

KERALA UNIVERSITY OF HEALTH SCIENCES

Regulations and syllabus for the Four-year B.Pharm degree course

(2010 admission onwards)

Section – I

Aim and Objectives of the Course

The profession of Pharmacy has, in recent times, evolved as a dynamic, versatile, rapidly growing, multifaceted, multidisciplinary and increasingly diversified scientific field that provides exciting opportunities of service for the bright and talented new generation.

The aim of the course is to mould the student to suit the varied requirements of

- Pharmaceutical industry – Research & Development, Manufacturing, Quality Control, Quality Assurance, Packaging, Marketing
- Practice settings in – Hospital Pharmacy, Clinical Pharmacy, Community Pharmacy
- Academics
- Regulatory Affairs
- Clinical Research

Section – II

Regulations

1. Minimum qualification for admission to the course

1.1 Minimum qualification for admission to first year B Pharm course.

A candidate who has undergone any of the following courses and passed the examination with an aggregate of 50% marks in the optional subjects.

1. Higher secondary examination of Govt. of Kerala with Physics, Chemistry & Biology/Mathematics as optional subjects.

2. Any other Examination with Physics, Chemistry & Biology /Mathematics as optional subjects approved as equivalent to the above examination by the Kerala University of Health Sciences

Note: In respect of candidates who have taken Physics, Chemistry, Biology & Mathematics as optional subjects, the aggregate of Physics, Chemistry and Biology or Physics, Chemistry and Mathematics whichever is higher shall be considered for the purpose of admission

1.2. Minimum qualification for admission directly to the second year of the B Pharm course (Lateral admission)

A candidate who has passed the Diploma in Pharmacy course of Educational Regulations 1991 under Pharmacy act 1948 from an institution approved by the Pharmacy Council of India with a minimum of 50% marks in the final year examinations Direct admission of Diploma in Pharmacy holders to the second year B. Pharm course is subject to the ceiling of approved strength of the first year course by the Pharmacy Council of India and All India Council for Technical Education.

2. DURATION OF THE COURSE & PERIOD OF COMPLETION

The course of study for B. Pharm shall be for a period of four academic years for those admitted to the First year B. Pharm course. For those admitted directly to the second year, the course of study for B. Pharm course shall be for a period of three academic years. Each academic year consists of 200 working days.

3. MEDIUM OF INSTRUCTION AND EXAMINATIONS

Medium of instruction and examinations shall be English

4. ATTENDANCE, PROGRESS AND CONDONATION

A candidate is required to obtain at least 80 % attendance in theory and practical subjects separately from arecognised institution affiliated to the Kerala University of health Sciences. Only students with 70% and above attendance are eligible for condonation. Condonation for shortage of attendance shall be vested with a committee constituted by the Principal/ Head of the respective college, with the Principal/ Head as the Chairman and five members (senior teachers) in the committee. The benefir t of condonation will be available to the students only once during the entire course.

5. INTERNAL ASSESSMENT MARKS

A. Theory: Three sessional examinations (evenly placed) shall be conducted during the academic year. The average marks of the best two examinations shall be computed out of a maximum of 50 marks , which will constitute the sessional marks in theory.

B. Practical: Students are expected to perform the experiments listed in the respective syllabus. Students are required to maintain practical records for each of the practical subjects and certified bonafied records should be produced at the time of practical examination. Marks shall be awarded out of amaximum of 10 to each of the practical exercises and an average of these shall be computed out of a maximum of 40 marks. While awarding the sessional marks for practical experiments, the following considerations should be taken into account.

Marks for practical experiments shall be awarded on the basis of preparedness of the candidate, manipulative skill, results, knowledge of the experiments, regularity in recording the reports and viva-voce.

The remaining 10 marks of practical sessional marks will be on the basis of a practical sessional examination conducted at the end of the academic year

A regular record of theory and practical sessional marks shall be maintained for each student in the institution.

Improvement of Sessional marks

Candidates who could not pass a university examination can improve the theory sessional marks of the subjects in which he/she failed. For improving the sessional marks ,two sessional examinations will be conducted and their average will be taken into account. Such improvement is allowed for a maximum of two times for a particular subject. The improvement of sessional marks will not be permitted for practicals. A record of the improvement sessional marks shall also be maintained in the institution.

6.COURSE OF STUDY

The course of study for B.Pharm I, II, III and Final year shall include the respective theory and practical subjects as given below:

FIRST YEAR B. PHARM

Subject code	Subject	Hours of theory per week	Hours of practical per week
1-1	Pharmaceutical Chemistry I (Inorganic and Physical Chemistry)	2	3
1-2	Pharmaceutical Chemistry II (Organic Chemistry)	3	3
1-3	Pharmaceutics I (Dispensing and General Pharmacy)	2	6
1- 4	Human Anatomy & Physiology	3	3
1-5	Pharmacognosy-I	3	3
	Tutorials	4	
	Total number of hours /week	17	18

SECOND YEAR B. PHARM

Subject code	Subject	Hours of theory per week	Hours of practical per week
2- 1	Pharmaceutical Chemistry - III (Advanced Organic Chemistry)	3	3
2- 2	Pharmaceutical Analysis -I	2	6
2- 3	Pharmaceutics –II (Physical Pharmacy)	2	3
2- 4	Pathophysiology, Health Education & Community Pharmacy	2	-
2- 5	Mathematics, Biostatistics & Computer applications	4	-
2- 6	Pharmaceutics III (Pharmaceutical Technology)	2	3
2- 7	Applied Biochemistry & Molecular Biology	3	3
	Total number of hours /week	18	18

THIRD YEAR B. PHARM

Subject code	Subject code	Hours of theory per week	Hours of practical per week
3- 1	Pharmaceutics IV (Pharmaceutical Microbiology & Biotechnology)	2	3
3- 2	Pharmaceutical Chemistry IV (Chemistry of Natural Products)	3	3
3- 3	Pharmacology – I	3	3
3- 4	Pharmaceutics- V (Biopharmaceutics & Pharmacokinetics)	2	3
3- 5	Pharmaceutical Jurisprudence	2	-

3- 6	Pharmacognosy -II	2	3
3- 7	Pharmaceutical Management	2	-
	Tutorials	4	-
	Total number of hours /week	20	15

FINAL YEAR B. PHARM

Subject code	Subject	Hours of theory per week	Hours of practical per week
4- 1	Pharmaceutical Chemistry –V (Medicinal Chemistry)	3	3
4- 2	Pharmaceutical Analysis -II	2	3
4- 3	Pharmacognosy-III	2	3
4- 4	Pharmaceutics IV (Formulative & Industrial Pharmacy)	3	6
4- 5	Pharmacology –II -	3	3
4- 6	Pharmacy Practice(Hospital Pharmacy & Clinical Pharmacy)	2	2
4- 7	Project work	1	
	Total numbers of hours /week	16	20

7. APPROVAL OF INSTITUTION CONDUCTING THE COURSE OF STUDY

The regular course for B pharm shall be conducted by an institution approved and affiliated to the Kerala University of Health and Allied Sciences. The approval and affiliation will be granted only if adequate arrangements for teaching with regard to building, laboratories, library, equipments and staff patterns as laid down by the regulations of All India Council for Technical Education and Pharmacy Council of India are available. The number of admissions in an institution shall not be more than 60 as laid down by the All India Council for Technical Education regulations.

8. SCHEDULE OF EXAMINATIONS

The University Examinations shall be held at the end of each academic year, ordinarily in July-August. A supplementary examination shall also be held ordinarily in January –February.

9. SCHEME OF EXAMINATIONS

The candidate shall have to produce certificates at the end of each academic year from the Head of the institution in proof of his/her attendance , having regularly and satisfactorily undergone the course of study by attending not less than 80% of classes held both in theory and practicals separately in each subject. The marks awarded for the examinations will be as follows:

FIRST YEAR B.PHARM

Subject code	Subjects	Maximum marks for Theory			Maximum marks for Practical			
		University Examination	Sessional Examination	Total	University Examination	Sessional Examination	Viva voce	Total
1—1	Pharmaceutical Chemistry I (Inorganic and Physical Chemistry)	100	50	150	70	50	30	150
1—2	Pharmaceutical Chemistry II (Organic Chemistry)	100	50	150	70	50	30	150
1—3	Pharmaceutics I (Dispensing and General Pharmacy)	100	50	150	70	50	30	150
1—4	Human Anatomy & Physiology	100	50	150	70	50	30	150
1--5	Pharmacognosy I	100	50	150	70	50	30	150
TOTAL								
GRAND TOTAL		750			750			
1500 MARKS								

SECOND YEAR B .PHARM

Subject code	Subjects	Maximum marks for Theory			Maximum marks for Practical			
		University Examination	Sessional Examination	Total	University Examination	Sessional Examination	Viva voce	Total
2- 1	Pharmaceutical Chemistry III (Advanced Organic Chemistry)	100	50	150	70	50	30	150
2- 2	Pharmaceutical Analysis	100	50	150	70	50	30	150
2- 3	Pharmaceutics II (Physical Pharmacy)	100	50	150	70	50	30	150
2- 4	Pathophysiology, Health Education & Community Pharmacy	100	50	150				
2- 5	Mathematics, Biostatistics & Computer Applications	100	50	150	-	-	-	-
2- 6	Pharmaceutics III (Pharmaceutical Technology)	100	50	150	70	50	30	150
2- 7	Applied Biochemistry & Molecular Biology	100	50	150	70	50	30	150
	Total			1050				750
	GRAND TOTAL 1800 MARKS							

THIRD YEAR B. PHARM

Subject code	Subjects	Maximum marks for Theory			Maximum marks for Practical			
		University Examination	Sessional Examination	Total	University Examination	Sessional Examination	Viva voce	Total
3- 1	Pharmaceutics IV (Pharmaceutical Microbiology and Biotechnology)	100	50	150	70	50	30	150
3- 2	Pharmaceutical Chemistry IV (Chemistry of Natural Products)	100	50	150	70	50	30	150
3- 3	Pharmacology - I	100	50	150	70	50	30	150
3- 4	Pharmaceutics- V (Biopharmaceutics & Pharmacokinetics)	100	50	150	70	50	30	150
3- 5	Pharmaceutical Jurisprudence	100	50	150	-	-	-	-
3- 6	Pharmacognosy -II	100	50	150	70	50	30	150
3- 7	Pharmaceutical Management	100	50	150	-	--	-	-
	Total							
	GRAND TOTAL 1800 MARKS			1050				750

FINAL YEAR B. PHARM

Subject code	Subjects	Maximum marks for Theory			Maximum marks for Practical			
		University Examination	Sessional Examination	Total	University Examination	Sessional Examination	Viva voce	Total
1								
4- 1	Pharmaceutical Chemistry –V (Medicinal Chemistry)	100	50	150	70	50	30	150
4- 2	Pharmaceutical Analysis -II	100	50	150	70	50	30	150
4- 3	Pharmacognosy-III	100	50	150	70	50	30	150
4- 4	Pharmaceutics VI (Formulative & Industrial pharmacy)	100	50	150	70	50	30	150
4- 5	Pharmacology –II	100	50	150	70	50	30	150
4- 6	Pharmacy Practice (Hospital Pharmacy & Clinical Pharmacy)	100	50	150	70	50	30	150
4- 7	Project work			100				
	TOTAL							
	GRAND TOTAL 1900 MARKS			1000				900

NOTE:-The duration of theory examination of each subject will be 3 hours and of Practical examination will be 4 hours including Viva -Voce

10.CRITERIA FOR PASS

Candidate who has secured a minimum of 45% marks in the University examination and 50% marks in Total (aggregate of marks in University examination and Sessional examination) for theory and practical separately in any subject or subjects shall be declared to have passed in that subject / subjects and exempted from appearing in subsequent examination.

11. CONDITIONS UNDER WHICH CANDIDATES ARE PERMITTED TO PROCEED TO THE NEXT HIGHER CLASS

Candidates who have secured the minimum required for a pass in a subject shall be exempted from appearing for the subsequent examination in such subject. A subject includes both theory and practical, if that subject is having a practical examination. A candidate who fails in theory or practical examination in any subject need to appear only for the theory or the practical examination in which the candidate has failed. Candidates who have registered for the university examination of a class will be eligible for promotion to the next higher class. Candidates with 80% attendance shall register for the exam in the concerned year. Candidates with shortage of attendance have to repeat the course and shall have to appear for the next regular examination. Only registered candidates will be eligible for attending the next higher class. For registering for the third B.Pharm examination the candidate should have passed in all subjects of First B.Pharm and for registering for the final B.Pharm examination the candidate should have passed in all subjects of Second B.Pharm

12.DECLARATION OF CLASS

Class shall be awarded for first year B Pharm, Second year B Pharm & Third year B Pharm examinations as explained below:

- 1. First class-**The candidates securing 60% marks or above in aggregate in all subjects of the B Pharm examinations shall be declared to have passed in First class.
- 2.Second class-**The candidates securing 50% marks or above but less than 60% of the aggregate in all subjects of the B Pharm examinations shall be declared to have passed in Second class.
- 3. Distinction-** The candidates securing 75% marks or above in the aggregate of theory and practical in each subject in the B Pharm examination in first appearance shall be declared to have distinction in that subject. (Applicable to all four years)

For calculation of class for the course, the aggregate of the marks of Second, Third & Final year B Pharm will be considered. The candidates securing 60% marks or above in aggregate in the Second, Third & Final year B Pharm examinations shall be declared

to have passed in First class for the course. The candidates securing 50% marks or above but less than 60% of the aggregate in the Second, Third & Final year B Pharm examinations shall be declared to have passed in Second class for the course.

13. INTERNSHIP (PRACTICAL TRAINING)

Every candidate shall undergo practical training in a Pharmaceutical manufacturing House / approved Hospital with at least three specialities / National research laboratory for a period of not less than one month after the course..B Pharm degree will be awarded only after the training certificate from the training institute ,of having undergone the training successfully, is forwarded to the university by the Principal/Head of the department

14. AWARD OF RANK

Ranks and medals should be awarded on the basis of aggregate of marks in the second, third and final year B. Pharm examinationsA candidate who fails in any of the subjects during the B Pharm course shall not be eligible for award of ranks.More over the candidates should have completed the B Pharm course in the prescribed (minimum) number of years.

