

SYLLABI OF BACHELOR OF PHARMACEUTICAL SCIENCES

THIRD YEAR B. PHARMACY

3.1 (T) PHARMACEUTICS-II (Theory) 90 Hrs. (3 hrs per week)

| Topic No | SECTION-I | Hrs. |
|----------|---|------|
| 1. | <p>Concept of Formulation Design:</p> <p>a) Preformulation: Introduction, General consideration, Preliminary evaluation & molecular optimization, Bulk characteristics, Solubility analysis, Stability analysis.</p> <p>b) Design of Dosage Form: Principles, Dosage form design, Biopharmaceutical & Therapeutic aspects of dosage form design.</p> <p>c) Study of excipients: Introduction, classification & selection criteria</p> | 5 |
| 2. | <p>Stability studies:</p> <p>Concept of stability studies.</p> <p>a) cGMP & ICH guidelines for Accelerated stability Testing.</p> <p>b) Interaction of containers & closure Compatibility Testing</p> | 5 |
| 3. | <p>III. Solid Dosage Forms:</p> <p>A. Tablets:</p> <p>Introduction, Advantages & Disadvantages, Types of tablets.</p> <p>Formulation development: Preformulation of drugs & additives. Introduction to tablet additives. Need of granulation. Mechanisms, Manufacturing processes and Equipments for Wet granulation and Dry granulation processes. Advanced granulation techniques - Extrusion, spheronization, Pelletization, Spherical crystallization, Fluidized bed granulation, Melt solidification & granulation. Characterization and Evaluation of granules. Mechanism, Manufacturing process and Equipments for Direct compression technique. Physics of Tablet compression. Tablet compression machines. Formulation and manufacture of Chewable tablets, Effervescent tablets, Dispersible tablets, Mouth dissolving tablets, Layered & Compression coated tablets. Manufacturing problems & remedies thereof. Packaging & labeling- strip, blister & bulk packaging. IPQC for tablets. Evaluation of tablets as per IP, BP, USP</p> | 20 |
| | <p>Tablet Coating:</p> <p>Introduction and concept of tablet coating. Types of tablet coating including Sugar, Film & Enteric coating. Material, processes employed & equipments for tablet coating. Manufacturing problems & remedies during tablet coating. Evaluation of coated tablets.</p> | 4 |
| | Layout of tablet manufacturing section. | 1 |
| | <p>B. Capsules:</p> <p>a) Raw material for capsule shell: Manufacturing of gelatin for capsule. Introduction and concept of size selection of capsules. Selection criteria</p> | 10 |

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| | <p>and size selection of capsules (with examples)</p> <p>b) Hard gelatin capsules: Preparation of hard gelatin capsule shell, standards & defects thereof. Formulation & development: Filling, processing & capsule filling equipments. Problems in capsule filling & remedies thereof. In process quality control & quality control parameters.</p> <p>Soft gelatin capsules: formulation and development, manufacturing, processing & equipment. In process quality control & quality control parameters. Packaging & labeling of capsules: Strip, Blister & Bulk Packaging.</p> | |
| SECTION- II | | |
| 1. | <p>Disperse systems: Free energy consideration, thermodynamic v/s kinetic stability. Classification of disperse system.</p> | 2 |
| | <p>A) Suspensions: Physicochemical principles. Theory of suspension: DLVO theory. Wetting, Sedimentation, Flocculated & Deflocculated system. Structured vehicle, particle size, particle charges & caking in suspensions. Importance of changes in solubility because of changes in particle size, polymorphic form, temp. Preformulation data. Formulation development, manufacturing, packaging & equipments employed for the same. Rheology of suspensions. Formulations of pharmaceutical suspensions (oral & topical), suspending agents, wetting agents, dispersants, deflocculating & flocculating agents. Evaluation of suspensions. Quality control standards.</p> | 10 |
| | <p>B) Emulsions: Physicochemical principles. Theory of emulsification. Creaming, coalescence, cracking, destabilization kinetics, role of viscosity, energy barriers to coalescence. Film barriers, steric stabilization. Emulsifier & choice of emulsifier, HLB value & phase inversion temperature. Multiple emulsions. Evaluation of emulsion, stress testing. Packaging of emulsions.</p> | 6 |
| | <p>C) Suspension & emulsion manufacturing equipments: Mechanical stirrers, homogenizers, colloid mill, foaming removal.</p> | 2 |
| | <p>D) Layout and designing of manufacturing facility for suspension and emulsion.</p> | 1 |

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| 2. | <p>Semisolids: Properties of drugs, semisolid bases and additives, Selection of bases and additives for ointment, cream, paste and gels. Percutaneous absorption. Formulation and development, manufacturing of Ointment, Cream, Paste and Gels. Processing equipments for ointment, cream, paste and gels. In process quality control & quality control parameters, skin irritation test, packaging & labeling.</p> | 8 |
| 3. | <p>III) Cosmetics & Cosmeceuticals:</p> <p>A) Cosmetics: Cosmetics v/s drug formulation. Type of cosmetics. Formulation, manufacturing & safety testing & quality control of following cosmetics. Skin products: Moisturising, cleaning, cold, vanishing, face pack, anti wrinkle, antiperspirants, deodorants, suntan,& sunscreen preparations. Hair products: Shampoos, hair tonics, hair dyes, depilatories, shaving preparations. Eye products: Eye mascara, eye shadow, eye liner, eyebrow pencil. Lip product: Lipstick. Manicure products: Nail lacquer, Lacquer remover.</p> | 12 |
| | <p>B) Cosmeceuticals: Introduction, Definition and difference from cosmetics. History of cosmeceuticals. Cosmeceutical Agents- Retinoids, hydroxyl acids, beta hydroxyl acids, Antioxidants and others. Recent developments in Cosmeceuticals.</p> | 4 |

3.1 PHARMACEUTICS-II

(Practical) 90 Hrs. (3 hrs/week)

- I) Raw material testing of any 5 Experiments
- II) Formulation, Preparation and Evaluation of the following dosage forms.

