Concise Medical Physiology. New Central Book Agency (P) Ltd., Calcutta.
10. Godkar P.B and Godkar D.P., Textbook of Medical Laboratory Technology. Bhalani Publishing House, Mumbai.
11. Joshi V.D. Practical Physiology. Vora Medical Publications, Mumbai.
12. DiFiore-Mariano S.H., Atlas of Human Histology. Lea and Febiger, Philadelphia.
13. Garg K., Bahel I. and Kaul M., A Textbook of Histology. CBS Publishers and Distributors, New Delhi.
14. Goyal, R.K., Patel, N.M. and Shah, S.A., Practical Anatomy, Physiology and Biochemistry. B. S. Shah Prakashan, Ahmedabad.
15. Ranade, V.G., Joshi, P.N. and Pradhan, S., Textbook of Practical Physiology. Pune Vidyarthi Griha Prakashan, Pune.
16. Singh, I., BD., Chaurasia's Human Anatomy. CBS Publisher and Distributors, New Delhi.
17. Singh, I., Textbook of Human Histology. Jaypee brothers Medical Publishers, New Delhi.
18. Upasani, C.D. and Undale, V., Human Anatomy and Physiology. Tech-Max Publications, Pune.
19. Mukherjee, K.L., Medical Laboratory Technology. Tata McGraw Hill Publishing Company Ltd. New Delhi.
20. Beck, W.S., Human Design: Molecular, Cellular and Systemic Physiology. Harcourt Brace Jovanovich Inc. New York.

1.2.4 P HUMAN ANATOMY & PHYSIOLOGY –II (Practical)

(3 hrs / week)

Experiments

- 1 Determination of osmotic fragility of Red Blood Cells
- 2 Determination of platelets.
- 3 Determine differential WBC count
- 4 Determination of reticulocytes.

- 5 Determination of Arneith Index.
- 6 To study the human skeleton (axial)
- 7 To study the human skeleton (appendicular)
- 8 To study different types of joints
- 9 To study central nervous system with the help of chart, model and histological slides
- 10 To study the autonomous nervous system with the help of chart
- 11 Determination of tidal volume & vital capacity by using Hutchinson spirometer
- 12 To determine the pH of urine sample by pH meter
- 13 To study of family planning devices
- 14 Visit to Medical College and/or Hospital (Optional)
- 15 First aid demonstration.

Recommended Books:

1. Godkar P.B and Godkar D.P., Textbook of Medical Laboratory Technology. Bhalani Publishing House, Mumbai.
2. Joshi V.D. Practical Physiology. Vora Medical Publications, Mumbai.
3. DiFiore-Mariano S.H., Atlas of Human Histology. Lea and Febiger, Philadelphia.
4. Mukherjee, K.L., Medical Laboratory Technology. Tata McGraw Hill Publishing Company Ltd. New Delhi.
5. Beck, W.S., Human Design: Molecular, Cellular and Systemic Physiology. Harcourt Brace Jovanovich Inc. New York.
6. Chatterjee, C.C., Human Physiology. Medical Allied Agency, Kolkata.
7. Ganong, W.F., Review of Medical Physiology. Prentice-Hall International, London.
8. Guyton, A.C., Textbook of Medical Physiology. W. B. Saunders Co., Philadelphia, USA.
9. Tortora, G.J. and Grabowski, S.R., 2005. Principals of Anatomy and Physiology. Harper Collins College Publishers, New York.
10. Vander, A.J., Sherman, J.H. and Luciano, D.S., Human Physiology. McGraw-Hill Publishing Co., USA.
11. Garg K., Bahel I. and Kaul M., A Textbook of Histology. CBS Publishers and Distributors, New Delhi.

1.2.5 T PHARMACOGNOSY (Theory)

(3 hrs / week)

Learning objectives: on completion of following theory topics & laboratory experiments, learner should be able to:

A) Knowledge:

1. Illuminate relevance & significance of biology to Pharmaceutical Sciences.
2. Clarify principles of genetics & explain how these can be applied in crop improvement process.
3. Explain basic components of cell, their functions & fundamental processes of cell division.
4. Clarify on basic tissues & tissue systems & apply that knowledge in understanding of anatomy of different parts of plant.
5. Explain modes of nutrition & how these influence in evolution of chemical defense in autotrophs. Explain basic photosynthetic process.
6. Explain need, approaches of classification along with their merits & demerits. Explain significance of internationally accepted standards of nomenclature.
7. Comprehend & explain how ecosystem is composed, working & degrading. Learner should also be able to explain remedies to get rid from ecosystem & environmental degradation in general & Western Ghats in particular.
8. Explain meaning of term 'Pharmacognosy' & also explain its development, linkages to other branches of sciences & significance of study of natural products.

B) Skill:

1. Explain correct use of various equipments in Pharmacognosy laboratory.
2. Handle simple/compound/digital microscope in technically correct way.
3. Demonstrate skill of plant material sectioning, staining, mounting & focusing.
4. Decide on staining reagents required for specific part of plant.
5. Identify the parts of plants from its morphological & microscopical features by applying experimental & theoretical knowledge of morphology & anatomy obtained in theory classes.
6. Draw morphological & microscopical diagrams & able to label component/parts.
7. Explain significance of qualitative microscopy & its social relevance.
8. Demonstrate skill of preparation & labeling of herbarium specimen & explain its significance.
9. Explain how to prepare sample for microtome sectioning & demonstrate handling of microtome.