15. INDUSTRIAL TOUR

Students of fourth B Pharm course should visit several manufacturing houses or national research laboratories as a supplement to the academic training and submit a report to the satisfaction of the Head of institution.

Section III
Subject and Course Content

FIRST YEAR B PHARM

**1.1 PHARMACEUTICAL CHEMISTRY – I
(INORGANIC & PHYSICAL CHEMISTRY)**

THEORY (2hrs/wk)

A) INORGANIC CHEMISTRY:

1. **Introduction:** Pharmacopoeia and monograph.

2. **Quality control and test for purity:** Sources of impurities in Pharmaceutical substances.

Limit tests: Definition, importance, general procedure for limit test for chlorides, sulphates, iron, arsenic, heavy metals, lead and modifications with suitable examples.

3. **Radiopharmaceuticals and contrast media:** Nuclear reactions, nomenclature, units and measurement of radioactivity, clinical applications and dosage, hazards and precautions, handling & storage, radio pharmaceutical preparations and standards of radioactive material iodine-131(I^{131}), Cobalt -58(Co^{58}). Radio opaque contrast medium- barium sulphate.

4. **Study of pharmaceutically important compounds:** Method of preparation, properties, assay, identification test, test for purity, official preparation, storage conditions and uses of inorganic compounds listed in I.P belonging to the following categories.

a. **Gastrointestinal agents and related compounds**

(i) **Acidifiers:** Dilute hydrochloric acid, Sodium phosphate, Ammonium chloride.

(ii) **Antacids:** Classification, Qualities of an ideal antacid, side effects, advantages of combination therapy, acid neutralizing capacity, sodium bicarbonate, Potassium citrate, Aluminium hydroxide gel, Aluminium phosphate, Magnesium hydroxide,

magnesium trisilicate, light and heavy magnesium carbonate, Calcium carbonate, Dimethicone, Magaldrate, Bismuth carbonate.

(iii) **Adsorbents and protectives:** Light Kaolin, Activated charcoal, Bismuth subcarbonate.

(iv) **Saline cathartics:** Magnesium sulphate, Magnesium carbonate.

b. Topical Agents

(i) **Protectives:** Talc, Zinc Oxide, Calamine, Zinc Stearate, Titanium Dioxide, Silicon Polymers and Dimethicone.

(ii) **Astringents:** Alum, Zinc Sulphate and Zinc chloride.

(iii) **Anti-microbials:** Hydrogen Peroxide, Potassium Permanganate, Chlorinated Lime, Boric Acid, Silver Nitrate, Sodium Stilboglucanate, Povidone-Iodine, Selenium Sulphide and Zinc Undecenoate.

c. Dental products

i. **Anti-caries Agents:** Role of Fluorides as anti-caries agents, Sodium fluoride.

ii. **Dentifrices:** Calcium carbonate, dibasic calcium phosphate, Strontium chloride, Zinc chloride.

d. Major intra and extra cellular electrolytes:

i. Physiological role of Chloride, Phosphate, Bicarbonate, Sodium, Potassium, Calcium and Magnesium.

ii. **Electrolytes used for replacement therapy:** Sodium chloride, Potassium chloride, Calcium chloride, Calcium gluconate, Calcium lactate, Tribasic calcium phosphate.

iii. Physiological acid-base balance and its importance.

iv. **Electrolytes used in the acid-base therapy:** Sodium acetate, Potassium acetate, Sodium citrate, Potassium citrate, Sodium lactate, Ammonium chloride. Electrolyte combination therapy, Compound sodium chloride solution, Sodium chloride injection and Oral rehydration salt.

e. **Gases:** Oxygen, Carbon dioxide, Helium, Nitrogen and Nitrous Oxide.

f. **Essential and Trace ions:** Definition, Physiological role of Iron, Copper, Zinc, Chromium, Manganese, Molybdenum, Selenium, Sulphur and Iodine. Ferrous

fumarate, Ferrous gluconate, Ferrous sulphate, Iron and Ammonium citrate, Zinc chloride and Potassium iodide.

Official formulation: Iron dextran injection, Official solutions of iodine.

g. **Pharmaceutical Aids:** Sodium bisulphite, Sodium metabisulphite, Sulphurdioxide, Bentonite, Magnesium stearate, Aluminium sulphate, Sodium benzoate, Sodium carboxy methyl cellulose, Sodium methylparaben, Sodium lauryl sulphate, Purified water, Water for injection, sterile water for injection.

h. **Miscellaneous:**

i. **Sclerosing agents:** Hypertonic saline, Sodium tetra decyl sulphate.

ii. **Expectorants:** Ammonium chloride, Potassium iodide.

iii. **Sedative:** Potassium bromide.

iv. **Antidotes:** Sodium nitrite, Sodium thiosulphate, Charcoal.

v. **Respiratory stimulant:** Ammonium carbonate.

5. Theory of co-ordination compounds with special reference to application in Pharmacy and Pharmaceutical analysis: EDTA, Dimercaprol, Penicillamine, 1,10-Phenanthroline

B) PHYSICAL CHEMISTRY:

1. **Solutions:** Ideal and real solutions, solutions of gases in liquids, colligative properties, partition coefficient, Debye-Huckel theory.
2. **Adsorption:** Definition, chemisorption, state of adsorbed molecule, factors influencing adsorption, types of adsorption isotherms, Freundlich, Langmuir's and Gibb's adsorption isotherms.
3. **Behaviour of Gases:** Kinetic theory of Gases, Deviation from ideal behaviour and explanation
4. **The Liquid state:** Physical Properties (Surface tension, Parachor, Refractive index, Optical rotation and Dipole moment)

PRACTICALS (3hrs/wk)

I. Preparation of the following inorganic pharmaceuticals and their identification tests and other tests given in I.P.

- a) Aluminium hydroxide
- b) Zinc oxide
- c) Barium sulphate
- d) Calcium carbonate
- e) Potassium citrate
- f) Boric acid
- g) Magnesium sulphate
- h) Ferrous sulphate.

II. Test for purity for the following:

- a. Swelling property of bentonite.
- b. Acid neutralizing capacity of aluminium hydroxide gel.
- c. Ammonium salts in potash alum.

- d. Adsorption power in heavy kaolin.
 - e. Presence of iodates in potassium iodide.
 - f. Ferric ion and reducing sugars in ferrous gluconate.
- III.** Limit test for chlorides, sulphates, iron, heavy metals, arsenic and modified procedure for limit test for chloride, sulphate on potassium permanganate and sodium bicarbonate
- IV.** Assay of at least 5 pharmaceutically important inorganic compounds.
- V.** Determination of specific rotation of a compound.
- VI.** Determination of refractive index.
- VII.** Determination of partition co-efficient.

Books recommended:

1. Bentley and Driver's Textbook of Pharmaceutical Chemistry.
2. Inorganic Medicinal and Pharmaceutical Chemistry by J.H. Block, E.B. Roche, T.O. Soine and C.O. Wilson.
3. Roger's Inorganic Pharmaceutical Chemistry by T.O. Soine and C.O. Wilson.
4. Practical Pharmaceutical Chemistry by A.H. Beckett and J.B. Stenlake Vol. I.
5. Pharmaceutical Chemistry by M.L. Schroff.
6. Indian Pharmacopoeia

1.2 PHARMACEUTICAL CHEMISTRY-II (ORGANIC CHEMISTRY)

THEORY (3hrs/wk)

I. Structure and Activity of Organic Molecules: Shapes of organic molecules, bond lengths, bond angles and bond dissociation energies. Electronic effects in organic molecules: inductive effect, electromeric or mesomeric effect, hyperconjugation, concept of resonance.

II. Study of the following organic compounds, including their reaction and reaction mechanisms

a) **Hydrocarbons:**

Aliphatic/Alicyclic Hydrocarbons:

Alkanes: Nomenclature, isomerism (chain, conformational and geometrical) relative stabilities (heats of combustion and hydrogenation), ring stabilities of cyclohexane, chair-boat conformation, Bayer's strain theory and Sachse-Mohr theory. Free radical substitution reactions (halogenation) of alkanes, selectivity of halogen.

Alkenes: Electrophilic addition reactions of alkenes, Markovnikov's rule, Kharasch effect, Bayer's oxidation (cis-hydroxylation, polymerisation).

Alkadienes: Stability & 1,4 addition reactions of conjugated alkadienes.

Alkynes: Acidity of 1-alkynes, formation of metal acetylides. Stereo specific

reduction of alkynes. Addition of hydrogen halide (HCl) addition of water and keto-enol tautomerism.

Aromatic Hydrocarbons: Kekule's structure of benzene, bond lengths, heats of hydrogenation and stability, molecular orbital picture of benzene, aromaticity, Huckel's rule, nomenclature of benzene derivatives, characteristic reactions of benzene and theory of reactivity and orientation in monosubstituted benzenes

b) Halogen Compounds:

Aliphatic: Nomenclature, general methods of preparation, characteristic nucleophilic substitution reactions, Walden inversion, elimination reaction and Saytzeff's rule.

Aromatic: Nomenclature, low reactivity of halo benzenes towards nucleophilic substitution.

c) Alcohols:

Nomenclature, classification, general methods of preparation, physical properties, hydrogen bonding, characteristic nucleophilic substitution reactions (replacement of -OH by -Cl), elimination reactions, Reimer Tiemann reaction and relative reactivities of 1°, 2° and 3° alcohols,

d) Ethers:

Nomenclature, Williamson's synthesis, action of hydroiodic acid on ethers (Ziesel's method).

e) Phenols:

Nomenclature, general methods of preparation, physical properties, acidity of phenols, stability of phenoxide ion, reactions of phenols, Kolbe-Schmidt reaction, stability of conjugated dienes, and Fries rearrangement.

f) Carbonyl Compounds: Nomenclature, two important methods of preparation, polarity of carbonyl group, relative reactivities of carbonyl compounds, nucleophilic addition and addition-elimination reactions, oxidation-reduction reactions, aldol condensation, Cannizzaro reaction, benzoin condensation, Perkins reactions, Reformatsky reaction, Oppenauer oxidation.

g) Carboxylic acids and their derivatives:

Carboxylic acids:

Nomenclature, intermolecular association, acidity, stability of carboxylate anion, two important methods of preparation, decarboxylation, functional groups reactions, reduction of carboxylic acids. A note on dicarboxylic acids.

Acid derivatives: (acid chlorides, anhydrides, esters and amides). Nomenclature, reactions like hydrolysis, reduction of esters and amides, Hofmann's degradation of amides. Brief account of malonic and acetoacetic esters, their importance in synthesis.

h) Nitrogen Compounds:

Nitro compounds:

Nomenclature, acidity of nitro compounds reactions of aromatic nitro compounds.

Amines: Nomenclature, basicity of amines, classification, relative reactivity, Hinsberg method of separation, acylation reactions. Diazotisation and reactions of diazonium salts.

Nitriles and isonitriles: Nomenclature, two methods of synthesis, reactivity and functional reactions.

PRACTICALS (3hrs/wk)

1. Systematic qualitative analysis of organic compounds including preparation of derivative not less than 10 compounds with different functional groups.
2. Preparation of organic drugs or intermediate involving one-step reaction (at least 10 compounds).
3. Introduction to the use of stereo models.
 - a) Methane b) Ethane c) Acetylene d) Ketone e) Benzene

BOOKS RECOMMENDED:

1. T.R.Morrison and R.N.Boyd, Organic chemistry, Prentice Hall of India private limited, New Delhi.
2. Bruce, Organic chemistry.
3. Jerry March Advanced Organic Chemistry.
4. Practical Organic Chemistry by Mann & Saunders.
5. Jerry March, Reactions and Mechanism 4th ed.
6. I.L. Finar Vol.I. & Vol. II., The Fundamental Principles of Organic Chemistry, ELBS/Longman.P

1.3 -PHARMACEUTICS-I (DISPENSING AND GENERAL PHARMACY)

THEORY (2 hours/week)

1. Introduction to Pharmacopoeias (I.P, B.P, USP, B.P.C, NFI) with special reference to history & development of I.P.
2. Introduction to dosage forms- General classification, definitions and uses.
3. Principles of dispensing- Prescriptions, handling of prescription, Latin terms, General dispensing procedures including labeling, sources of error in prescriptions and legality of prescriptions
4. Pharmaceutical calculations:
Posology- Calculation of paediatric doses, enlarging and reducing recipes, percentage solutions, alligations, alcohol dilution, proof spirit.
5. Principles involved and dispensing procedures adopted for prescription of powders, solutions, aromatic waters, mixtures, emulsions, lotions, liniments, ointments, paints,

- lozenges, jellies, pastes, suppositories.
6. Extraction and galenical products-Principles and methods of extraction, preparation of infusions, tinctures; Dry, soft and liquid extracts.
 7. Incompatibilities-Physical, chemical and therapeutic.

PRACTICALS (3 hours/week)

A minimum of 60 prescriptions should be dispensed, at least one prescription from each category.

Dispensing of prescriptions falling under the categories studied in theory maintaining complete record of each.

Identification and rectification of incompatibilities in prescriptions

BOOKS RECOMMENDED:

1. Dispensing for Pharmaceutical Student; S.J.Carter;12th edition; CBS publishers & distributors.
2. Ansel's Pharmaceutical Dosage Forms & Drug Delivery Systems; Loyd.V.Allen,Nicholas.G.Popovich,Howard.C.Ansel;8th edition; Lipincott Williams & Wilkins.
3. Remington: The Science & Practice Of Pharmacy; 21st edition;Lipincott Williams & Wilkins.
4. Pharmaceutical Practice; Diana.M.Collett, Michael.E.Aulton, Churchill Livingstone.
5. Bentley's text book of Pharmaceutics: E.A.Rawlins;8th edition ;English language book society.
6. Cooper and Gunn's Tutorial Pharmacy;S.J.Carter;6th edition; CBS Publishers & Distributors.
7. Pharmacopoeias (I.P, B.P, U.S.P, B.P.C, NFI, Martindale Extra Pharmacopoeia)

1.4 HUMAN ANATOMY AND PHYSIOLOGY

THEORY (3hrs/week)

(Discussion of anatomy with a brief overview of microscopy in each system)

1. Introduction

Definition, scope of anatomy and physiology, description of body and basic Terminologies

2. General anatomy and physiology

Cell, cell junctions, transport mechanisms, homeostasis, ion channels, secondary messengers.