1. Suspensions

- Calamine lotion
- Milk of Magnesia
- Paracetamol Suspension
- Antacid Suspension

Evaluation Parameters: Sedimentation volume, Organoleptic Properties, pH, Viscosity, Stability, and assay of any one preparation

2. Emulsions

- Liquid paraffin oral Emulsion
- Turpentine Liniment
- Formulation of Emulsion (HLB Consideration)

Evaluation Parameters: Organoleptic Properties, pH, Globule size, wt/ml, and assay of any one preparation

3. Semisolids

- Pain balm

- Antifungal ointment/cream
- Medicated Gel
- Antiacne preparation
- Non staining Iodine ointment with Methyl Salicylate

Evaluation Parameters: pH, Spreadability, Organoleptic properties and assay of any one preparation

4. Tablets

- Aspirin – Using non aqueous binder solution
- Paracetamol – By Wet granulation
- Chewable, Dispersible, Effervescent Tablets

Evaluation of granules- Angle of repose, Particle size, Densities and Carr's Index

Evaluation of Tablets: Hardness, Friability, Weight variation, Tablet porosity, Dimensions, Disintegration time, Dissolution time. Assay and Uniformity of content of any one preparation.

5. Capsules

- Ferrous Fumerate Capsules
- Antibiotic Capsules

Evaluation of Empty and Filled Hard gelatin capsule shell.
Evaluation of capsule- Weight variation, dissolution time

6. Tablet Coating (Demonstration)

7. Cosmetics

- Cold cream
- Vanishing cream
- Shampoo
- Tooth Paste
- Saving cream
- Moisturising cream
- Sunscreen cream/lotion
- Lip stick
- Eye shadow, Eye liner, Eye Mascara
- After shave lotion
- Nail lacquer

Evaluation Parameters: Organoleptic properties for all preparation.
Foam test for shampoo and shaving cream
Film formation test for lipstick and eye preparation.

Recommended Books

1. Remington "The science and practice of pharmacy" 21st edition, Mack publishing company, 2005.

2. James J.Wells “ Pharmaceutical Preformulation : The physicochemical properties of drug substances “ Ellis Horwood, Chichester, UK,1988
3. www.ich.org
4. H.C.Ansel; N.G.Poporich; L.V.Allen “Pharmaceutical dosage forms and Drug Delivery systems” 9th edition, Wolters kluwer/ Lippincott Williams and wilkins, 2009.
5. L.Lachman; H.A.Liberman; J.L.Kanig “The Theory and Practice of Industrial Pharmacy” 3rd edition; Verghese publishing House, Mumbai 1991. / Special Indian edition, 2009.
6. M.E.Aulton “Pharmaceutics –The design and manufacture of medicines” 3rd edition; Churchil livingstone, 2007.
7. Bentley’s “Test book of Pharmaceutics” Bailliere Tindall; 8th edition; ELBS Publication, 1996.
8. G.S.banker, R.K.Chalmers “Pharmaceutics and Pharmacy Practice “J.B.Lippincott Company, Philadelphia, PA, 1982.
9. J.Swarbrick; J.C.Boylan” Encyclopedia of pharmaceutical technology” Vol.1; Marcel Dekker, 1998.
10. K.Ridgway “Hard Capsules Development and Technology” The Pharmaceutical Press, London, UK, 1987.
11. H.A.Lieberman, L.Lachman and J.B.Schwartz “Pharmaceutical dosage forms: Tablets” Marcel Dekker, Vol. I, II, III 1998.
12. L. L. Augsberger, S. W. Hoag “Pharmaceutical Dosage Forms: Tablets” 3rd edition, Informa Healthcare, Vol. I, II, III 2008.
13. Lieberman, Riser and Banker “Pharmaceutical Dosage forms and Disperse system” Marcel Dekker; Vol. I, II, III 1988.
14. J.Knowlton and S.Rearce “ Handbook of cosmetic science and technology” 1st edition; Elsevier science publisher; oxford, UK, 1993
15. J.B.Wilkinson and R.J.Moore “Harry’s Cosmetology” 7th edition; Longman science and technical, London 1982.
16. P. P. Sharma, “Cosmetic Formulation, Manufacturing and Quality Control” 7th edition, Vandana publication, 2001.
17. E.G.Thosmsen” Modern cosmetics Universal Publishing Corporation.
18. J. B. Wilkinson, R. J. Moore, “Harry’s Cosmetology”, 7th edition, Longman Scientific and Technical, 1994
19. L.Appell “The formulation and preparation of cosmetics, fragrance and flavours” Micelle press
20. W.A.Pocher” Poucher’s Perfumes, Cosmetics and Soaps” Vol.III; Chapman and Hall
21. Dr. Laba “Rheological properties of cosmetics and toiletries” Marcel Dekker.
22. “Indian Pharmacopoeia” 2007, Vol. I, II, III. Indian Pharmacopoeia Commission, Government of India, Ministry of Health and Family Welfare.
23. “USP 30 NF 25 The United States Pharmacopoeia” 2007, Vol. I, II, III. National formulary publication of US Pharmacopoeia.
24. “British Pharmacopoeia” 2005, Vol. I, II, III, IV. Stationary office on behalf of Medicine and Healthcare Product Regulatory Agency (MHRA).

3.2 PHARMACEUTICAL BIOTECHNOLOGY

(Theory) 60 Hrs. (2 hrs per week)

| Topic No | SECTION-I | Hrs. |
|--------------------|--|------|
| 1. | Introduction to Biotechnology, Scope, Potential & Achievements | 1 |
| 2. | Genetic Engineering : | |
| | 2.1 Recombinant DNA technology :- Gene cloning :- Introduction, enzymes acting on DNA (restriction endonucleases, S ₁ nuclease, alkaline phosphatase, polymerase, ligase, reverse transcriptase), types of cloning vectors, expression vectors (expression vectors in brief), transformation & growth of cells, Selection of clones (screening methods). | 4 |
| | Gene transfer: - Introduction & Types (Direct & Indirect gene transfer methods) Ti & Ri plasmid mediated gene transfer. | 4 |
| | 2.2 Genetic Engineering techniques :- Isolation of DNA, Genomic & cDNA libraries, Gel electrophoresis, DNA Hybridization, Blotting techniques, polymerase chain reaction (PCR) Site directed mutagenesis, Restriction Fragment Length Polymorphism (RFLP), Human Gene therapy, DNA fingerprinting. Gene synthesis & gene machine, Gene sequencing methods. | 8 |
| 3. | Plant Cell and Tissue Culture:- | |
| | 3.1 Introduction to plant cell, media & laboratory requirements for tissue culture | |
| | 3.2 Types of cultures:- Callus, suspension, meristem, root-tip, hairy root, haploid cultures, anther cultures /Pollen grains (Introduction, methodology & applications of above types) | 8 |
| | 3.3 Protoplast culture & protoplast fusion & application Transgenic Plants introduction, Method, Application) | |
| | 3.4 Germplasm storage & cryopreservation | |
| 4. | Animal Cell Culture | |
| | 4.1 Introduction, isolation of cells, preparing cells in culture, established cell lines, culture media for animals, Role of blood plasma & serum, Preparation of chicken serum, mammalian serum & embryo extract. | 5 |
| | 4.2 Introduction to transgenic animals and their applications | |
| SECTION- II | | |
| 5. | Immunotechnology | |
| | 5.1 Vaccines Why vaccines? How it works? Traditional vaccine approaches, Subculture and recombinant vaccines, Future directions, Edible vaccines | 7 |
| | 5.2 Hybridoma technology, Preparation of Monoclonal Antibodies and its | |