Topic No	Name of the topic and contents	Hrs
1.	<i>Biology & Pharmaceutical Sciences:</i> Introduction to important branches of biology, under-disciplinary subjects, applied biology, applied botany (economic botany); relevance of biology to Pharmaceutical sciences.	3
2.	<i>Principles of Genetics:</i> History of structure of DNA, DNA structure, replication & transcription, genetic code, RNA translation, protein structure & function, molecular basis of hereditary, Mendelian genetics.	5
3.	<i>Plant cell & cell division:</i> Structure of cell & functions of component; ergastic cell contents (secretory, excretory products & reserve materials); Cell division (mitosis & meiosis).	4
4.	<i>Cell differentiation & plant tissues:</i> meristematic & permanent tissues; types, structure & functions of permanent tissues & tissue systems; primary & secondary growth.	3
5.	<i>Plant description, morphology & anatomy:</i> Leaves & tops (herbs), barks, wood, leaves/leaflets, inflorescences & flowers, fruits, seeds, subterranean organs, unorganized drugs.	6
6.	<i>Plant Physiology:</i> Mode of nutrition: autotrophic, heterotrophic, saprophytic, parasitic; Photosynthesis & chemosynthesis; significance, site & pathways involved in photosynthesis; plant growth regulators (phytohormones) auxin, gibberellins, cytokinins, ethylene and abscisic acid.	7
7.	<i>Plant taxonomy:</i> Need of classification, historical account of contribution to botanical systems of classification, artificial & natural methods of classification, divisions of plant kingdom, binomial nomenclature.	4
8.	<i>Ecology and Environment:</i> Ecosystems: types, dynamics, degradation, ecological succession; food chains and energy flow; vegetation types of the world, pollution and global warming, speciation and extinction, conservation strategies, phytoremediation, overview of significance of Western Ghat biodiversity & factors responsible for rapid degradation of habitats of Western Ghats.	6
9.	<i>Application of genetics to crop improvements:</i> Hybridization & Mutation/Polyploidy breeding.	3
10.	<i>Introduction to Pharmacognosy:</i> Definition, history, development, status, scope & significance; Crude drugs: definition & classification.	4

1.2.5 P PHARMACOGNOSY (Practical)

(3 hrs / week)

Experiments

1. Introduction of microscope and other equipments used in Pharmacognosy practical.
2. Introduction to parameters to morphological study; microscopical study (preliminary treatment, preparation of specimen of surface tissues, transverse/longitudinal sections, disintegration of tissues; Clarification of microscopic particles; various staining techniques; use of polarizing filters)
3. To study microscopical details of epidermal structures (epidermis, cuticle, stomata, trichomes; (Min. 2 Expt.)
4. To study microscopical details of cell inclusions such as starch grains, calcium oxalate crystals (Min. 2 Expt.)
5. To study morphology & microscopy of parts of plants indicated in theory syllabus (comparative study of T.S. of monocotyledon & dicotyledonous stems; stems & roots; leaf, barks, flowers, fruits, seeds etc.) (Min. 6 Expt.)
6. Introduction to techniques in preparation of herbarium specimen & its significance. To prepare & submit herbarium specimen of any one plant).
7. Use of microtome in preparation of sections (Demonstration).

Recommended Books (Practical's):

1. Brain K.R. & Turner T.D., **The Practical Evaluation of Phytopharmaceuticals**, Wright-Scientifica, Bristol, 1975.
2. Khandelwal K. R., **Practical Pharmacognosy**, Pragati Books Pvt. Ltd., Pune, ISBN 8185790302.
3. Kokate C. K., **Practical Pharmacognosy**, Vallabh Prakashan, 1993.
4. Wallis T. E., **Practical Pharmacognosy**. J.A. Churchill Ltd., London, 1953.

1.2.6 T PHARMACEUTICAL ANALYSIS I (Theory)

(3 hrs / week)

Learning objectives: on completion of following theory topics & laboratory experiments, learner should be able to:

A) Knowledge:

1. illuminate relevance & significance of Analytical Chemistry to Pharmaceutical Sciences.
2. clarify basic principles of data treatment and data handling.
3. explain basic concepts and principles of aqueous acid base titrations.
4. clarify need and basic principles of non-aqueous acid base titrations.
5. clarify different terms, types and basic principles of precipitation titrations.
6. explain concept and reaction conditions for complexation.
7. understand the basic concepts and applications of redox reactions.
8. understand and explain the difference between precipitation and gravimetric analysis.

B) Skill:

1. clarify and understand the correct use of laboratory equipments with calibration of various apparatus used in Analytical Chemistry laboratory together with safety measures to be followed.
2. develop practical hand in titrimetric analysis by estimation of analyte concentration in pure form and in formulation with thorough understanding of principle and procedure used in different titration methods such as aqueous, non-aqueous, precipitation, complexometric, redox titration methods.
3. understand the principle with quantitative estimation of analyte by gravimetric analysis.