3. Tissues

Definition, classification of tissues, their location, characteristics and functions, electrophysiology of muscle.

4. Human skeleton

Structure, composition, classification and function of bones. Identification and few salient features of important bones of axial and appendicular skeleton. Classification of joints, types of movements, disorders of joints (Definitions only)

5. Body fluids and blood

Body fluids, composition and functions of blood including their disorders, haemopoiesis, mechanism of coagulation, bleeding and clotting disorders, blood grouping and its significance, blood transfusion, lymphatic system and reticuloendothelial system.

6. Cardio Vascular system

Anatomy and physiology of heart, blood circulation, cardiac output, cardiac cycle, heart rate, blood pressure, electrocardiogram, heart sounds and Cardiovascular disorders. (Definitions only)

7. Digestive system

Gross anatomy of G.I. Tract and its physiology with special reference to liver, pancreas and stomach, digestion, absorption, movements of intestine, gastrointestinal hormones, disorders and disorders of digestive system (definitions only)

8. Respiratory system

Anatomy of respiratory tract, mechanism of respiration, regulation of respiration lung volumes and capacities, transport of oxygen and carbondioxide, artificial respiration, resuscitation methods and disorders of respiratory system (definitions only).

9. Urinary system

Structure and functions of kidney and urinary tract, physiology of urine formation, micturition reflex and acid base balance. Disorders of urinary system (definitions only).

10. Reproductive system

Structure and function of male and female reproductive system, sex Hormones, physiology and menstruation, coitus, fertilization, Spermatogenesis, oogenesis, pregnancy and parturition. Disorders of Reproductive system (definitions only).

11. Endocrinology

Introduction, chemistry and action of hormones, basic anatomy and physiology of pituitary, thyroid, parathyroid, adrenal and pancreas. Local hormones. Disorders of these glands (definitions only).

12. Nervous system

- a. Introduction, neurons, classification and properties of nerve fibres, neuroglia, receptors, synapses and neurotransmitters.
- b. Central nervous system – Structure and function of brain and spinal cord, functions of cerebrum, cerebellum, vital centers of medulla oblongata, CSF and cerebral ventricles, cranial nerves and their functions. Disorders of CNS (definitions only).
- c. Autonomic nervous system-Anatomy, physiology and division of autonomic nervous system.

13. Sense organs:

Anatomy and physiology of eye, ear, skin, nose and tongue.
Disorders related to sense organs (definitions only).

Human Anatomy and Physiology (Practical)

3 Hours/week

1. Study of compound microscope.
2. Identification of bones and points of identification
3. Study of different systems with the help of charts and models.
4. General techniques in Haemocytometry
5. Enumeration of Red Blood Corpuscles(RBC)
6. Determination of White Blood Corpuscles (WBC)
7. Estimation of hemoglobin
8. Estimation of Differential Leukocyte Count(DLC)
9. Estimation of Erythrocyte Sedimentation Rate (ESR)
10. Determination of Blood groups.
11. Determination of Bleeding and Clotting time
12. To record human heart rate and pulse rate.
13. Measurement of blood pressure and to study the effect of posture and exercise on blood pressure.
14. Recording of human body temperature.
15. Determination of tidal volume & vital capacity.
16. Experiments related to special senses.

Recommended Books

1. Anatomy and Physiology in Health and Illness by Kathleen J.W. Wilson.
2. Physiological basis of Medical Practice-Best and Tailor.
3. Text book of Medical Physiology-Guyton and Hall.
4. Principles of Anatomy and Physiology by Tortora Grabowski.
6. Human Physiology (vol 1 and 2) by Dr. C.C. Chatterrje
7. Textbook of Human Histology by Inderbir Singh

1.5 PHARMACOGNOSY –I

THEORY [3 hrs/week]

1. Methods of classification of plants.
2. Microscopy- Basic methods employed for preparation of plant material for microscopic examinations. reagents, special staining techniques for various cell constituents including chromosomes, clearing agents and mountants
3. Definition, history, scope and development of pharmacognosy.
Sources of drugs, biological, marine, mineral, plant and tissue culture as source of drugs.
4. Classification of drugs: alphabetical, morphological, taxonomical, chemical and pharmacological.
5. Plant taxonomy: Study of following families with special reference to medicinally important plants, Apocynaceae, Solanaceae, Umbelliferae, Leguminosae, Rubiaceae, and Labiatae.
6. Cultivation, collection processing and storage of crude drugs. Factors influencing cultivation of medicinal plants. Types of soils and fertilizers of common use, pest management and natural pest control agents- plant hormones and their applications- polyploidy, mutation, and hybridization with reference to medicinal plants.
7. Systematic pharmacognostic study of following.
 - a) Carbohydrates and derived products: Agar, guar gum, acacia, Ispaghula, pectin, starch and tragacanth.
 - b) Lipids: castor oil, cocoa butter, hydnocarpus oil, linseed oil, rice bran oil.
8. Study of drugs containing resins and resin combinations: colophony, podophyllum, cannabis, capsicum, myrrh, asafoetida, balsam of tolu, balsam of peru, benzoin, turmeric, ginger.
9. Study of tannins and tannin containing drugs: catechu and myrobalan.
10. Volatile oils: General methods of obtaining volatile oils from plants and their classification, general properties, chemical nature and chemical tests. Study of volatile oils of mentha, coriander, cinnamon, cassia, lemon peel, orange peel, lemon grass, caraway, dill, clove, fennel, nutmeg, eucalyptus, cardamom, valerian, sandal wood.
11. Study of fibres used in pharmacy such as cotton, silk, wool, nylon, glass wool, polyster and asbestos.
12. Study of pharmaceutical aids like talc, diatomite, kaolin, bentonite, and natural colours.

13. Drugs of animal origin : Shellac, cochineal, Cantharides, Spermaceti, Wool fat, Honey, Beeswax, Cod liver oil and shark liver oil.

PRACTICALS (3hrs/wk)

1. Identification and morphological study of drugs mentioned in theory. (Any 15)
2. Microscopic studies of cell constituents: starch grains, calcium oxalate crystals and Phloem fibres.
3. Chemical tests for the identification of following drugs and adulterants in them.
[a] Acacia [b] Agar [c] Tragacanth [d] Starch
[e] Honey [f] Asafoetida [g] Benzoin [h] Myrrh
4. Isolation of volatile oils mentioned in theory (any one)
5. Preparation of Herbarium sheets (Two per students)
6. Tests for identification of adulterants in
[a] Castor oil [b] Shark liver oil [c] Wool fat [d] Bees wax
[e] Sesame oil
7. Taxonomical studies of following plant families mentioned in theory.
[a] Apocynaceae [b] Solanaceae [c] Labiatae [d] Rubiaceae
8. Histological studies of following organised drugs mentioned in theory.
[a] Cinnamon [b] Clove [c] Eucalyptus [d] Fennel
[e] Cardamom

Books Recommended

1. Wallis TE, Text book of Pharmacognosy, J&K Churchill limited, London.
2. Wallis TE, Analytical Microscopy, J & K Churchill limited, London.
3. Trease and Evans WC, Pharmacognosy, Bailliere Tindall, Eastbourne UK
4. Kokate CK, Purohit AP and Gokhale SB, Pharmacognosy (Degree), Nirali prakashan, Pune.
5. Kokate CK, Practical Pharmacognosy, Vallabh Prakasan, Delhi.
6. Harborns JB, Phytochemical methods, Chupman and Hall, International edition, London.
7. Atal CK and Kapoor BM, Cultivation and Utilisation of Medicinal Plants, RRL, Jammu.
8. Martindale, The Extra Pharmacopoeia, Pharmaceutical society of great Britain, London.
9. Indian Herbal Pharmacopoeia, Indian drug manufacturers

association, Mumbai.

10. The Ayurvedic Pharmacopoeia of India volume : I – V, Government of India, Ministry of Family and Welfare, Department of Indian System of Medicine & Homeopathy, New Delhi.
11. Medicinal plants of India, Indian Council of Medical Research, New Delhi.
12. Ashutosh kar, Pharmacognosy & Pharmacobiotechnology, New age international publishers, New Delhi.
13. Tyler VE, Brady R, Pharmacognosy.
14. Ansari SH, Essentials of Pharmacognosy, Birla publications Pvt Ltd, Delhi.
15. Wagner SB, Zgainsky, Plant drug analysis.
16. Vinod D. Rangari, Pharmacognosy and Phytochemistry, Part I – II; Career Publications, Nashik.

SECOND YEAR B PHARM

2.1 PHARMACEUTICAL CHEMISTRY - III (ADVANCED ORGANIC CHEMISTRY) THEORY 3 hrs/wk

1. Stereochemistry:

a) Optical isomerism:

Stereoisomerism, Definition, Tetrahedral carbon, chirality, relative and absolute configurations and sequence rule. Conventions used in stereochemistry. Lexicon of elements of symmetry, racemic modifications, properties, resolution of racemic modifications and conformational analysis. Walden inversion and stereo mutation. Asymmetric synthesis, stereospecific and stereo-selective synthesis.

b) Geometrical isomerism:

Nature, rotation about a carbon-carbon double bond. Modern theory of double bonds, Nomenclature of isomers and determination of configuration.

c) Stereochemistry of cyclic compounds including Biphenyl compounds .

d) Stereochemistry of Nitrogen compounds, amines and oximes.

2.A study of the mechanism and application in synthesis of the following named reactions:

Catalytic hydrogenation, dehydrogenation, metal hydrate reduction. Reduction with hydrazine and its derivatives, Birch reduction, Mannich reaction, Michael addition reaction, Hoffmann rearrangement. Curtius rearrangement, Clemmenson's reduction. Meerwin – Ponderoff reduction, oxidation with perchloric acid, lead tetra acetate, mercuric acetate and selenium oxide, Beckmann rearrangement, Schmidt rearrangement, Darzen's reaction.

3. Heterocyclic chemistry:

Classification of Heterocyclic compounds, nature and nomenclature. Preparation and important reactions of Pyrrole, furan, thiophene, pyrazole, imidazole, oxazole, isoxazole, thiazole, pyridine, pyrimidine, indole, quinoline, isoquinoline, acridine, phenothiazine, azepines, diazepines, dibenzazepines, Oxepines, Quinolones and Quinazolones.

4. Polynuclear aromatic hydrocarbons:

Nomenclature, structure and aromatic character of naphthalene, anthracene, phenanthrene and naphthacene resonance structures, electron density and reactivity. Electrophilic substitution, oxidation and reduction reactions.

PRACTICALS (3hrs/wk)

I. Synthesis of some simple heterocyclic compounds.

- a. 3, 5-Dimethylpyrazole from Acetylacetone.
- b. 3, 5-Dimethylisoxazole from Acetylacetone.
- c. 4, 5-Diphenylimidazole from Benzil.
- d. Benzoxazole from o-Aminophenol.
- e. 2, 5-Dioxopiperazine from Glycine.
- f. Oxazolone from Benzoylglycine.

II. Molecular rearrangements and named reactions

- a. Benzimidazole from o-phenylenediamine (Phillip's Reaction).
- b. O-hydroxyacetophenone from phenyl acetate (Fries migration)
- c. Benzanilide from benzophenone oxime (Beckmann's rearrangement)
- d. Preparation of 2-phenylindole from Phenylhydrazine by Fischer's method.

III. Workshop on molecular modelling of elements of symmetry, optically active compounds and geometrical isomers.

IV. Quantitative determination of organic compound via functional groups such as alcoholic and phenolic, carboxylic acid, aldehyde, ketone, amines, ester, ether.

BOOKS RECOMMENDED:

1. R Morrison and R. Boyd, organic chemistry, Pub by Printice Hall of India, New Delhi.
2. I .L Finar, Organic Chemistry, Vol. I. & II, 6th Pearson education
3. O.P Agarwal, Reactions and Reagents
4. Eliel, Stereochemistry of Organic compounds.
5. Arun Bahl & S.S Bahl, Advanced Organic Chemistry
6. Jerry March, Advanced Organic Chemistry 4th Ed.
- 7 Cram & Hammond.Organic Chemistry.
8. A.I. Vogel, A textbook of practical organic chemistry
9. Solomons, Organic Chemistry

2.2 -PHARMACEUTICAL ANALYSIS -I

THEORY (2 hrs/wk)

Introduction: Importance of quality control, different techniques of analysis, preliminaries and definitions, significant figures, concept of error, precision, accuracy, mean and standard deviation, calibration of analytical equipments, fundamentals of volumetric analysis, methods of expressing concentrations, primary and secondary standards.

1. Neutralization titrations:

Acid-base concepts, relative strength of acids and bases, law of mass action, common ion effect, ionic product of water, pH, Henderson–Hasselbach equation, buffer solutions, theory of indicators, neutralization curves, choice of indicators, mixed and universal indicators, titration of polyprotic system

2. Non-aqueous titrations:

Theoretical basis, types of solvents, scope, limitations, preparation and standardization of titrant solutions used in non-aqueous titrations of weak acid and weak bases .

3. Precipitation titrations:

Principles of precipitation titrations, solubility product, effect of acids, temperature and solvent on the solubility of precipitate. Argentometric titrations- different methods.

4. Complexometric titrations:

Complexation, chelation, Werner's co-ordination number, stability of complexes, titration curves, importance of buffer, types of complexometric titration, methods of end point detection. pM indicator, masking and demasking agents.

5. Oxidation – reduction titrations:

Concepts of oxidation–reduction, standard oxidation potential, Nernst equation, theory of redox titrations, redox indicators, titrations involving ceric ammonium sulphate, potassium permanganate, titanous chloride, sodium–2,6–dichlorophenol–indophenol, iodimetry, iodometry,

6. Gravimetric analysis:

Basic concepts, precipitation techniques, organic and inorganic precipitants, co-precipitation, post-precipitation. Various steps involved in gravimetric analysis. Thermogravimetry. Pharmaceutical applications.

Determination of barium as barium sulfate, calcium as calcium oxalates, Magnesium as magnesium pyrophosphate, silver as silver chloride.

7. Miscellaneous methods:

1. Diazotisation titrations 2. Kjeldhal method of nitrogen estimation 3. Oxygen Flask combustion method 4. Gasometry 5. Karl Fischer method.