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| | applications 5.3 Immunoassay by different techniques- Enzyme Linked Immuno Sorbant Assay (ELISA), Radio Immuno Assay (RIA), Immunofluorescence | |
| 6. | Enzyme Technology Introduction to enzyme, Immobilization of enzyme & its applications | 2 |
| 7. | Fermentation Technology 7.1 Study of methods at sterilization details & their applications to Pharmaceutical Manufacturing 7.2 Fermentation as a biochemical process – Fermenter, its material of construction, Accessory components and working, Down streaming Processing (Product Recovery and Processing), Fermentation discharge and Effluent treatment 7.3 General Application of fermentation in Manufacturing of Antibiotics (penicillin, Streptomycin, Tetracycline), Dextran, Vitamins (Vitamin B ₂ and Vitamin B ₁₂) | 10 |
| 8. | Healthcare Biotechnology:- 8.1 Examples of Biotechnology derived Products: Human insulin, Somatotropin, Interferons, Biogenetic drugs (Production and uses) 8.2 Purification Toxicity studies in establishing safety and efficacy in biotechnological Products. 8.3 Introduction to collection, processing, and storage of blood and blood products | 6 |
| 9. | Biotechnology and Ethics :- 9.1 Social & ethical issue in Pharmacy, Agriculture, Energy & Environment. 9.2 Humans:-Artificial Insemination (AI), <i>In-vitro</i> Fertilization & embryo Transplants, Surrogate motherhood, Freezing germ cells, Human Embryos and Cloning (Facing Problems and finding solutions) | 5 |
| | Total | 60 |

Recommended Books:

1. Olive Kaiser ,Rainer Muller, Pharmaceutical Biotechnology: Drug Discovery and Clinical Application, Wiley VCH publisher, 2004
2. Peter J. Russel, Genetics 5th Edition ,The Benjamin Cummins Publishing California;1998
3. Watson WH Freeman and company N.Y. Recombinant DNA 2nd edition Holtzbrinck Publishers 1992
4. Gliek, Molecular biotechnology 3rd edition ASM press Washington, USA 2003

5. Vyas and Dixit Pharmaceutical Biotechnology, 1st CBS Publisher New Delhi, 1991
6. Dr. S. Iganacimuthu, Basic Biotechnology – Tata McGraw Hill Publishers
7. P. K. Gupta, Elements Of Biotechnology, Rastogi Publication, 10th edition, 2004
8. S.S. Purohit, Biotechnology Fundamentals and Applications Student edition Agrobios Publisher;2002
9. H. S. Chawala, Introduction of Plant Biotechnology, 2nd edition, IBH Publishing Co. Pvt.Ltd. New Delhi, 2002
10. M.H. Razdan, Introduction to Plant Biotechnology , 2nd edition Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi. 2003
11. K. Sambamurthy, Ashutosh Kar, Pharmaceutical Biotechnology, 2nd edition New AGE International (LP) Limited, 2007.

3.3 MEDICINAL CHEMISTRY –I

(Theory) 90 Hrs. (3 hrs per week)

| Sr. No | SECTION- I | Hrs. |
|--------|--|------|
| 1 | General considerations: Structure of biological membrane, Selected physicochemical properties affecting drug action; solubility, partition coefficient, Ferguson principle, stereo chemical aspects of drug action, Bioisosterism, Drug absorption; distribution, metabolism and elimination, Protein binding, Blood brain barrier. | 06 |
| 2 | Receptors: Types of receptors, Types of forces involved in drug receptor interaction; intracellular cyclic nucleotides and other mediators of biological response, Transduction mechanism. | 04 |
| 3 | History and general aspects of the design & development of drugs including classification, nomenclature, structure activity relationship (SAR), mechanism of action, adverse effects, therapeutic uses, and recent developments of following categories. Biochemical approaches in drug designing wherever applicable should be discussed. | |
| 3.1 | Cholinergic agonists and antimuscarinic agents: Neurotransmitters, impulse, Biosynthesis of acetylcholine, its release and metabolism. Cholinergic agonists: Receptor subtypes and their structural features, Cholinergic antagonists, cholinesterase inhibitors, Antimuscarinic agents: Ganglionic Blockers and neuromuscular blockers: Ganglionic stimulants, Ganglionic transmission, Ganglionic blockers and nicotinic receptors. Neuromuscular blockers | 09 |
| 3.2 | Adrenergic agonists and antagonists: Biosynthesis, release and metabolism of noradrenaline, Receptor subtypes and their structural features. | 07 |
| 3.3 | Cardiovascular drugs a. Cardiotonic drugs b. Antianginal agents c. Antiarrhythmic agents d. Antihypertensive agents e. Currently used Anti-lipedemic drugs | 12 |
| 3.4 | Diuretic agents | 05 |

| SECTION- II | | |
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| 3.5 | CNS Stimulant Drugs a. Analeptics and respiratory stimulants b. Hallucinogens | 04 |
| 3.6 | CNS Depressant Drugs a. General anesthetic agents b. Sedative & Hypnotic agents c. Anticonvulsants | 06 |
| 3.7 | Drugs used in Neurodegenerative diseases a. Parkinson's disease b. Alzheimer's disease | 05 |
| 3.8 | Psychotherapeutic agents a. Antipsychotic agents b. Antidepressant agents c. Anxiolytic agents | 06 |
| 3.9 | Local anesthetic agents | 05 |
| 3.10 | Anti-migraine agents | 02 |
| 3.11 | Diagnostic agents: Radio Opaque diagnostic agents, Agents for organ function test, Miscellaneous diagnostic agent. | 03 |
| 3.12 | Oral hypoglycemic drugs (including insulin) | 05 |
| 3.13 | Prodrugs, soft drugs and hard drugs | 03 |
| 4 | Scheme of synthesis of following drugs from various therapeutic categories: Carbachol, dantrolene sodium, methyldopa, propranolol, atenolol, salbutamol, thiopental sodium, lignocaine, prazocin, guanethidine, terbutaline, captopril, amitriptyline, hydralazine, imipramine, diazepam, chlorpromazine, haloperidol, trifluoperazine, phenytoin, sodium valproic acid, losartan, alprazolam, metazepine, fluoxetine, clofibrate, sumatriptan, ondansetron, glyburide, rosiglitazone, tolbutamide, furosemide, dicyclomine hydrochloride, chlorthiazide, amiloride, donepezil | 08 |
| Total | | 90 |