Sr	Topics	Hr
1	Introduction to Analytical Chemistry- Review of fundamental aspects- qualitative, quantitative analysis, Types of quantitative analysis, Normality, Molarity, Molality, Mole fraction, Molecular weight, Equivalent weight, Expression of concentration and strength of solution, Primary and secondary standards.	4
2	Introduction to Statistical Treatment of Analytical Data Accuracy and precision, errors and their types, significant figures, standard deviation, confidence limit, test of significance, rejection of a result, correlation coefficient and coefficient of determination.	3
3	Acid Base Titration Theories, acid - base equilibria in water, the pH scale, distribution of acid- base species with pH, weak acids & bases, salts of weak acids & bases, buffers, polyprotic acids and their salts. Acid base titration curves for strong acid-strong base titration, weak acid-strong base titration,	10

	weak base - strong acid titration, titration of polyfunctional acids and bases, acid - base indicators, titration of amino acid.	
4	Non-aqueous Acid Base Titration Dissociating and non-dissociating solvents, acid - base character, leveling and differentiating effects, solvents, titrants & indicators used in determination of acids & bases.	3
5	Precipitation Reactions and Titration Solubility of slightly soluble salts, solubility product, effect of pH, temperature and solvent on solubility of salts, common ion effect, calculation of titration curves, indicators used, argentometric titration and titration involving ammonium and potassium thiocyanate, Mohr's method, Volhard's method and Fajan's method.	6
6	Complexometric Reactions and Titration Complexes and stability constants, chelates, metal-EDTA titration curves, metal indicators, types of complexometric titration.	5
7	Oxidation - Reduction Reactions and Titration Half reactions, Nernst equation, redox equivalent weights, redox indicators, titration with potassium permanganate, cerimetry, potassium dichromate, iodine, periodic acid, potassium bromate Titration, Sodium Nitrite Titration, Titanous Chloride Titration.	10
8	Gravimetric Methods Principles, formation and properties of precipitates, Unit operations in gravimetry, organic precipitants.	4

1.2.6 P PHARMACEUTICAL ANALYSIS I (Practical)

(3 hrs / week)

Experiments

- Introduction to calibration, care and use of balances, methods of weighing and errors in weighing.
 - Cleaning, care and calibration of volumetric apparatus.
- Acid-base Titration - Preparation and standardization of acids and bases using primary standards, estimation of Aspirin I.P./ Sodium bicarbonate Injection I. P.
- Non-aqueous Titration – Preparation and standardization of perchloric acid and sodium/potassium / lithium methoxide and estimations of Sodium Salicylate I.P./ Diclofenac sodium I. P./ Ephedrine hydrochloride I. P.
- Precipitation Titration – Preparation and standardization of silver nitrate and ammonium thiocyanate, Mohr's method, Volhard's method and Fajan's method. Estimation of Sodium Chloride Irrigation solution I.P./ Sodium Chloride Injection I.P.
- Complexometric Titration – Preparation and purification of disodium edetate and estimations of Calcium lactate Tablet I.P./ Calcium gluconate I.P.

6. Oxidation- Reduction Titration – Preparation and standardization of redox titrants like potassium permanganate, potassium dichromate, iodine, sodium thiosulphate and estimations of Hydrogen peroxide solution I.P./Ascorbic acid I.P./ Sodium metabisulphite I. P.
7. Gravimetric determination of Piperazine Phosphate (as per IP)/ Barium as Barium sulphate / Thiamine Hydrochloride

References:

1. Vogel's Text Book of Quantitative Chemical Analysis, 6/Ed., Pearson Education.
2. Quantitative analysis by V. Alexyev, Student Edition, CBS Publisher & Distributors.
3. Fundamentals of Analytical Chemistry by Skoog, West, Holler, Harvest, 8/Ed., Thomson Brookscole.
4. Pharmaceutical Analysis by Higuchi, Reprint 2004, CBS Publisher & Distributors.
5. The quantitative analysis of drugs by Garrat DC, 3/Ed., CBS Publisher & Distributors.
6. Quantitative Analysis by Day R A & Underwood A L. 5/Ed., Prentice Hall of India Pvt. Ltd. New Delhi.
7. Analytical Chemistry by Christian G D, 6/Ed., John Wiley & Sons.
8. A Textbook of Pharmaceutical Analysis by Connors KA, 4/ed., John Wiley & Sons.
9. Practical Pharmaceutical Chemistry Part-I by Beckett A H & Stanlake J B, 4/Ed., CBS Publisher & Distributors.
10. Pharmaceutical Analysis Vol. II & K. R. Mahadik, S.G. Wadodkar, H. N, More, Nirali Prakashan.
11. Pharmaceutical Drug Analysis by Ashutosh Kar, First Print, 2001, Minerva Press, New Delhi.
12. Indian Pharmacopoeia, 6th Edition, 2010, The Indian Pharmacopoeia Commission, Ghaziabad.