PRACTICALS (6hrs/wk)

1. Standardization of analytical weights and calibration of volumetric apparatus.
2. Preparation and standardization of volumetric solutions and assay of official compounds involving Acidimetry, Alkalimetry, (including Non-aqueous titrimetry), Permanganometry, Cerimetry, Iodimetry, Iodometry, Chromatometry, Argentometry, Complexometry and Gravimetry. At least 10 primary standard solution to be prepared and used for 10 different assays strictly as per IP' 96.

RECOMMENDED BOOKS:

1. Practical Pharmaceutical Chemistry by A.H. Beckett and J.B. Stenlake.
2. Quantitative analysis by V. Alexeyev.
3. Vogel's Textbook of Quantitative Inorganic Analysis.
4. Indian Pharmacopoeia.
5. Jenkins Quantitative Pharmaceutical Chemistry
6. Fundamentals of Analytical Chemistry by Skoog, West and James Holler.

2.3 PHARMACEUTICS II (PHYSICAL PHARMACY)

Theory: 2 hrs /week

1. Diffusion and Dissolution - Fick's laws, Dissolution and dissolution test apparatus.
2. Surface and interfacial phenomena:
 - a) Liquid interfaces- surface and interfacial tensions, measurement, electrical properties of interface, surface free energy spreading coefficient
 - b) Surface active agents- HLB classification, solubilization, adsorption at liquid solid and gas interfaces
3. Dispersions systems:
 - a) Colloids- Definition, types, optical, kinetic and electrical properties.
 - b) Coarse dispersions:
 - (i) Suspensions – Theory of sedimentation, wetting of particles, Flocculation, Deflocculation and controlled flocculation, Sedimentation parameters
 - (ii) Emulsions – Theories of emulsification, phase volume ratio, Stability problems and stabilization.
4. Viscosity and Rheology:
 - a) Newtonian systems- properties
 - b) Non Newtonian systems- Plastic, Pseudo plastic, Dilatant, Thixotropy
 - c) Measurement of viscosity- Viscometers- capillary, Falling sphere, Cup and Bob, Cone and Plate.
5. Kinetics and Drug Stability:

Orders and rates of reaction, Half life determination ,Zero order ,Apparent zero order, Pseudo first order and First order –Effect of temperature ,light ,solvent reaction kinetics.

Accelerated stability studies-Stability problems, stabilization technique of pharmaceutical dosage forms, Expiration dating.
6. Micromeritics and Powder rheology:

Particle size and size distribution, Methods of determination- Optical microscopy, Sieving, sedimentation

Particle volume-Coulter counter

Particle surface area-Air permeability, Adsorption

Derived properties of powders- Porosity, Packing arrangement, Bulkiness, Flow properties, Densities-Carr's index, Hausner ratio,dosage form design.
7. Complexation methods for enhancement of solubility
Protein binding – Kinetics of protein –drug binding

Practicals: 3 hrs/week

Determination of interfacial properties-Surface tension, HLB value, Critical micellar concentration.

Effect of viscosity on sedimentation rate. Preparation of various types of suspensions and determination of their sedimentation parameters.

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

Determination of rates of reactions.

Study of derived properties of powders- Densities, porosity, compressibility, Angle of repose.

Study of emulsions- globule size analysis and stability.

Study of different types of complexes.

Accelerated stability testing, shelf life determination.

References:

1. Physical Pharmacy. Alfred Martin ; Fourth edition; Lipincott Williams & Wilkins
2. Remington, The Science and practice of pharmacy; 21st edition; Lipincott williams & wilkins
3. Cooper and Gunn's Tutorial Pharmacy; S.J.Carter; 6th edition ; CBS publishers & Distributors.
4. Pharmaceutics, The Science of dosage form design: Micheal.E.Aulton; 2nd edition ; English language book society/churchill livingstone.
5. Encyclopedia of Pharmaceutical technology; James.C.Boylan; 2nd edition; Marcel Dekker INC.

2.4 - PATHOPHYSIOLOGY & HEALTH EDUCATION

THEORY(2 hours/week)

A: PATHOPHYSIOLOGY

1. Basic principles of cell injury and adaptation: Causes of cellular injury, pathogenesis, morphology of cell injury, and cell death. Reversible and irreversible cell injury. Cellular adaptations Ex:- Atrophy, Dysplasia, Hyperplasia, Metaplasia & hypertrophy. Intercellular alterations in lipids, proteins, and carbohydrates.

2. Inflammation and repair: Alterations in vascular permeability and blood flow. Migration of WBC, acute and chronic inflammation, mediators of inflammation, brief outline of the process of repair.

3. Etiology, Pathophysiology & clinical significance of common diseases: Hypertension, CCF, Angina, AMI, Atherosclerosis, Asthma, Diabetes Mellitus, Peptic ulcer, Ulcerative colitis, Hepatic disorders, Anemia, Acute and chronic failure, Rheumatoid arthritis, Gout, Epilepsy, Mania, Depression, Psychosis, Urinary tract infections, Tuberculosis, Sexually transmitted diseases.

4. Neoplasms: Brief account on the etiology and pathogenesis of cancer. Characteristic features that differentiate benign and malignant neoplasms. Classification of important categories of neoplasms.

B: HEALTH EDUCATION

1. Concept of health and disease: Definition of physical health, mental health, social health spiritual health, determinants of health, indicators of health, concept of disease, natural history of disease, the disease causing agents and prevention of diseases.
2. Nutrition: Classification of food requirements, Balanced diet, Nutritional deficiency disorders, their treatment and prevention.
3. Environment and Health: Sources of water supply, specifications for drinking water, purification of water, water pollution, health and air, noise light – solid waste disposal and control – medical entomology, arthropod borne disease and their control, rodents, animals and diseases.
4. National immunization schedule, principles of disease control and prevention, hospital acquired infection, prevention and control.
5. Demography and Family planning: Demography cycle, Fertility, Family planning, Contraceptive methods. Legal aspects of Medical termination of pregnancy.
6. Communicable diseases: Causative agents, modes of transmission, Symptoms and prevention - Chicken pox, Measles, Influenza, Diphtheria, Whooping cough, Tuberculosis, Poliomyelitis, Hepatitis, Cholera, Typhoid, Food poisoning, Helminthiasis, Malaria, Filariasis, Rabies, Trachoma, Tetanus, Leprosy, Syphilis, Gonorrhoea and AIDS.
7. Non-communicable diseases: Etiology, preventive measures and control – Cancer, Diabetes Mellitus, Blindness, Cardiovascular diseases.
8. First aid: Emergency treatment of Shock, Snake bite, Burns, Heart diseases (AMI & LHF), Fractures and Resuscitation methods, General methods of treatment of Poisoning.

BOOKS RECOMMENDED:

1. Pathology and Therapeutics for Pharmacists Russel J Greene and Norman D Harris.
2. Text book of Basic pathology by Robbins S.L Kumar V & Cotran.
3. Text book of Preventive and Social Medicine by K. Park.
4. Remington: The Science and Practice of Pharmacy.
5. Text book of pathology – N C Dey and T K Dey.
6. Merck manual.
7. Text book of Pathology by Harsh Mohan

2.5 MATHEMATICS , BIOSTATISTICS & COMPUTER APPLICATIONS **(4 hrs/week)**

1. CALCULUS:

a) **DIFFERENTIAL:-** Limits and functions, definition of differential coefficient, differentiation of standard functions, Logarithmic differentiation, Parametric differentiation and Successive differentiation.

b) **INTEGRAL :-** Integration as inverse of differentiation, indefinite integrals of standard forms, Integration by parts, substitution and partial fraction, formal evaluation of definite integrals.

c) DIFFERENTIAL EQUATIONS

Revision of integral calculus, Definition and formation of differential equations, equations of first order and first degree variable separable, homogenous and linear differential equations of higher order with constant coefficients, Complimentary function and particular integral.

2. **LAPLACE TRANSFORM:** Definition, Properties of Laplace Transform, Laplace Transform of certain function, Inverse Laplace Transform, Applications to differential equations.

3. **BIOSTATISTICS:** Collection and classification of data, Diagrammatic representation of data, Bar chart pie diagram, Frequency polygon, Frequency curve, Cumulative frequency curves.

4. **MEASURES OF CENTRAL TENDENCY :-** Mean, Median, Mode, Measures of dispersion, Standard deviation, Coefficient of variation, Concept of probability and events, Bayes theorem, Probability distributions, Binomial and Poisson distribution, Normal distribution curve – correlation and regression analysis, Method of least squares, Statistical inferences, Student's t-test, F test and elements of ANOVA.

COMPUTER APPLICATIONS

1. Computer Hardware- Brief overview of input devices and output devices- Key board, Mouse, trackball, OCR, VDU, Printers, Plotters & Scanners, etc.
2. An outline of modern computing devices- Computer architecture, embedded systems and their applications.
3. SoftwareS: types of software – System, application and Custom software.
Operating systems- Types of Operating systems and their functions.
4. Programming languages – Machine language, Assembly language, High level Languages, Compilers and interpreters.

5. Computer Memory: Primary and secondary memory, Secondary storage devices- Floppy, CD, DVD, Flash Drive, etc.
6. Computer Networks – LAN, WAN, MAN, Inter and Intranet, wireless network, the World Wide Web, e-mails, web browsers, Search engines and servers.
7. Introduction to Office softwareS- Use and illustration of Word processing, presentation, spreadsheet and database management softwares including RDBMS
8. Pharmacoinformatics: Information systems and virtual library, Drug and poison information services, Application of computers in Pharmacy – Drug design and development, manufacture and In-process and Quality Control, Pharmacokinetics, Hospital, Community and Clinical Pharmacy, medication history storage and retrieval, dispensing of prescriptions, Pharmaceutical Research and Education. (Theory should be supplemented with practical training)

BOOKS RECOMMENDED :

1. Pharmaceutical statistics, David Jones
2. Mathematics for B.Pharm students, Frank Publication.
3. Computer Science Sumitha Arora. Dhanpathraj & Co.
4. Fundamentals of Computers. V Rajaraman. Prentice-Hall of India.
5. Bioinformatics 2000, Higgins and Taylor, OUP
6. Chemical space navigation in lead discovery by Tudor I Opera
7. Database management and information systems, by Henry Korth

**2.6 PHARMACEUTICS III
(PHARMACEUTICAL TECHNOLOGY)**

Theory 2 hrs/ week

1. Materials handling: Liquid handling- Different types of pumps. Reciprocating, Rotary, centrifugal and diaphragm pumps. Gas handling- various types of fans, blowers and compressors. Solid handling- Storage bins. Hoppers and conveyers.
2. Heat transfer: Sources and uses of heat in Pharmaceutical Industry. Use of steam as a heating medium. Conduction- Fourier' s law of heat conduction through variable area like pipes, spheres etc. Convection- Natural and forced convection. Flow of heat through liquids and equation for rate of heat transfer. Concept of individual film coefficient. Overall heat transfer coefficient. Log mean temperature difference.
3. Mechanical separation:
 - (a) Filtration and centrifugation- theory of filtration, filter media. filter aids, industrial filters including filter press, filter leaf, rotary filter, edge filter etc. Principles of centrifugation: Industrial centrifugal filters and centrifugal sedimenters.
 - (b) Size reduction and size separation: Definition, objectives of size reduction, factors affecting size reduction, laws governing energy and power requirements of a mill, types of mills including ball mill, hammer mill, fluid energy mills etc.

4. Evaporation: Factors affecting evaporation- Types of evaporators- short tube, forced circulation and film evaporators. Single effect and multiple effect evaporators.
5. Distillation. Raoult's law, Volatility, simple, steam and flash distillation. Principles of rectification, azeotropic and extractive distillation.
6. Drying: Moisture content and mechanism of drying, rate of drying and time of drying. Classification and types of dryers. tray, vacuum, tunnel, rotary, fluidized bed, spray, and drum dryers. Principles of freeze drying.
7. Humidification: Basic concepts and definition. Wet bulb and adiabatic saturation temperature. Humidity chart and measurement of humidity. Equipments for dehumidification operations.
8. Mixing: Theory of mixing. Mixers for powders, pastes and liquids
9. Materials of construction: Classification, Applications, Advantages and disadvantages. General study of composition, corrosion resistance & properties with special reference to stainless steel & glass. Brief overview of corrosion and its prevention.
10. Industrial hazards and safety precautions: Mechanical. Chemical & Electrical. Life and dust hazards, industrial dermatitis. Accident records etc.

PRACTICALS (3 hours/ week)

1. Determination of rate of filtration and study of factors affecting filtration including filter aids.
2. Determination of humidity-Use of dry bulb and wet bulb thermometers and psychrometric charts
3. Determination of overall heat transfer co-efficients.
4. Experiments based on simple, steam and azeotropic distillation. Determination of vaporisation efficiency.
5. Determination of rate of drying. Free moisture content and equilibrium moisture content.
6. Screen analysis of powders.
7. Sedimentation in liquids.
8. Particle size analysis using principles of settling (beaker decantation, pipette analysis)
9. Determination of rate of evaporation.
10. Experiments to illustrate solid -solid mixing, determination of mixing efficiency using different types of mixers.
11. Experiments to illustrate principles of size reduction, laws governing energy and power requirement of size reduction.

BOOKS RECOMMENDED:

1. Unit Operations of Chemical Engineering. McCabe and Smith
2. Introduction to Chemical Engineering. Badger and Banchero.
3. Cooper and Gunn's Tutorial Pharmacy; S.J.Carter; 6th edition ;CBS publishers & Distributors.
4. Pharmaceutics, The Science of dosage form design: Micheal.E.Aulton; 2nd edition ; English language book society/Churchill Livingstone.