3.3 (P) MEDICINAL CHEMISTRY –I **(Practical) (90Hrs. (3 hrs per batch))**

1. Purification techniques of solvents/liquids by Fractional distillation and distillation under vacuum
2. Determination of partition co-efficient, dissociation constant, molar refractivity and RM values of compounds for QSAR analysis.
3. Resolution of Racemic mixtures of any two APIs by any two methods
4. Demonstration of simple QSAR software (Hansch Analysis)
5. Demonstration of construction of stereo models of drugs (minimum two)
6. Preparation of acid salts of drugs and evaluation of its physical properties.
7. Two or more step synthesis of drugs and drug intermediates being studied in theory (any ten)

Recommended Books for Theory and Practicals

- 1 An Introduction to the Chemistry of Heterocyclic Compounds, by Acheson RN, Interscience Publishers New York.
- 2 Bentley and Driver's Textbook of Pharmaceutical Chemistry by Atherden LM, 8th edition Oxford University Press London.
- 3 Inorganic Medicinal and Pharmaceutical Chemistry by Block & Roche, 1st edition, Varghese Publishing House.
- 4 A Textbook of Pharmaceutical Chemistry by Chatten LG, Vol I & II, Marcel Dekker New York.
- 5 Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry by Wilson and Gisvold, J. Lippincot Co. Philadelphia.
- 6 Stereochemistry of Carbon Compounds by Eliel EL, 32nd reprint 2005, TATA McGraw Hill.
- 7 The Organic Chemistry of Drug Synthesis, Vol. 1,2,3,4 by Lednicer Daniel, 1st edition, John Wiley & Sons INC..
- 8 Profiles in Drug Synthesis Vol 1 & 2 by Gogate.
- 9 Exploring QSAR Vol; I Fundamentals and Applications in Chemistry and Biology by C Hansh and A Leo Vol. II: hydrophobic, Electronic and Steric Constants by C Hansh, A Leo and D Hockman ACS Book Catalog.
- 10 Organic Chemistry by Finar IL, Vol. I & II, Pearson Education.
- 11 Foye's Principles of Medicinal Chemistry by Foye, 6th edition, Lippincott William Wilkins.
- 12 Comprehensive Medicinal Chemistry by Hansh C, Vol IV, Elsevier Pergamon.
- 13 Quantitative Drug Design- A Critical Introduction by Martin YC, Marcel Dekker Inc. New York.
- 14 Medicinal Chemistry-A Biochemical Approach by Nogrady T, Oxford University Press New York, Oxford.
- 15 Computer Aided Drug Design, by Pops and Perruns, Academic Press, NY
- 16 Burger's Medicinal Chemistry by Wolff ME, John Wiley & Sons, New York.
- 17 Antibacterial Chemotherapeutic Agents by SL Dax, Blackie Academic and Professional Publications, Chapman and Hall, 1997.
- 18 Principles of Medicinal Chemistry by Kadam SS, Mahadik KR, Bothara KG, Vol. I & II, 10th Edition, Nirali Prakashan.
- 19 Introduction to Medicinal Chemistry' – How Drugs Act and Why by Alex Gringauz, Willey-VCH Publication 1997.
- 20 Drug Design by Bothara KG & Kulkarni VM, 3rd edition, Nirali Prakashan.
- 21 An Introduction to Drug Design by SN Pandeya & IR Dimmock, 1st edition, New Age International Publishers.
- 22 Structure based Drug Design by Veerapandian, 1st edition, Taylor & Francis New York, London.
- 23 Pharmaceutical Substances by Kleeman & Engel, 4th edition, Thieme Publications.
- 24 Practical Pharmaceutical Chemistry by Beckett AH & Stenlake JB, Vol. I and II, 4th edition, CBS Publisher & Distributor.
- 25 Steric Constants by C Hansch, A Leo and D Hockman, ACS Book Catalog.
- 26 Textbook of Practical Organic Chemistry, The ELBS Longman, London.
- 27 Computer Software Application in Chemistry by Jurs PC, John Wiley & Sons, New York.
- 28 Jenkins's Quantitative Pharmaceutical Chemistry by Knevel AM and Digangi FE, McGraw Hill Book Co. New York.

- 29 Practical Organic Chemistry by Mann FC & Saunders BC, The English Language Book Society and Longman Group Limited, London.
- 30 Quantitative Drug Design - A Critical Introduction by Martin YC, Marcel Dekker Inc. New York.
- 31 Vogel's A Text book of Practical Organic Chemistry by Vogel, 3rd edition, The English language book society and Longman group limited, London.
- 32 Advanced practical Medicinal Chemistry by Ashutosh Kar, 1st edition, New Age International Publications.
- 33 Vogel's Elementary Practical Organic Chemistry Small Scale Preparation by Arthur I., 2nd Edition, Part-I, CBS Publication.