5. Remington, The Science and practice of pharmacy; 21st edition; Lipincott williams& Wilkins

2.7. APPLIED BIOCHEMISTRY AND MOLECULAR BIOLOGY

THEORY (3hrs/week)

1. Introduction

a. Cell organelles and its biochemical functions

2. Bioenergetics:

a. Concept of free energy,; determination of change in free energy from equilibrium constant; Redox potential.

b. Energy rich compounds; ATP, Cyclic AMP , their production and biological significance

3. Enzymes

a. Definition; Nomenclature; IUB classification

b. Properties of enzymes

c. Factor affecting enzyme activity

d. Enzyme kinetics (Michaelis plot, Line Weaver Burke plot)

e. Enzyme inhibitors with examples

f. Mechanism of enzyme action and theories of enzyme action

g. Allosteric enzymes, Enzyme induction and repression

h. Isoenzymes and their diagnostic applications

i. Industrial, therapeutic and diagnostic applications of enzymes

j. Coenzymes –Vitamins as co enzymes and their biochemical significance, Metals as co enzymes and their biochemical significance

4. Biological oxidation

a. Enzymes and co-enzymes involved in Biological oxidation.

b. Electron transport chain (its mechanism and role).

c. Oxidative phosphorylation (its mechanism) and substrate level phosphorylation

d. Inhibitors ETC and Uncouplers or inhibition of oxidative phosphorylation

5. Carbohydrate metabolism

a. Definition, classification, chemistry and biological role of carbohydrates
Biological conversion of polysaccharides to glucose-1- phosphate.

b. Glycolysis and significance

- c. Citric acid cycle- significance, reactions and energetics of the cycle, amphibolic role of the cycle , glyoxalic acid cycle.
- d. HMP shunt and its significance
- e. Glycogen metabolism (Glycogenolysis and glycogenesis)
- f. Gluconeogenesis and its significance
- g. Various shuttle systems (glycerol – phosphate & malate - aspartate)
- h. Uronic acid pathway and its significance
- i. Hormonal regulation of carbohydrate metabolism
- j. Diabetes mellitus and glycogen storage diseases

6. Lipid metabolism

- a. Definition, classification, chemistry and biological role of lipids
- b. β -Oxidation of saturated and unsaturated fatty acids
- c. Ketone bodies metabolism (Ketogenesis and ketolysis) and ketosis
- d. Biosynthesis of fatty acids (*De novo*), essential fatty acids , eicosanoids (prostaglandins, thromboxanes, and leukotrienes.)
- e. Metabolism of cholesterol (Biosynthesis and degradation)
- f. Atherosclerosis, fatty liver and hypercholesterolemia
- g. Phospholipids and Sphingolipids (Chemistry, biosynthesis, significance)

7. Amino acid metabolism

- a. Definition, classification , biosynthesis and biological role of amino acids
- b. Transamination, deamination & decarboxylation., assimilation of ammonia
- c. Urea cycle and its metabolic disorders
- d. Metabolism of sulfur containing amino acids
- e. Catabolism of tyrosine, tryptophan, phenylalanine and their metabolic disorders
- f. Synthesis and significance of biological substances; creatine, histamine,
- g. 5-hydroxy Tryptophan (5-HT), dopamine, noradrenaline, adrenaline
- h. Porphyrins, bile pigments; hyperbilirubinemia (Metabolism of heme)

8. Nucleic acid metabolism

- a. Definition, chemistry and biological role of nucleosides, nucleotides
- b. Biosynthesis of purine and pyrimidine nucleotides
- c. Catabolism of purine and pyrimidine nucleotides

9. Molecular Biology

- a. Informational macromolecules
- b. Structure of DNA and significance as genetic material
- c. Central Dogma of Molecular Biology
- d. RNA, structure, types and significance in protein synthesis
- e. DNA replication, types and details on semi conservative model

- f. Transcription, Translation and regulation of gene expression
- g. Mutation and DNA damage and repair mechanism
- h. A brief account of genetic engineering and polymerase chain reaction.
- i. Structure and function of chromosomes and a brief account of its disorders
- j. Genetic code
- k. Molecular basis of disease diagnosis-DNA detection methods, Immunological methods

Practicals (3hrs/wk)

Qualitative experiments

1. Qualitative analysis of carbohydrates (Glucose, fructose, lactose, maltose, sucrose).
2. Qualitative analysis of Proteins (Casein, Albumin, Gelatin, and Peptone)
3. Qualitative analysis of normal constituents of urine.
4. Qualitative analysis of abnormal constituents of urine.
5. Separation of lipids by TLC
6. Isolation and determination of RNA, DNA

Quantitative experiments

7. Quantitative estimation of carbohydrates by DNSA method.
8. Quantitative estimation of proteins by Biuret method.
9. Quantitative estimation of urine sugar by Benedict's reagent method.
10. Quantitative estimation of urine chlorides by Volhard's method.
11. Quantitative estimation of urine creatinine by Jaffe's method.
12. Quantitative estimation of urine calcium by precipitation method.
13. Quantitative estimation of blood sugar Folin-Wu tube method.
14. Quantitative estimation of blood creatinine by Jaffe's method
15. Quantitative estimation of serum cholesterol.
16. Estimation of Urea in Serum.
17. Estimation of SGOT in serum.
18. Estimation of SGPT in serum.
19. Determination of Salivary amylase activity.
20. Study the effect of pH and temperature on salivary amylase activity.
21. Preparation of standard buffer solutions (citrate, phosphate, and carbonate) and its pH measurements

Recommended Books:

1. Principles of Biochemistry by Lehninger.
2. Harper's Biochemistry by Robert K. Murry, Daryl K. Granner and Victor W. Rodwell.
3. Biochemistry by Stryer.
4. Biochemistry by D. Satyanarayan and U.Chakrapani
5. Outlines of Biochemistry by Conn and Stumpf
6. Practical Biochemistry by R.C. Gupta and S. Bhargavan.
7. Introduction of Practical Biochemistry by David T. Plummer. (3rd Edition)

8. Practical Biochemistry by Harold Varley.
9. Laboratory manual of Biochemistry by Pattabiraman and Sitaram Acharya
10. Medical Biochemistry and Biotechnology by Dr. Mohammed Amanullah. New Central Book Agency
11. Fundamentals of Biochemistry by Dr. A. C. Deb. New Central Book Agency

THIRD YEAR B PHARM

3.1. PHARMACEUTICS IV

(PHARMACEUTICAL MICROBIOLOGY AND BIOTECHNOLOGY)

Theory 2 hrs/Week

1. Introduction to the scope of microbiology. Microscopy-compound, dark field, phase contrast, UV, fluorescence and electron microscopy.
2. Classification of microbes and bacterial taxonomy. Elementary study of important pathogenic microorganisms, biochemical methods for identification.
 - a) Structure of bacterial cell. Endospores and mechanism of spore formation. L forms. Identification methods of microbes; stains and types of staining techniques.
 - b) Bacterial Nutrition, cultivation of bacteria. Culture media, its classification with examples. Aerobic and anaerobic culture methods. Isolation of Pure culture.
 - c) Classification & Structure of Viruses. Cultivation of Viruses, Viral replication. Virus-Host interactions. Bacteriophages, phage typing. Bacteriocins.
 - d) Introduction to fungi of Medical and pharmaceutical importance. Fungal reproduction and cultivation.
3. Microbial genetics and variation. Isolation of mutants, factors influencing rate of mutation. Genetic recombination: Transformation, Conjugation, Transduction, Protoplast fusion.
Gene Cloning and their Applications, introduction to the methods of rDNA technology, Introduction to transgenesis and its applications.
4. Immunity. Primary and Secondary defensive mechanisms of body, microbial resistance. Interferons.
 - a) Immunological Preparations: Principles, Antigens and Haptens, Immune System, Cellular and Humoral Immunity, Antibodies, Immunological Tolerance. Hypersensitivity.
Active and Passive immunization, Vaccines and Sera, their preparation, standardization and storage. Development of Hybridoma for Monoclonal Antibodies.
 - b) Antigen – Antibody reactions and their applications.
5. Control of microbes by Physical and Chemical methods:
 - a) Disinfection, factors influencing disinfectants, dynamics of disinfection, Evaluation of Disinfectants.
 - b) Sterilisation- different methods, validation of sterilisation methods and equipments.
Sterility testing of pharmaceutical products as per the I P.

6. a) Antibiotics: Antimicrobial Spectrum and methods used for standardization. Microbial assay of antibiotics.
b) Fermentation technology; Basic principles of fermentation, isolation and screening of industrially important microbes, types of fermentation, downstream process, Fermenter design and control of different parameters. Fermentation process. Screening of soil for organisms producing antibiotics. Extraction of fermentation products with special reference to Penicillin, alcohol, amylase and Vitamin B₁₂.
7. Enzyme immobilization: Techniques of immobilization of enzymes.
8. Microbial transformation: Introduction, Types of reactions mediated by microorganisms, selection of organisms, Biotransformation process and its improvements with special reference to steroids.

Practicals: 3 hrs/week

1. Experiments devised to prepare different types of culture media, distribution of microorganisms in the environment, sub culturing of various aerobic and anaerobic bacteria.
2. Aseptic transfer and isolation of pure culture.
3. Demonstration of bacterial motility by hanging drop experiment
4. Various staining methods-Simple, Gram, Negative staining.
5. Demonstration of biochemical activities of microorganisms
6. Antigen-Antibody reaction.
7. Sterility testing as per I.P
8. Microbial sensitivity testing and assay of antibiotics.

Books recommended :

1. "Prescott, Harley & Klein's Microbiology"
2. "Pharmaceutical Microbiology" W.B Hugo and A.D Russel.
3. "Text book of Microbiology" R. Anantha Narayanan and C.K Panicker.
4. "Industrial microbiology" L E Casida.
5. "Pharmaceutical Biotechnology" O Kayser, R H Muller.
6. "Industrial Microbiology: Fundamentals and applications" Agarwal and Purohit.
7. "Microbiology- A Laboratory Manual" James G Cappuccino
8. "Laboratory manual in microbiology" P Gunasekharan

3.2. PHARMACEUTICAL CHEMISTRY –IV (CHEMISTRY OF NATURAL PRODUCTS)

THEORY 3hrs/wk

1. Carbohydrates:

Definition, classification, nomenclature, relative configuration of some important monosaccharides, mutarotation, structure determination of glucose and fructose, ring structure of glucose, determination of ring size oxidation-reduction reactions, osazone formation, action of barium hydroxide, epimerization, Lobry De Bruyn – Van Ekenstein reaction, structure of sucrose, maltose, lactose, properties of sucrose, glycosidic linkage, non-reducing nature; structure of starch, cellulose, cellulose derivatives and deoxy sugars. A brief account on pharmaceutical importance of various carbohydrates.

2. Proteins and Amino acids:

Amino acids: Definition, classification, essential amino acids, configuration, important methods of preparation of amino acids, physical properties-Zwitter ionic nature, isoelectric point, chemical properties, peptides, peptide synthesis and determination of structure of peptides [End group analysis]

Proteins: Definition, classification, denaturation, primary, secondary and tertiary structure of proteins. pharmaceutical importance of amino acids, polypeptides and proteins.

3. Terpenoids:

Introduction, classification, isoprene rules, chemistry and uses of geraniol, alpha-terpineol, camphor, ionones.

4. Alkaloids:

Introduction, Chemical classification, general isolation, Structural elucidation of alkaloids-General methods, chemistry Structural elucidation and pharmacological activity of Atropine, morphine, &ephedrine.

5. Glycosides:

Introduction, Chemistry of Cardiac glycosides including their chemical structures with SAR, Chemistry of sapogenins.

6. Vitamins:

Classification, structural elucidation, chemistry and pharmaceutical uses of vitamin A, D, B₁, B₂, B₆ & C.

7. Purines:

chemistry and structural elucidation of uric acid & caffeine. Inter-relationship of caffeine, theobromine and theophylline.

8. Fats &Oils:

Introduction, Analytical constant of fats & oils, methods for their determination & significance.

9. Steroids:

Introduction, Nomenclature of steroids, stereochemistry and numbering the ring system. Chemistry of cholesterol, ergosterol, & bile acids.

10. Hormones:

- a) Estrogens – Structures & inter-relationship of estrone, oestradiol, & oestriol. Synthesis and uses of non-steroidal estrogenic compounds.
- b) Progesterone – structure and uses. Synthesis of Progesterone from cholesterol. Steroidal oral contraceptive agents
- c) Androgens – Structure and biological activities & uses of Testosterone and synthetic anabolic steroids
- d) Hormones of Thyroid: Skeletal structure, biological activities of Thyroxine and triiodothyronine
- e) Adrenal Cortex Hormones:
Mineralocorticoids: Structure, biological activities and uses of Aldosterone,
Glucocorticoids: Cortisone & Hydrocortisone – Structure, biological actions and uses of important synthetic corticosteroids.
- f) Hormones of Pancreas:
Insulin – Introduction, structural features – some sequence differences in insulins of some species like humans, pork, beef.
Glucagon – Structure and Physiological role.

11. Prostaglandins:

Introduction, biological importance and structures of Prostaglandins

PRACTICALS (3hrs/wk)

1. Identification of alkaloids by specific colour tests.
2. Tests for steroids and cardiac glycosides. Liberman- Burchard test, Salkowski reaction, etc.
3. Tests for flavanoids and their glycosides.
4. Determination of chemical constituents of fats & oils
(Acid value, Saponification value, Iodine value, Acetyl value and peroxide value of fixed oils)
5. Analysis of proteins: C-terminal & N-terminal analysis.
6. Synthesis of simple peptides
7. Estimation of drugs coming under alkaloids, antibiotics, vitamins & other pharmaceutically significant products of natural origin.

BOOKS RECOMMENDED:

1. O.P. Agarwal, Natural products Vol.1 & 2, Goel publications – Meerut.

2. JB Harborne, Phyto Chemical methods.
3. I. L Finar, Organic chemistry, Vol. II, the English language book society, London, New Delhi.
4. RT Morrison and R.N BOYD, Organic chemistry, Allyn and Bacon, inc., Boston
5. Me – Wolf, ed., Burger's medicinal chemistry, J. Wiley & sons, NY.
6. F.G. Mann & B. Saunders, Practical Organic chemistry Longmans green & Co. Ltd., UK.
7. RM. Acheson, an introduction to the chemistry of heterocyclic compounds

3.3. PHARMACOLOGY I

Theory(3hrs/wk)

A) .General pharmacology

a. Introduction

History of pharmacology, definitions of Drugs,proprietary name,non proprietary name, pharmacotherapeutics, pharmacokinetics, pharmacodynamics, posology, toxicology, bioequivalence,(Defenition only) chemotherapy, drug interaction, adverse drug reactions & pharmacovigilence (Defenition only),Pharmacoeconomics (Defenition only), pharmacoepidemiology,orphan drugs

b. Routes of drug administration

Routes of drug administration and factors governing choice of routes: Oral, parenteral, and local routes, transdermal drug administration, Newer drug delivery systems ,targeted delivery and drug eluting stents.

c. Pharmacokinetics :

1.Absorption -Absorption of drugs- Biological membranes, different membrane transport mechanism, Transmembrane transporters,Bioavailability, factors influencing drug absorption&bioavailability.