3.4 (T) PHARMACEUTICAL ANALYSIS-II (Theory) 90 Hrs. (3 Hrs./week)

| Topic No | SECTION-I | Hrs. |
|----------|--|------|
| 1 | Introduction to analytical methods, (Gravimetric methods, Titrimetric methods, Neutralization titrations and its applications, Complexometric reactions and titrations), Advantages and disadvantages of instrumental methods of analysis and respective problems, Instruments for analysis. | 4 |
| 2 | Atomic Absorption Spectroscopy: Theory, Instrumentation line broadening, Doppler effect, Flame types, different Interference and their Corrections, Pharmaceutical applications | 4 |
| | Flame Photometry: Principles, Instrumentation and Pharmaceutical applications | 3 |
| 3 | Refractometry: Specific and molar refraction, Refractive index, Measurement of RI (angle of refraction), Instrumentation and applications. | 3 |
| 4 | Electrophoresis – Principle, Instrumentation, Various types of Developments | 5 |
| 5 | Polarography: - Introduction, Principle, Dropping Mercury Electrode and Other Mercury Electrodes, Polarogram, half wave potential, Linear Scan & Differential Pulse Polarography, applications covering nonaqueous polarography | 5 |
| 6 | Fluorimetry and phosphorimetry: - Molecular luminescence, measurement of fluorescence, factors affecting fluorescence, quantitative aspects of fluorescence, Excitation and emission spectra. Instrumentation, advantages and disadvantages, applications, synchronous fluorescence. Spectrofluorometry Instrumentation, advantages and disadvantages, applications, optical bleachers, | 12 |
| 7 | Chromatography: Introduction, Brief history, Chromatographic selection of method, classification. Paper Chromatography: Technique, Development, application, Different types of paper, grain direction, ascent number. Thin Layer Chromatography: Principle, preparation, Adsorbents, Activity of Adsorbents, Development of TLC, applications. Column Chromatography: Principle, Column packing, techniques, application, theory, Efficiency of column, Van Deemter Equation in detail, Capacity factor and other performance parameters. | 15 |

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| | High Performance Thin Layer Chromatography (HPTLC): Theory, Instrumentation and Applications, Automated Multiple Development, Horizontal TLC and other development modes, Labeling of TLC, Centrifugal TLC | |
| SECTION-II | | |
| 8 | Electromagnetic spectrum, Interaction of Electromagnetic radiation with matter, classification of analytical methods, molecular analysis, elemental analysis, selecting an analytical method, classification of instrumental methods. | 6 |
| 9 | Ultraviolet and Visible absorption spectroscopy:- origin and theory of UV spectra, Fundamental laws of absorption, Instrumentation, Single beam and double beam UV – Visible Spectrophotometer, Optimum conditions for Spectrophotometric measurements, Derivative Spectrophotometry, techniques for color comparison, Spectrophotometric titration, Applications of UV-Visible spectrophotometry. | 12 |
| 10 | Coulometric Analysis: - Introduction, Coulometric methods, types of Coulometric analysis, Variations in Coulometric techniques, General characteristics of Coulometric techniques. Colorimetry at controlled potential, apparatus and general techniques, applications. | 6 |
| 11 | Amperometry: - Principles, Amperometric titration apparatus, general procedure, advantages and disadvantages, applications, Biamperometric titrations and its applications. Rotating Disc, ring and similar types of electrodes | 4 |
| 12 | Thermal Analysis: Differential Scanning Calorimetry (DSC) Definition, Types, Instrumentation, Principle, applications. Thermogravimetric Analysis (TGA): Introduction, Definition, Types, Instrumentation, Principle, applications. Differential Thermal Analysis (DTA): Introduction, Definition, Principle Instrumentation, applications. Isothermal titration calorimetry | 7 |
| 13 | Nephelometry and Turbidometry: Introduction Principle, Instrumentation, Applications. | 4 |

3.4 (P) PHARMACEUTICAL ANALYSES-II

(Practical) (75 Hrs. per batch)

1. Determination of refractive index by Abbe's Refractometer Molar refraction calculations, Use oils, fats and other similar samples also. **Three exercises**
2. UV spectrophotometric estimations of API and same from their formulations **Four exercises**
3. Fluorometric estimation of few fluorescent compounds. Minimum **Three exercises**
4. Na⁺, K⁺ Calcium and Lithium estimation from formulations by Flame Photometry, **two exercises** each for available filter
5. Nepheloturbidimetric estimation of few analytes containing ions, vitamins, alkaloids **Three exercises**
6. Paper chromatography ascending, Radial **Three exercises** each
7. Thin Layer chromatography **Three exercises**

Recommended Books for Theory and Practicals

- 1 Practical Pharmaceutical Chemistry (Part I & Part II) by A.H. Beckett and J.B. Staenlake, 4th Edition, CBS Publisher & Distributor New Delhi.
- 2 A Textbook of Pharmaceutical Analysis by K.A. Connors, 3rd edition, John Wiley and Sons.
- 3 Principles of Instrumental Analysis by Skoog, 5th edition, Thomson Brookscole.
- 4 A Textbook of Pharmaceutical Chemistry by L. K. Chatten, Vol I & II, Marcel Decker, New York.
- 5 Principles of Chromatography by KR Mahadik, KG Bothara, 1st edition, Nirali Prakashan.
- 6 Introduction to Chromatography (Theory and Practice) by VK Srivastav and KK Shrivastav.
- 7 Pearson's Analysis of Foods by Ronald Kiek and Ronald Sawyer (Longman).
- 8 Radio bioassays (Vol. I and II), by Faud S. Ashkar.
- 9 Vogel's A Text book of Practical Organic Chemistry by Vogel, 3rd edition, The English language book society and Longman group limited, London.
- 10 Macmillan Textbook of Physical Chemistry by Samuel Glasstone, 2nd edition.
- 11 Handbook of Instrumental Techniques for Analytical Chemistry by Frank Settle, Practice Hall Publications.
- 12 Instrumental Methods of Analysis by Willard Merit, Dean Settle, 7th edition, CBS Publisher & Distributor.
- 13 Analytical Chemistry by Gary D Christian, 5th edition, John Wiley & Sons Publications.
- 14 Instrumental Methods of Chemical Analysis by BK Sharma, Goel Publishing House.
- 15 Analytical Chemistry: Principles, 2nd edition, John. H. Kennedy.
- 16 Remington The Science and Practice of Pharmacy, 20th edition, Lippincott Williams & Wilkins.
- 17 Practical Pharmaceutical Chemistry by Beckett AH & Stenlake JB, Vol. II, 4th edition, CBS Publisher & Distributor and I.
- 18 Indian Pharmacopoeia. latest edition
- 19 British Pharmacopoeia. latest edition
- 20 United States Pharmacopoeia latest edition
- 21 High Performance Thin layer Chromatography, Quantitative Analysis of Pharmaceutical Formulations by PD Sethi, CBS Publisher & Distributors, New Delhi First Edition, 2001.
22. A Textbook of Analytical Chemistry, Y. Anjaneyulu, K.Chandreshekhar, Valli Manickam, Pharma Med Press.