2. Distribution - distribution of drugs,volume of distribution ,redistribution.

Barriers of dtribution .Plasma protein binding of drugs& clinical importance.

Tissue storage of drugs

3.Biotransformation- Biotransformation of drugs, microsomal enzyme induction and inhibition.Factors affecting metabolism. Prodrugs, first pass metabolism, enterohepatic cycling of drugs

4.Excretion- Excretion of drugs.

d. Pharmacodynamics :

1.General mechanism of drug action-Molecular mechanism of drug action

Enzymes as targets of drug action, dose response relationship Structure activity relationship,

2. Drug receptors-Receptor theories, affinity, efficacy, agonists, antagonists, partial agonists, inverse agonists, spare receptors, silent receptors, receptor up regulation & down regulation, desensitization`

3. Receptor subtypes- Types of receptors-Ionotropic, metabotropic, kinase linked, gene transcription regulating receptors

4. Dose response relationship-graded and quantitative relationship, D50, ED50, therapeutic index, therapeutic window, margin of safety

Combined effect of drugs-Additive effect, synergism, drug receptor antagonism.

Factors modifying drug action.

e) Drug dose & dosage:

Fixed dose combination-Advantages & disadvantages. Banned drugs

f) Rational use of medications:

Rational prescribing irrationalities in prescription P drug concept and P treatment, essential drugs, spurious drugs, expiry dates of medication

g). Pharmacogenetic variation in drug action

h). Principles of Toxicology

1. Definition of poison, general principles of treatment of poisoning.
2. Heavy metals and their antagonists.
3. Definition for acute, sub acute and chronic toxicity, genotoxicity, Carcinogenicity, teratogenicity and mutagenicity studies. Acute, subacute and chronic toxicity and genotoxicity studies, Various organ toxicities.

i. Drug interactions:

Definition, epidemiology, classification & pharmacological mechanisms of drug interactions with suitable examples and management.

j. Adverse effects of drugs:

Adverse drug reactions: Definition and classification, epidemiology, predisposing factors, mechanism of adverse drug reactions, Drug allergy-Mechanism, types and treatment.

Drug dependence: Tolerance, habituation, addiction, treatment.

k. Pharmacology of drugs in special groups:

Pregnancy, lactation pediatrics and elderly.

1. Chronopharmacology

Definition of rhythm and cycles, Biological clock and their significance leading to chronotherapy.

B). Pharmacology of following classes of drugs

Emphasize on classification, molecular mechanism of action, pharmacological actions, pharmacokinetics, adverse effects, contraindications, drug interaction, clinical uses, preparation and dosages.

1. Drugs acting on autonomic nervous system

- a. Cholinergic system –Neurotransmitters of cholinergic transmission, receptors of acetylcholine, cholinergic drugs, anticholinesterases, anticholinergic drugs, ganglionic stimulants and blockers, neuromuscular blocking drugs, drugs in myasthenia gravis
- b. Adrenergic system –Nor adrenergic transmission& neurotransmitters, Adrenergic receptors, adrenergic drugs , antiadrenergic drugs.
- c. Ocular pharmacology: Mydriatics, miotics and drugs used in glaucoma.

2. Autocoids and their antagonists.:

Histamin, antihistamins, 5HT, 5HT blockers. Renin -Angiotensin system and drugs modifying it. Kinins, enkephalins, prostaglandins and other polypeptides

3. Cardiovascular drugs :

- a. Cardiac glycosides, management of digitalis toxicity, drugs for heart failure, Pharmacotherapy of heart failure.
- b. Antiarrhythmic drugs and pharmacotherapy of cardiac arrhythmias.
- c. Vasodilators and antianginal drugs and pharmacotherapy of angina pectoris.
- d Hypolipidemic drugs and plasma expanders
- e. Anti hypertensive drugs and pharmacotherapy of hypertension

4. Drugs acting on respiratory tract:

Mucolytic agents, Antitussives, Expectorants, Drugs for bronchial asthma, Pharmacotherapy of bronchial asthma.

5. Drugs acting on endocrine system:

Anterior pituitary hormones, Thyroid hormones & antithyroid drugs, Parathyroid hormones. Insulin & oral antidiabetic agents, Pharmacotherapy of diabetes mellitus. Adrenal cortical steroids, Gonadotropins, Oestrogens & Progesterones. Antifertility agents & ovulation inducing agents. Androgens, antiandrogens & anabolic steroids

Pharmacology I (Practical) **3 Hours/Week**

1. Commonly used instruments in experimental pharmacology.
2. Common laboratory animals and anesthetics used for animal studies.
3. Physiological salt solutions and their preparation
4. Preparation of stock solutions of drugs and their dilutions
5. Handling of experimental animals, weighing and calculation of dose of a drug to be administered.
5. Some common and standard techniques.
 - a. Bleeding (blood withdrawal), and intravenous injection, intramuscular injection, intraperitoneal injection, intragastric administration
 - b. Procedures for rendering animal unconscious (CPSCEA guideline) and chemical euthanasia.
6. Study of different routes of drug administration in mice/rats.
7. To study the effect of hepatic microsomal enzyme inhibitors and inducers on the phenobarbitone sleeping time in mice.
6. Effect of autonomic drugs on rabbit's eye.
8. To record CRC of acetylcholine by using suitable skeletal / smooth muscle preparations.
9. Study of agonistic/potential of drug action using suitable isolated tissue preparation
10. Study of drug antagonism using suitable isolated tissue preparations.
11. To record the CRC of 5HT on rat fundus preparation.
12. Experiments based on computer models like Expharm.
13. Estimation of bioavailability parameters viz AUC, T_{max} , K_{el} from blood and urine samples in laboratory animals (rabbits)
14. Study of the effect of drugs on dog blood pressure using graphical recordings using computer models like Expharm
15. Study of the effect of drugs on frog heart using computer models/ graphical recordings .

Recommended Books:

1. Pharmacology by Rang. M.P. Dale, M.M, Reter J.M.
2. Pharmacology and Pharmacotherapeutics by Satoskar R.S and Bhandarkar S.D.
3. Goodman and Gilman's, The pharmacological basis of therapeutics by Gillman G, Rall

- T.W, Nies A.I.S, and Taylor P.
4. Hand book of Experimental Pharmacology by Kulkarni.S.K.
 5. Chronopharmacology by B. Lammer.
 6. Topics of Molecular Pharmacology I and II by Nurger and Roberts.
 7. Essentials of medical pharmacology by K.D.Tripathi.
 8. Essentials of Pharmacotherapeutics by F. S. K. Barar.
 9. Basic & Clinical Pharmacology by Katzung B.G.
 10. Lippincott's illustrated Reviews- Pharmacology by Mycek M.J, Gelnet S.B and Perper M.M.
 11. Fundamentals of Experimental Pharmacology by M. N. Ghosh.
 12. Pharmacological Experiments on intact preparations by Macleod L.J.
 13. Drug Discovery and evaluation by Vogel H.G.

3.4 -PHARMACEUTICS V (BIOPHARMACEUTICS AND PHARMACOKINETICS)

Theory 2 hrs/week

1. Introduction to biopharmaceutics and pharmacokinetics.

Biopharmaceutics – Biopharmaceutical classification system
 Significance of plasma – drug concentration.
 Absorption – passage of drugs across biological barriers.
 (Passive diffusion, Active transport, Facilitated diffusion, Endocytosis and Pinocytosis) Pharmacokinetics of drug absorption- zero order and first order absorption rate constants Method of residuals. Factors influencing absorption – physicochemical and pharmaceutical.

2. Distribution

Factors affecting distribution, physiological barriers for distribution, volume of distribution. Plasma protein binding.

3. Elimination

Biotransformation – Phase I and Phase II reactions
Excretion – Mechanism of renal clearance, Concept of clearance, Clearance ratio, Determination of renal clearance, Dosage adjustment in patient with renal failure, Extraction ratio, Hepatic clearance, Biliary excretion, Entero Hepatic Circulation.
Compartment models- Definition, One compartment model- IV Bolus, IV Infusion, Extra-Vascular administration. Determination of pharmacokinetic parameters from plasma and urine data. Two compartment model- IV Bolus- determination of pharmacokinetic parameters
Non linear pharmacokinetics- One compartment model IV Bolus administration, *Michaelis-Menten* equation.
Measurement of Bioavailability- C_{max}, t_{max}, AUC.

Design of single dose Bioequivalent study, dissolution and disintegration testing.
In vitro-in vivo correlation.

PRACTICALS

3 hrs/week

1. Determination of partition coefficient of drugs with different buffer/ solvent systems
2. Diffusion study of drugs using egg membrane and artificial membrane
3. Dissolution study of tablets as per the official monographs
4. Experiments to illustrate mechanism of absorption using isolated organs
5. Experiments to study transdermal permeation of drugs using Franz diffusion
6. In vitro study of protein binding of drugs
7. In vitro study of one compartment model for I V bolus and oral administration of drugs
8. In situ absorption study of drugs using animal model
9. In vivo absorption / bioavailability study of oral liquid dosage forms using animal models
10. Determination of pharmacokinetic parameters using given data of plasma/ urine concentration – time profile.

Books recommended:

1. Shargel L and Yu AB, Applied Bio-Pharmaceutics and Pharmacokinetics, Appleton & Lange
2. Rowland M and Tozer TN, Clinical Pharmacokinetics concepts and applications, 3rd Edn., Lea & Febiger
3. Rodney J Y Ho, Milo Gibaldi “Biotechnology & Biopharmaceutics”
4. Gibaldi M, Bio-Pharmaceutics and Clinical Pharmacokinetics, 4th edn, Lea and Febiger
5. Brahmankar and Jaiswal, Bio-Pharmaceutics and Pharmacokinetics – A Treatise, 2nd Edn., Vallabh Prakashan.

3.5- PHARMACEUTICAL JURISPRUDENCE

Theory: 2 hrs/ week

1. Introduction:

Definition and scope of Forensic pharmacy.

Pharmaceutical legislation in India. Historical developments.

Pharmacist's role in drug treatment and drug usage.

Pharmacist as a member of the Health Care Scheme.

Professional ethics in Pharmacy practice. Legal and ethical responsibilities of pharmacists.

2. A detailed study of the following Acts and their significance to the profession of Pharmacy:

- (a) Pharmacy Act.
- (b) Drugs and Cosmetics Act.
- (c) Medicinal and Toilet preparations (Excise Duties) Act and Rules.
- (d) Narcotic Drugs and Psychotropic Substances Act.
- (e) Drugs and Magic Remedies (Objectionable Advertisements) Act.

3. A brief study of the following Acts and their significance in Pharmacy:

- (a) Drugs Prices Control Order.
- (b) A.I.C.T.E. Act.
- (c) Patents Act.
- (d) Trade and Merchandise marks Act.
- (e) States Shops and Establishments Act.
- (f) Minimum Wages Act.
- (g) Factories Act.
- (h) Prevention of Food Adulteration Act and Rules.
- (i) Prevention of Cruelty to Animals Act.
- (j) Medical Termination of Pregnancy Act.
- (k) The Poisons Act.

4. Assignment Topics:

Drug tragedies. Drug poisoning, drug accidents and drugs in suicides. Committee reports on drug accidents.
 Trade names. Combination preparations, banned drugs & combinations.
 Newly introduced and out dated drugs.
 Important case decisions published in drug cases relating to various topics covered in the subject.

REFERENCES:

1. All Acts and Rules including the latest amendments as per syllabus. Published by the Government of India.
2. A Textbook of Forensic Pharmacy by N K Jain.
3. A Textbook of Forensic Pharmacy by B M Mithal.

3.6- PHARMACOGNOSY-II THEORY [2 hrs/week]

1. Study of the biological sources, cultivation, commercial varieties, chemical constituents, substitutes, adulterants, uses, diagnostic, macroscopic and microscopic features and specific chemical tests of the following groups of drugs containing glycosides:
 Saponins: Liquorice, Ginseng, Dioscorea and Sarasparilla

- Cardioactive sterols: Digitalis, Squill, Strophanthus and Thevitia.
 Anthraquinone cathartics: Aloes, Senna, Rhubarb and Cascara.
 Others: Psorelea, Gentian, Saffron, Chirata and Quassia.
2. Studies of traditional drugs, common vernacular names, botanical sources, morphology, and chemical nature of chief constituents, pharmacology, categories and common uses and marketed formulations of indigenous drugs:
 Amla, Kantakari, Satavari, Tylophora, Bhilwa, Arjuna, Asokha, Kalijiri, Rasna, Punarnava, Chirata, Apmarg, Gokhru, Shankapushpi, Brahmi, Methi, Lahsun, Palash, Guggal, Gymnema, Shilajit and Neem.
 3. Introduction to alternative systems of medicine. The Holistic concept of drug administration in traditional system of medicine. Introduction to Ayurvedic preparations like Asavas, Gutikas, Tailas, Choornas, Lehyas and Bhasmas.
 4. Systematic study of source, cultivation, collection, processing, commercial varieties, chemical constituents, adulterants, uses, diagnostic macroscopic and microscopic features and specific chemical tests of following alkaloid containing drugs:
 Pyridine & Piperidine: Tobacco, Areca and Lobelia.
 Tropane: Belladonna, Hyoscyamus, Datura, Duboisia, Coca and Withania.
 Quinoline & Isoquinoline: Cinchona, Ipecac, Opium.
 Indole: Ergot, Rauwolfia, Catharanthus, Nuxvomica and Physostigma.
 Imidazole: Pilocarpine.
 Steroidal: Veratrum and Kurchi.
 Alkaloidal amines: Ephedra and Colchicum.
 Glycoalkaloid: Solanum
 Purines: Coffee and Tea
 5. General techniques of biosynthetic studies and basic metabolic pathways. Brief introduction to biogenesis of secondary metabolites of pharmaceutical importance. Shikimic acid pathway, Acetate mevalonate Pathway, Isoprenoid synthesis
 6. Introduction, classification and study of different chromatographic methods and their application in evaluation of herbal drugs.
 7. Preparation of the extracts and various extraction techniques including super critical fluid extraction.
 8. Chemotaxonomy of medicinal plants.
 9. Marine pharmacognosy, novel medicinal agents from marine sources.
 10. Plant allergens and allergenic substances. Classification and preparation of allergenic extracts.
 11. Biological sources, preparation, identification tests and uses of the following enzymes: Diastase, Papain, Bromalein, Maltase
 12. Protein containing drugs : Gelatin, Collagen, spirulina