3.5 (T) PHARMACOLOGY

(Theory) 90 Hrs. (3 Hrs./week)

| Sr. No | SECTION- I | Hrs. |
|--------|--|------|
| | Basic pharmacology (classification, mechanism of action, pharmacokinetics, pharmacological actions, adverse effects, contraindications, therapeutic uses, drug interaction, dosage, symptoms and treatment of poisoning) and Clinical Management of diseases and drugs acting on following categories: | |
| 1. | Autonomic Nervous System a) Autonomic Nervous system-General Considerations b) Cholinergic system and drugs | |

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| | <ul style="list-style-type: none"> c) Anti-cholinergic drugs d) Neuromuscular blocking agents e) Adrenergic system and drugs f) Anti-adrenergic drugs g) Ganglion stimulants and blockers | 20 |
| 2. | Drugs acting on Central Nervous System <ul style="list-style-type: none"> a) Aliphatic alcohol b) General anesthetics c) Sedative and Hypnotics d) Antiepileptic drugs e) Anti-Parkinsonian drugs f) Drugs used in Mental illness (Psychopharmacological drugs)- Antipsychotic, anti-anxiety, antidepressant, anti-mania drugs g) Opioid analgesics and antagonists h) NSAIDs i) CNS stimulants and nootropic j) Drug dependence k) Introduction to Patient addiction rehabilitation Center and Principle of rehabilitation of drug addicts- Alcohol, tobacco, opioids. | 25 |
| SECTION- II | | |
| 3 | Drugs acting on Respiratory tract Drugs for cough and bronchial asthma | 04 |
| 4 | Drugs acting on gastrointestinal tract <ul style="list-style-type: none"> a) Drugs for peptic ulcers b) Emetics and antiemetics c) Drugs for constipation and diarrhea | 08 |
| 5 | Hormones and Hormones antagonists <ul style="list-style-type: none"> a) Anterior and Posterior Pituitary hormones b) Corticosteroids and corticosteroid antagonists c) Thyroid and antithyroid drugs, parathyroid hormones, drugs regulating calcium homeostasis, Vitamine D d) Insulin, Oral hypoglycemic agents, glucagon e) Gonadal hormones and Oral contraceptives, antifertility agents f) Oxytocin and drugs acting on uterus. | 25 |
| 6 | Pharmacotherapy of gout, rheumatoid arthritis and osteoarthritis. | 06 |
| 7 | Local Anesthetics | 02 |

3.5 PHARMACOLOGY- II **(Practical) (90 hrs: 3 hrs/week)**

1. Introduction to commonly used instruments in experimental pharmacology.
2. Care and handling of common laboratory animals, animal welfare and introduction of CPCSEA and its guidelines, OECD guidelines.
3. Introduction to animal physiology with their biochemical reference values in various animal species.
4. Study of various anesthetics employed to anesthetize laboratory animals.

5. Study of various routes of drug administration
6. Study of physiological salt solutions, drug solution and use of molar solution in various animal experiments.
7. Introduction to the techniques of Euthenesia, stunning and pithing
8. Study of various methods for collection of blood, body fluids and urine from experimental animals.
9. Computer simulations of following experiments through computerized simulated software programme using software such as X-Pharma, X-cology etc.
 - a) Record and interpret the concentration response of acetylcholine/histamine using suitable isolated tissues.
 - b) Study of synergism using isolated tissues.
 - c) Study of drug antagonism using isolated tissues.
 - d) Study of the miotic and mydriatic effect of drugs using rabbit eyes
 - e) To study effects of various cardiovascular drugs on following heart preparations.
10. Bioassay-Definition, Principle, types, advantages of various methods
11. Bioassay of Acetylcholine and histamine using suitable animal preparation
12. Behavioral pharmacology demonstrations using various instruments preferably by simulations on computers (A small number of mice (3) to be used for each the following experiments and the animals should not be sacrificed).
 - a) Study of analgesic activity of drugs using Eddy's hot plate analgesiometer, tail immersion.
 - b) Study of locomotor activity of drug using actophotometer.
 - c) Study of anticonvulsant activity of drug using maximal electroshock/ pentyleneterazol/ strychnine/INH method.
 - d) Study of muscle relaxant property of drug using rotarod.
 - e) Study of various drugs on sleeping time using suitable animals.
 - f) Study of local anesthetic effect of drugs using suitable animal.
 - g) Study of Haloperidol/ Clonidine/ Petazocin induced catalepsy using suitable animal.

Recommended Books

1. Barar, F.S.K., Essentials of Pharmacotherapeutics; S. Chand and Company, New Delhi
2. A textbook of Pathophysiology, Bodhankar, SL and Vyawahare, NS, Nirali Prakashan, Pune.
3. Craig, C.R. and Stitzel, B.E.; Modern Pharmacology, Little Brown and Co, Boston
4. Crossland, James and; Lewis,s Pharmacology Basis of Therapeutics, (Pergamon Press, New York)
5. Das, M. M. and Dutta S. K. : R. Ghosh,s Modern Concepts on pharmacology and Therapeutics, (HILTON and Co. Calcutta)
6. Goodman and Gilman; Pharmacological Basis of Therapeutics, McGraw-Hill
7. Katzung, B.G; Basic and Clinical Pharmacology, Lange Medical Publisher, USA
8. Rang, H.P. and Dale, M.M.; Pharmacology, Churchill Livingston, UK
9. Satoskar , R.S. and Bhandarkar S.D. Pharmacology and Pharmacotherapeutics (Popular Prakashan, Bombay).
10. Sharma H.L. Sharma K. K. General Pharmacology Basic Concepts. Paras Publication.
11. Tripathi K. D. Medical Pharmacology, Jaypee.

3.6 (T) PHARMACOGNOSY
(Theory) 90 Hrs. (3 Hrs./week)

| Sr. No | SECTION- I | Hrs. |
|---|--|------|
| Note: - Drugs mentioned in Bold must be studied in detail for their cultivation, collection and extraction | | |
| 1. | Glycosides - Introduction, definition, occurrence, properties, classification , uses , general biogenetic pathway. General extraction and isolation methods. <ul style="list-style-type: none"> • Anthraquinones – Senna, Aloe, Rhubarb • Cardioactive - Digitalis, Squill • Saponins – Liquorice, dioscorea , shatavari • Bitter- Quassia, Kalmegh, chirata • Cynogenetic – Bitter almond • Isothiocyanate – Black mustard • Flavonoid –Orange peels. • Coumarin/ furocoumarin – Psoralea • Lactone – Artemesia | 20 |
| 2. | A) Terpenoids - Introduction, occurrence, properties, classification, chemistry, uses, general biogenetic pathway. B) Volatile Oils – Introduction, occurrence, properties, classification, chemistry, uses, general methods of extraction and evaluation of volatile oils. Cardamom, cinnamon, cassia, lavender, caraway, dill, coriander, eucalyptus, nutmeg, fennel, clove, tulsi. | 12 |
| 3. | Lipids – introduction, occurrence, properties, classification, uses, methods of extraction, adulteration, evaluation, general biogenetic pathway. Fixed Oils- Castor oil , olive oil, Linseed oil, Sesame oil, Cod liver oil , Shark liver oil, soya oil.Fats – Cocoa butter, Kokum butter Waxes – Bees wax , Wool fat, Carnauba wax | 8 |
| 4. | General methods to study the biogenetic pathways with special reference to Tracer Technique and its application in the biogenetic investigations with suitable examples. | 5 |
| SECTION- II | | |
| 5. | Tannins – introduction, definition, classification, properties, uses, chemical tests and general method of extraction. Ashoka , Arjuna ,Bahera, Amala, Myrobalon ,Pale catechu , Black catechu | 8 |
| 6. | Resins and resins combinations – introduction, classification, properties, chemical composition extraction, and uses. Podophyllum , Asafoetida, Ginger, Turmeric, Capsicum, Benzoin , Colophony, Shellac, Cannabis , Guggul | 8 |
| 7. | Plant pesticides – Pyrethrum, Tobacco, Neem, Derris root. | 3 |
| 8. | Enzymes and proteins - Papain, gelatin, Bromelin, Streptokinase, Serratiopeptidase, Urokinase . | 3 |
| 9. | Drugs of mineral origin – Shilajit , Bentonite, Kaolin, Calamine, Fullers earth. | 3 |
| 10. | Extraction of Plant Material- Soxhlet extraction, Droplet-counter-current Extraction, Supercritical fluid extraction, Froth floating technique, Evaluation | 3 |

| | | |
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| | of herbal extract. | |
| 11. | Applications of Medicinal Plant Tissue Culture in Pharmacognosy. <ul style="list-style-type: none"> • Cultivation of Medicinal Plant Cells • Production of Secondary Metabolites • Bioconversions Using Plant Cells • Plant Cell Immobilization • Genetic manipulation: Mutation.Polyploidy, Hybridisation, Chemodemes, Transgenic plants , • Conservation of Endangered species through micropropagation. | 12 |

Recommended Books

1. Trease and Evans: Pharmacognosy, 15/ Ed., Saunders Company, London.
2. Tyler, Brady and Robbers: Pharmacognosy: CBS Publisher and Distributors, New Delhi
3. Wallis T. E. : Textbook of Pharmacognosy: CBS Publisher and Distributor
4. Kokate, Purohit, Gokhale: Pharmacognosy: Nirali Prakashan, Pune.
5. Rangari: Pharmacognosy: Career Publications
6. Chemistry of Organic Natural Products by O.P agrawal, Gowel Publication house
7. The Indian Pharmacopoeia, 1996 & 2007.
8. The British Pharmacopoeia.
9. M. A. Iyengar: Study of Crude Drug.
10. Martindale: The Extra Pharmacopoeia.
11. E. Ramstad: Modern Pharmacognosy: McGraw Hill Book Company, INC.
12. Kalia A. N: Industrial Pharmacognosy.
13. Mohammad Ali, Pharmacognosy/
14. Street H E, Tissue culture and plant science, Academic press, London.
15. Rainerat and Bajaj, plant tissue culture.
16. Satyanarayana "Biotechnology",Books and Allied Pvt Ltd.,
17. Razdan M.K.An Introduction to Plant Tissue Culture,Oxford publisher
18. T.M. Vasudevan & K.S. Laddha "Herbal Drug Microscopy" Yucca Publication..
19. M. A. Iyengar, S. G. K Nayak "Pharmacognosy Lab Manual",Manipal Press. Manipal.
20. M.A. Iyengar, S.G.K Nayak "Anatomy of Crude Drugs" Manipal press, Manipal.

3.6 Pharmacognosy- II

(Practical) (90 hrs: 3 hrs/week)

- 1) Study of plant tissues, stomata, trichomes, starch grains and calcium oxalate crystals.
- 2) Analytical study of morphological and microscopical characters, chemical and micro chemical tests for following crude drugs in entire and in powdered form (including surface preparation wherever required).
 - Leaf – Senna, digitalis, Eucalyptus (Comparitive study)
 - Bark- Cassia/ Cinnamon
 - Fruit- Fennel/ Caraway/ Dill/ Coriander/ Cardamom/ Capsicum.
 - Seed- Isapghula/ Linseed
 - Flower bud- Clove
 - Wood- Quassia
 - Stem – Kalmegh/ Chirata
 - Root and Rhizomes – Liquorice, Shatavari,Ginger. (Comparitive study)

- 3) Quantitative microscopy:
 - Determination of Leaf constant- Stomatal number and Stomatal index, Palisade ratio, Vein-islet no., Veinlet termination no.
 - Determination of length, width and diameter of cellular material/ cell contents.
 - Determination of % purity of crude drugs by lycopodium spore method
- 4) Experiments on – Sampling of crude drug for analysis. Determination of foreign matters, Moisture content (Loss on drying/ Toluene Distillation) Ash Values, Extractive values, Swelling index, Foaming index, Crude fibre (by dutch method)
- 5) Estimation of Acid Value/ Saponification value/ Iodine Value
- 6) Identification of natural fibres by general chemical tests and microscopical examination.
- 7) A) Identification of crude drugs mentioned in theory syllabus from their morphological and physical characters and preparation of herbarium for one medicinal plant.
 B) Identification of unorganized drugs by physical characteristics and chemical Tests. Acacia, Agar, aloe, Asafoetida, Catechu, Castor oil, Honey, Colophony, Guggul, Shellac, Benzoin, Tragacanth
- 8) Detection of adulteration in oils
- 9) Visit to a tissue Culture Laboratory.