PRACTICALS

[3 hrs/week]

1. Identification & morphological study of crude drugs listed in theory. (Any 15)
2. Microscopic study (T.S.) of crude drugs listed in theory (at least ten).
3. Standardization of some traditional drugs and their formulations – Asavas, arishtas,

- churnas, lehyas, gutikas.
4. Chromatographic techniques (demonstration only)
 - [a] Paper chromatography
 - [b] Thin layer chromatography
 - [c] Column chromatography
 5. Identification of following crude drugs by powder microscopy studied in theory. (Mixture of two)

[a] Cinchona	[b] Ephedra	[c] Digitalis	[d] Senna
[e] Valerian	[f] Vinca	[g] Rauwolfia	
[h] Quassia			
 6. General and specific chemical test for

[a] Alkaloids	-	Atropine, Quinine, Caffeine
[b] Cardiac glycosides	-	Digitoxin, Digoxin
[c] Saponins	-	Glycyrrhizin
[d] Anthraquinon Glycosides	-	Sennosides, Aloin
[e] Flavonoid Glycosides		
[f] Cynogenetic Glycosides		
 7. Chemical Assays:
 - a) Aldehyde content of volatile oil.
 - b) Ester value of volatile oil.
 - c) Phenol content of volatile oil.
 - d) Alkaloidal assay.
 8. Phytochemical screening of formulations

Books Recommended:

1. Bain KR, and Turner TD, Practical Evaluation of Phytopharmaceuticals "Wright scintecnica Bristol".
2. Trease and Evans WC, Pharmacognosy Lea & Febiger. Philadelphia.
3. Wallis TE. Analytical microscopy. J & A Churchill limited London.
4. Tyler VC, Brady LR and Robert JE, Pharmacognosy, Lea & Febiger Philadelphia.
5. Atal CK and kapur BM, cultivation and utilization of medicinal plants, RRL, Jammu.
6. Harborne JB. Biochemistry of phenolic compounds. Acadmic press New York.
7. Harborne JB, Phytochemical methods, Chapman and Hall, International Edition, London.
8. Iyengar MA study of crude drugs. Manipal power press. Manipal
9. Iyengar MA and Nayak SGK. Anatomy of crude drugs. Manipal power press. Manipal
10. Iyengar MA, Pharmacognosy of powdered crude drugs, Manipal press. Manipal.
11. Kokate CK, Practical Pharmacognosy. Vallabh Prakashan. Delhi.
12. Kokate CK, Purohit AP and Gokhale SB. Pharmacognosy (Degree) Nirali Prakashan, Pune.

13. Agarwal SS, Paridhavi M, Herbal Drug Technology. Orient Longmann Pvt. Ltd. Hyderabad.
14. Ansari S. H, Essentials of Pharmacognosy. Birla publications Pvt Ltd. Delhi.
15. Ashutosh kar, Pharmacognosy & Pharmaco biotechnology, New age international publishers, New Delhi.
16. Zafar R, Medicinal Plants of India, CBS Publisher, New Delhi.
17. Indian Herbal Pharmacopoeia, Indian drug manufacturers association, Mumbai.
18. The Ayurvedic Pharmacopoeia of India volume : I – V, Government of India, Ministry of Family and Welfare, Department of Indian System of Medicine & Homeopathy, New Delhi.
19. Medicinal plants of India, Indian Council of Medical Research, New Delhi.

3.7- PHARMACEUTICAL MANAGEMENT
(PHARMACEUTICAL INDUSTRIAL MANAGEMENT AND
REGULATORY AFFAIRS)
Theory 2hrs/week

- 1. Accountancy-** Accounting concepts and conventions, Preparation of journals, ledgers, cashbooks.
- 2. Trade-** Different types of trade. Procedure for import and export of goods. Pharmaceutical Marketing. Functions, buying and selling, transportation, storage, feedback information, channels of distribution, wholesale, retail, departmental stores, multiple shops and mail order business.
- 3. Salesmanship** - Principles of sales promotion, advertising ethics of sales, merchandising, literature, detailing, recruitment, training, Evaluation, compensation to the pharmacist.
- 4. Management** –Principles of management, administrative and productive management, HR and Financial management, Market research. Measuring and forecasting market demand.
- 5. Industrial material management**-Basic principles, purchase, raw material stores, inventory control.
- 6. Good Manufacturing Practice**-Definition. cGMP in manufacturing, facilities, quality audit, design, development and process validation methods for Pharmaceutical operations involved in production of tablets.
- 7. Stability testing protocols** –for various pharmaceutical products. Protocols- for bioavailability and bio equivalence studies
- 8. Intellectual property rights**, New Drug Applications and Abbreviated New Drug Applications.

REFERENCES:

1. Pharmaceutical Marketing in India by S.V Subba Rao
2. Marketing Management by Philip Kotler, Printice Hall publication
3. Accountancy and Commerce by T. Krishna Rao and V V Varma

4. Principles and methods of Pharmacy Management by Smit
5. Principles of Pharmaceutical Marketing by Smith. Lea and Febiger
6. Pharmaceutical Industrial Management by R M Mehta

FINAL YEAR B PHARM

4.1. PHARMACEUTICAL CHEMISTRY - V (MEDICINAL CHEMISTRY)

THEORY (3hrs/wk)

1. Physicochemical properties in relation to biological action:

Ionization, Drug distribution and pKa, Hydrogen bonding, Protein binding, Chelation, Isosterism, Optical and Geometrical isomerism, Steric Effect and Redox potential.

2. Principles of Drug Design :

Traditional analog, Quantitative structure activity relationship (QSAR) and mechanism based approaches. Applications of Quantum mechanics, Computer aided drug Designing (CADD) and Molecular modeling.

3. Basic Concepts and Applications of Prodrug Design:

4. Study of Classification, Mechanism of Action, Structure activity relationship, uses and Synthesis of selected drugs (Only drugs marked with asterisk) on the following categories of drugs:

- a) **General Anaesthetics:** Halothane*, Diethyl ether, Thiopentone Sodium, Thiamylal sodium*, Ketamine.
- b) **Local Anaesthetics:** Benzocaine, Procaine, Lignocaine*, Mepivacaine, Dibucaine*, Phenacaine.
- c) **Anxiolytics, Sedatives and Hypnotics:** Chlordiazepoxide, Diazepam*, Oxazepam, Alprazolam, Triclofos Sodium, Buspirone.
- d) **Antipsychotics:** Chlorpromazine*, Thioridazine, Prochlorperazine*, Chlorprothixene, Thiothixene, Haloperidol, Risperidone.

- e) **Anticonvulsants:** Phenytoin*, Fosphenytoin, Trimethadione, Ethosuximide, Carbamazepine, Sodium Valproate*, Clonazepam
- f) **Antidepressants:** Imipramine*, Amitryptiline, Doxepine*, Fluoxetine.
- g) **Adrenergic agents:** Adrenaline *, Isoprenaline, Salbutamol*, Naphazoline, Xylometazoline.
- h) **Adrenergic antagonists:** Tolazoline, Prazosin, Propranolol*, Metoprolol*.
- i) **Cholinergic Drugs:** Acetylcholine, Carbachol*, Neostigmine, Pyridostigmine*.
- j) **Cholinergic Blocking agents:** Cyclopentolate*, Dicyclomine*, Clidinium bromide, Propantheline bromide.
- k) **Antipyretics:** Aspirin, Salsalate, Paracetamol*
- l) **Narcotic Analgesics:** Morphine, Codeine, Levorphanol, Pethidine*, Pentazocine.
- m) **Non steroidal anti-inflammatory agents:** Oxyphenbutazone, Indomethacin*, Ibuprofen*, Diclofenac, Naproxen, Piroxicam*, Nimesulide, Celecoxib
- n) **Antihistaminic agents:** Diphenhydramine*, Tripelenamine, Chlorpheniramine, Triprolidine, Promethazine*, Cyclizine*, Cetirizine, Astemizole.
- o) **H₂ Receptor antagonist and Proton Pump Inhibitors:** Cimetidine, Ranitidine, Famotidine, Omeprazole, Pantoprazole.
- p) **Diuretics:** Acetazolamide, Hydrochlorothiazide, Furosemide*, Ethacrynic acid, Spironolactone, Triamterene*, Indapamide*.
- q) **Antihypertensive agents:** Methyl dopa*, Hydralazine, Diazoxide, Enalapril, Nifedipine, Losartan.
- r) **Antihyperlipidemic Agents:** Clofibrate, Niacin, Lovastatin, Ezetimibe.
- s) **Oral Hypoglycemic agents and Antithyroid drugs:** Tolbutamide*, Glipizide, Metformin*, Glimepride, Rosiglitazone, Carbimazole*.
- t) **Local Anti infective agents:** Liquified Phenol, Benzalkonium chloride, Chlorhexidine.
- u) **Antifungal agents:** Griseofulvin, Clotrimazole, Fluconazole, Tolnaftate*.
- v) **Antitubercular agents:** INH*, PAS*, Pyrazinamide, Ethionamide.
- w) **Antiprotozoal agents:** Metronidazole*, Tinidazole, Diloxanide.
- x) **Anthelmintics:** DEC*, Mebendazole*, Niclosamide, Ivermectin.
- y) **Antimalarials:** Chloroquine*, Hydroxychloroquine, Mefloquine, Trimethoprim, Sulfadoxine.
- z) **Sulfonamides and Sulfones:** Sulfacetamide*, Sulfapyridine, Sulfamethoxazole, Sulfamethizole, Silver Sulfadiazine*, Sulfasalazine, Dapsone*, Solapsone.
- aa) **Antibiotics:**
- Chloramphenicol *
 - Penicillin and Cephalosporins: Methicillin, Ampicillin*, Carbencillin, Cephalexine, Cefachlor, Cefotaxime.
 - Tetracyclines
 - Flouroquinolones: Ciprofloxacin, Norfloxacin.
 - Macrolide Antibiotics: Azithromycin.
- bb) **Antiviral agents:** Amantadine, Idoxuridine, Acyclovir*, Zidovudine, Saquinavir, Ribavirin.

- cc) **Antineoplastic agents:** Chlorambucil, Cyclophosphamide, Carmustine, Thiotepe, Busulfan, Dacarbazine, Methotrexate*, 6-mercaptopurine, 5-flourouracil*, Tamoxifen, Cisplatin, Azathioprine.

PRACTICALS (3 hrs/wk)

- 1) Synthesis of selected drugs involving two or more steps and study spectral analysis of drugs synthesized (At least SIX drugs)
- 2) Establishing the Pharmacopoeial Standards of drugs synthesized.
- 3) Identification and estimation of drug metabolites from biological fluids (3 Experiments)
- 4) Determination of Partition coefficient, Dissociation constant and Molar refractivity of compounds for QSAR analysis (At least 3 experiments)
- 5) Workshop on drug design softwares.

Books recommended:

- 1) Burger's Medicinal Chemistry Volume 1-6.
- 2) Remington's Pharmaceutical Sciences 20th Edition.
- 3) Medicinal Chemistry by Wilson and Gisvold.
- 4) The Organic Chemistry of Drug Synthesis by Lednicer Volume 1-5.
- 5) Medicinal Chemistry by W. A. Foye.
- 6) Indian Pharmacopoeia 2007, Volume I – III.

4.2. PHARMACEUTICAL ANALYSIS II (MODERN METHODS OF PHARMACEUTICAL ANALYSIS) THEORY (2 HRS /WK)

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

1. Chromatography

- i) **Column chromatography:** Adsorption and Partition theory, preparation, procedure and methods of detection.
- ii) **Thin layer chromatography:** Theoretical consideration, preparation, procedure and detection of compounds.
- iii) **Paper chromatography:** Theory of partition, different techniques employed and different grades of papers used, quantitative and qualitative detection.
- iv) **Gas Chromatography:** Introduction, fundamentals of column operation and detection.
- v) **Ion Exchangers:** Types of exchangers, mechanism of ion exchange and column operation.

- vi) Counter current extraction, ultra centrifugation and gel filtration.
- vii) HPLC and HPTLC.

2. Potentiometric titrations:

Introduction, Electrochemical cells, half-cells, electrodes, measurement of potential and application in pharmaceutical analysis.

3. Conductometric titrations:

Basic concepts, different types of conductometric titrations, apparatus used and applications in Pharmaceutical Analysis.

4. Thermal Analysis:

Basic Concepts and Applications in Pharmaceutical Analysis.

5. Polarography:

Basic concept, theoretical considerations, Basic instrumentation, apparatus, principles, general polarography analysis and applications in pharmaceutical analysis.

6. Amperometry:

Amperometric titrations with one polarized electrode, general procedure, titration curves and applications.

7. Electrophoresis:

Principle, instrumentation and application.

8. Turbidimetry and Nephelometry:

Theory of light scattering, Nephelometry, Turbidimetry for Practical Analysis of dispersions, study of the working principles of instrument used for analysis and applications in Pharmacy.

9. Theoretical aspects, basic instrumentation, elements of interpretation of spectra and applications of the following analytical techniques should be discussed.

- a. UV and Visible Spectrophotometry.
- b. Fluorimetry.
- c. Infrared Spectrophotometry.
- d. Nuclear Magnetic Resonance Spectroscopy including ¹³C-NMR.
- e. Mass Spectrometry.
- f. Flame Photometry.
- g. Emission Spectroscopy.
- h. Atomic Absorption Spectroscopy.
- i. X-ray diffraction.
- j. Radio Immuno Assay.

10. Quality Assurance

- a. GLP, ISO 9000, TQM, Quality Review, quality documentation and International Conference of Harmonization (ICH).
- b. Regulatory control, regulatory drug analysis and interpretation of analytical data.
- c. Validation, quality audit, quality of equipment, validation of equipment and validation of analytical procedures.

PRACTICALS (3hrs/wk)

1. Quantitative estimation of at least ten formulations containing single drug or more than one drug, using instrumental techniques.
2. IR of samples with different functional groups (-COOH, -COOR, -CONHR, -NH₂, -NHR, -OH, etc.).
3. Workshop to interpret the structure of simple organic compounds using UV, IR, NMR and MS.
4. Chromatographic analysis of some pharmaceutical products.