Recommended Books

1. Kokate, Purohit, Gokhale, Pharmacognosy, Nirali Prakashan, Pune.
2. Rangari V D, Pharmacognosy & Phytochemistry, Vol I, II, Career.
3. Khandelwal K.R. Practical Pharmacognosy, Nirali Prakashan, Pune.
4. E Ramstad, Modern Pharmacognosy, Mc-graw hill Book Company. Pridham J B, Swain B, Biosynthetic pathways in higher plants, Academic Press, New york.
5. Shah & Quadry, A text book of Pharmacognosy.
6. Chopra, Indigenous drugs of India.
7. Wealth of India
8. Materia Medica by Nadkarni,
9. Ayurvedic Pharmacopoeia.
10. British Pharmacopoeia.
11. Martindale Extra Pharmacopoeia.
12. Cultivation and utilization of medicinal plants- Attal and Kapoor.
13. M. A. Iyengar, S. G. K Nayak "Pharmacognosy Lab Manual", Manipal Press. Manipal.
14. M.A. Iyengar, S.G.K Nayak "Anatomy of Crude Drugs" Manipal press, Manipal.

3.7 (T) Pharmaceutical Business Management
(Theory) 60 Hrs. (2 Hrs./week)

| Sr. No | SECTION- I | Hrs. |
|--------|---|------|
| 1. | 1. Fundamentals of management | |
| | i) Management basic Concepts: Definition, Need for management, Function of management, Management thoughts, Contribution of Taylor, Fayol, Peter Drucker in modern management. Functions and responsibilities of a manager. | 3 |
| | ii) Planning: Nature and purpose of planning, important steps in planning, types of planning, planning process, advantages and limitations. Sales forecasting methods, analysis, advantages and limitations. | 3 |
| | iii) Objectives: Types of objectives, Importance of objective, Management by objectives, Advantages and Limitations | 2 |
| | iv) Organizing: Organizational structure, basic principals of organization, Departmentalization, Delegation, Decentralization, Staffing, Line & Staff organization. | 2 |
| | v) Decision making: Types of strategies, Policies, Definition and Importance of decision making, Decision making process | 2 |
| | vi) Controlling: Concepts and purpose of control techniques, Budgetary and non budgetary control, Management audit, Management information system, Break even analysis, Network techniques (PERT & CPM), Profit and loss account, Balance sheets | 3 |
| 2. | Pharmaceutical industry and operation management | 1 |
| | i) Historical perspective of pharmaceutical industry in India, Current status and growth scenario. | |
| | ii) Operation management in Pharmaceutical Industry: Controlling of manufacturing operation, Importance and function of Q.C and Q.A. | 2 |
| | iii) R&D in Pharma industry, Drug discovery process, Drug development process, Clinical research organization. | 3 |
| | iv) Material management: Classification of materials, objectives and principals of purchasing, inventory control. | 3 |
| 3. | 3. Industrial relations. | |
| | Meaning, Scope, Causes of disputes, Tribunals, Strikes, Lock outs. Labor law. Trade unions, Job satisfaction, Personal counseling. Introduction to Factories Act, 1948, Trade unions Act 1926 and Industrial Disputes Act 1947. | 5 |
| | SECTION- II | |
| 1. | 1. Pharmaceutical Marketing | 3 |
| | i) Difference between marketing and selling, Channels of distribution, Wholesale, Retail, Departmental. | |
| | ii) Sales promotions, Objective, Principles & Techniques. Ethics of sales, Advertising- Needs & Methods, Merchandising, Detailing | 3 |
| | iii) Medical representative: Role & Qualities. | 1 |
| | iv) Marketing research: Nature & Importance | 2 |
| | v) Product management: Product life cycle, Launching a new product, | 3 |

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| | Branding, Packaging | |
| | vi) Price: Definition, Factors affecting , procedure for determination of price, types of price | 3 |
| 2. | 2. Human Resource and Development i) Motivation: definition, concept, Theory's- Maslow's Theory, Hertzberg's theory, Vroom's theory, Expectancy theory, Reinforcement theory, Equity or social comparison theory X & Y. | 4 |
| | ii) Leadership: definition, importance, qualities of leadership, leadership styles, trait theory, managerial grid | 3 |
| | iii) Communication: importance, functions, communication process, forms of communication, types of communication | 2 |
| | iv) Interview techniques: - presentation skills - group discussion | 2 |
| | v) Performance appraisal: need and techniques, recruitment and training | 2 |
| 3. | 3. International market. Pharmaceutical export, procedure, documentation. Export, registration authorities, regulatory agencies | 2 |

Recommended Books

- 1) Peter Drucker; The Practice of management, Harper and Row, New York, 1954.
- 2) Harold Koontz, Cyril O'Donnel & Heinz Weihrich; Management, 7th edition, 1980.
- 3) P.C. Tripathi & P.N. Reddy; Principals of Management, Tata McGraw Hill publishing Co/ Ltd, 2nd edition, New Delhi.
- 4) Koontz H. & Weihrich H.; Essentials of Management, Tata McGraw Hill publishing Co/ Ltd, 5th edition, New Delhi, 1998.
- 5) Satya Saran Chatterjee; An Introduction to Management, The world Press Pvt. Ltd, 12th Edition, Calcutta, 1998.
- 6) G. Vidyasagar; Pharmaceutical Industrial Management, Pharma book Syndicate, Hyderabad, 2005.
- 7) Philip Kotler & Gary Armstrong; Principles of Marketing, Pearson Education Pvt. Ltd., 10th Edition, Singapore, 2005.
- 8) Mickey Smith; Principles of Pharmaceutical Marketing, CBS Publisher & Distributors, 3rd Edition, New Delhi, 2001.
- 9) J.C. Gandhi; Marketing A Managerial Intoduction, Tata McGraw Hill publishing Co/ Ltd, 8th Edition New Delhi, 1995.
- 10) Mickey Smith; Pharmaceutical Marketing in the 21th Century, Viva Books Pvt. Ltd., New Delhi, 2001.
- 11) Horngren, Sundem & Stratton; Introduction to Management Accounting, Prentice Hall of India Pvt. Ltd., 11th Edition, New Delhi, 2000.
- 12) Cost Accounting & Management Accounting: Everest Publication, New Delhi.
- 13) Principles and Methods of Pharmacy Management by Harry Smith.
- 14) Marketing Management by Philip Kotlar.
- 15) Marketing in New Millennium by Dr. M. J. Xavier, 1998.
- 16) Principles and Management: Koonz O' Donnel.