Books recommended:

1. Practical Pharmaceutical Chemistry by A.H. Beckett and J.B. Stenlake.
2. Vogel's textbook of Quantitative Inorganic Analysis.
3. Indian Pharmacopoeia
4. Fundamentals of Analytical Chemistry by Skoog, West and James Holler.
5. Textbook of Quantitative Analysis by Kenneth.A.Connors
6. Instrumental Methods of Analysis by Willard.H.H,Meritt.J.A

4.3 -PHARMACOGNOSY III

THEORY [2hrs/week]

1. Chemical and spectral approaches to simple molecules of natural origin
2. Concept of stereoisomerism taking example of natural products
3. Chemistry, biogenesis and pharmacological activity of medicinally important monoterpenes, sesquiterpenes, diterpenes and Triterpenoids.
4. Glycosides: Chemistry and biosynthesis of Digoxin, Digitoxin, Hecogenin, Sennosides, Diosgenin and Sarasapogenin.

5. Alkaloids: Chemistry, biogenesis and pharmacological activity of atropine and related compounds Quinine, Reserpine, Morphine, Papaverine, Ephedrine, Ergot and Vinca alkaloids.
6. Chemistry and biogenesis of medicinally important lignans, Quassinoids and Flavanoids.
7. World-wide trade in medicinal plants and derived products with special reference to Diosgenin(Dioscorea), Taxol(Taxus sp), Digitalis, Tropane alkaloid containing plants, Papain, Cinchona, Ipecac, Liquorice, Ginseng, Aloe, Valerian, Rauwolfia and plants containing laxatives, Role of medicinal and aromatic plants in national economy.
8. A brief account of plant based industries and Institutions involved in work on medicinal and aromatic plants in India.
9. Biodiversity and its conservation. In situ conservation of biodiversity. Threats to biodiversity. Endangered and endemic species of India, germ plasm conservation
10. Plant tissue culture, Totipotency,types of cultures, nutritional requirements, growth and their maintenance. Applications of plant tissue culture in pharmacognosy.
12. Gene transfer, Gene mapping of plants, transgenic plants, introduction to DNA finger printing
13. Introduction to herbal drug technology. Development and evaluation of herbal formulations
14. Adulteration and evaluation of crude drugs. Standards for herbal formulations. WHO guidelines in evaluation of drugs
15. Herbaceous health foods.
16. Herbal cosmetics

PRACTICALS [3hrs/week]

1. Laboratory experiments on isolation, separation and purification of various groups of chemical constituents of pharmaceutical significance.
2. Isolation of some selected constituents studied in theory: Aloin, Andrographolide, Quinine, Ammonium Glycyrrhinate, Ca-Sennosides, Caffeine.
3. Estimation of phytopharmaceuticals : Atropine, Quinine, Curcumine, Aloin, Caffeine
4. Physicochemical evaluation of crude drugs and formulations including ash values, extractive values, refractive index
5. Quantitative microscopy experiments
6. Initiation of callus culture
7. Preparation of herbal cosmetics and herbaceous health foods
8. Simple experiments in TLC and paper chromatography
9. Analysis of fixed oils

[a] Iodine value	[b] Saponification value
[c] Ester value	[d] Acid value

Books Recommended:

1. Bain KR and Turner TD, Practical Evaluation of Phytopharmaceuticals. Wright – Suintechnica, Bristol.
2. Trease GE and Evans WC, Pharmacognosy, Lea and Febiger, Philadelphia.
3. Wallis TE, Test Book of Pharmacognosy, J & A Churchill Limited, London.
4. Tyler VC, Bready IR and Robert JE, Pharmacognosy, Lea and Febiger, Philadelphia.
5. Manitto P, The Biosynthesis of Natural Products. Ellis Horwood Chichester.
6. Robbers JE, Speedle MB and Tyler VE, Pharmacognosy and Pharmacobiotechnology, Williams and Wilkins, Philadelphia.
7. Harbone JB, Phytochemical methods, Chapman and Hall, International Edition, London.
8. Kokate CK, Practical Pharmacognosy, Vellabh Prakashan, Delhi.
9. Kokate CK, Purohit AP and Gokhale SB. Pharmacognosy (Degree) Nirali Prakashan, Pune.
10. Clark, ECG, Isolation and Identification of Drugs, The Pharmaceutical Press, London.
11. Indian Herbal Pharmacopoeia, Indian drug manufacturers association, Mumbai.
12. Ansari SH, Essentials of Pharmacognosy. Birla publications Pvt Ltd. Delhi.
13. Ashutosh kar, Pharmacognosy & Pharmaco biotechnology, New age International publishers, New Delhi.
14. Dewik, Medicinal Natural Products- A Biosynthetic Approach.
15. Agarwal SS, Paridhavi M, Herbal Drug Technology. Orient Longmann Pvt. Ltd. Hyderabad.
16. Stahl E, Thin layer chromatography – A Laboratory hand book, Springer – Verlag, Berlin.
17. Rajpal V, Standardization of Botanicals, Vol- I & II.
18. Chatwal, Organic Chemistry of Natural Products, Vol- I & II.
19. Medicinal plants of India, Indian Council of Medical Research, New Delhi.

PHARMACEUTICS VI (FORMULATIVE & INDUSTRIAL PHARMACY)

Theory 3hrs/week

1. Tablets: Characteristics, advantages and disadvantages. Types of tablets, excipients, granulation methods, machinery involved.
Tablet compression operation-single punch and rotary tablet presses, processing problems, evaluation, packaging.

2. Tablet coating: Types-sugar coating, film coating, compression coating, electrostatic and enteric coating. Film forming materials, formulation of coating solution, equipments for coating, Processing problems in coating, evaluation.
3. Capsules: Advantages and disadvantages of capsules. Materials and method of production of hard gelatin capsule, size of capsules, Formulation, method of filling, equipments involved, finishing techniques and evaluation. Storage of capsules. Soft gelatin capsules-shell and capsule content, manufacture, processing and control.
4. Sterile products:
 - a) Injections- classification, routes and volume of administration, methods of production and storage, vehicles-water for injection, non aqueous vehicles. Isotonicity and methods of adjustment of Isotonicity.
 - b) Formulation details, containers, closures and their selection.
 - c) Prefilling treatment, washing of containers and closures-relevant standard operating procedures, preparation of solutions and suspensions, filling and sealing of ampoules and vials. Manufacture of large volume parenterals. Equipments for large scale manufacture, quality control tests for parenterals.
 - d) Lyophilisation and preparation of sterile powders and dry mixtures.
 - e) Aseptic techniques, source of contamination and methods of prevention, design and maintenance of aseptic area-classification, air handling units, laminar airflow units.
 - f) Total parenteral nutrition and dialysis fluids.
 - g) Ophthalmic preparations-ideal requirements, types, components, formulation, methods of preparation, containers, closures and evaluation.
5. Pharmaceutical aerosols-components, propellants, containers, valves and actuators, types of aerosol systems, manufacture, quality control, pharmaceutical applications.
6. Surgical ligatures and sutures, types, Catgut-preparation and standardization. Cotton-absorbent and non absorbent.
7. Blood products and plasma substitutes.
8. Packaging materials. Types of glasses and plastics employed for packing and their evaluation.
10. Cosmetics. Introduction, fundamentals of cosmetic science. Formulation, preparation, packaging and evaluation of following Cosmetics:
 - a) cosmetics for skin and face-vanishing cream, cold cream, face powder.
 - b) Nail polish, lipstick, rouge
 - c) Hair preparation-Shampoo, Hair dyes, depilatories, shaving cream, after shave lotion.
 - d) Oral hygiene preparation-dentifrices, mouth washes.
11. Controlled drug delivery systems-advantages of controlled drug delivery systems.
 - a) An introduction to novel drug delivery systems- Liposomes, niosomes, nanoparticles and osmotically controlled systems.
 - b) Micro encapsulation
 - c) Transdermal drug delivery systems-Formulation and evaluation.
12. Process validation and performance evaluation

Practicals 6hrs/week

1. Formulation and evaluation of different types of tablets

2. Coating of tablets and their evaluation
3. Hard gelatin capsule filling and evaluation
4. Formulation of small volume parenterals and evaluation
5. Formulation of ophthalmic products
6. Formulation of Total parenteral nutrition
7. Evaluation of containers.
8. Evaluation of water for injection as per monographs.
9. Short term stability studies of various formulations
10. Formulation of various types of cosmetic preparations studied in the theory portions.
11. Formulation and evaluation of microencapsulated products and other controlled drug delivery systems.

Books recommended:

1. Theory and practice of industrial pharmacy; by Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig; Third edition; Lea & Febiger.
2. Pharmaceutics, The Science of Dosage Form Design: Michael E. Aulton; Second edition; English language book society/Churchill Livingstone.
3. Bentley's text book of Pharmaceutics: E. A. Rawlins ; Eighth edition; English language book society.
4. Modern Pharmaceutics: Gilbert S. Banker, Christopher T. Rhodes; Third edition; Marcel Dekker, INC.
5. Pharmaceutical dosage forms: Tablets, Volume 1,2,3; Herbert A. Lieberman, Leon Lachman & Joseph B. Schwartz; Marcel Dekker INC.
6. Remington, The Science and Practice of pharmacy; 21st edition; Lipincott Williams & Wilkins.
7. Novel Drug Delivery Systems; Yie W. Chein; Second edition; Marcel Dekker INC.
8. Cosmetics: Science and Technology; M.S. Balsam and Edward Sagarin; second edition John Wiley & Son's Newyork.
9. Ansel's Pharmaceutical Dosage forms and Drug Delivery Systems; Loyd V. Allen, Nicholas G. Popovich, Horward C. Ansel; eighth edition; Lipincott Williams & Wilkins.
10. Pharmaceutical Dosage Forms: Parenteral Medications Volume 1 & 2; Kenneth E. Avis, Leon Lachman & Lieberman; Marcel Dekker INC.
11. Encyclopedia Of Pharmaceutical Technology; James C. Boylan; 2nd edition ; Marcel Dekker INC.

4.5 PHARMACOLOGY II

THEORY (3 Hrs/wk)

A). Measurements in pharmacology:

Bioassay:- Principles, indications types and requirements of bioassay

Bioassay of insulin, digitalis, adrenaline, acetyl choline, histamine, oxytocin, d-tubocurarine, Antihaemophilic fraction, Heparin Sodium, Diphtheria anti toxin, Anti rabies vaccine.

Radioimmunoassay: principles and application

B). Drug discovery and new drug development :

- (a) Approaches to drug discovery, preclinical studies, clinical trials, design, phases and conduct of clinical trial , ethical issues, informed consent, role of placebo, different terminologies related to clinical trial
- (b) Bioinformatics- definition, aim and applications in drug development

C) Pharmacology of the following groups of drugs :

With emphasis on Classification, Mechanism of action, Pharmacokinetics, Pharmacodynamics, Adverse effects , Drug interactions, Contra indications, Clinical uses & Preparations and dosages. And pharmacotherapy of the following mentioned diseases.

- 1) Drugs acting on central nervous system
 - a. Neurohumoral transmitters in CNS
 - b. General anaesthetics , sedatives & hypnotics, management of barbiturate poisoning
 - c. Alcohols, management of methanol poisoning
 - d. Analgesics-antipyretics, narcotic analgesics, Non- steroidal anti-inflammatory agents , anti gout remedies, drugs in rheumatoid arthritis.
 - e. Management of Paracetamol poisoning, morphine poisoning, salicylate poisoning.
 - f. Pharmacotherapy of gout and hyper-uricemia , rheumatoid arthritis
 - g. Antiepileptics and pharmacotherapy of epilepsy
 - h. Drugs used in parkinsonism & Pharmacotherapy of Parkinsonism
 - i. CNS stimulants
 - j. Psychopharmacological agents- antipsychotics, antidepressants, anti anxiety agents, pharmacotherapy of psychosis and depression
 - k. Drugs in Alzheimers disease.
- 2) Local anaesthetics
- 3). Drugs acting on uterus- Oxytocics, uterine relaxants
- 4). Drugs affecting renal function :Diuretics & antidiuretics
- 5). Drugs acting on the blood and blood forming organs
 - a. Dugs effective in different types of anaemia – Iron deficiency anaemia, aplastic anaemia, megaloblastic anaemia. Pharmacotherapy of anaemias
 - b Drugs effecting coagulation of blood -coagulants, anticoagulants, thrombolytic agents, drugs affecting platelet function, Blood products and plasma volume expanders
 - c. Drugs used in shock, Pharmacotherapy of shock.

- 6). Pharmacology of vitamins: Source, absorption, fate, action, therapeutic uses and adverse effects
- 7). Heavy metals and heavy metal antagonists
- 8). Enzyme in therapy- Hyaluronidase, L-asparaginase, seratiopeptidase
- 9). Therapeutic gases: Oxygen, Helium, CO₂, water vapour
- 10). Drugs acting on gastro-intestinal tract-Appetizers,`digestants,carminatives,appetite suppressants , Emetics,antiemetics,antidiarrhoeals, Cathartics, Antacids &Drugs used in the treatment of peptic ulcer. Pharmacotheraapy of constipation , diarrhea, vomiting, peptic ulcer disease.
- 11). Drugs acting on Skin: Drugs used in skin disorders, sclerosis, melanizing and demelanizing agents

D) Antimicrobial drugs & Chemotherapy

- i. History of Chemotherapy. Bacterial resistance , Combined use of antimicrobials, prophylactic use of antimicrobials.
Classification based on mechanism of action of antimicrobial agents
- ii. Classification including recent drugs,Mechanism of action, Spectrum of activity, Pharmacokinetics, Pharmacodynamics, Adverse effects , Drug interactions, Contra indications,Clinical uses& Preparations and dosages of the following :- Sulphonamides, quinolones, pencillins, cephalosporins,Monobactams, tetracyclines,Chloramphenicol, polypeptide antibiotics,macrolide antibiotics,Aminoglycoside antibiotics, Monobactams, Lincosamides,Oxazolidinones,Urinary antiseptics., Antiseptics and disinfectants
- iii. Pharmacotherapy of Urinary tract infection, Upper respiratory tract infection, Enteric infection.
- iv. Antifungal agents
- v. Antiviral agent-Drugs in different viral infections,non selective antiviral drugs
- vi. Anti HIV agents and therapy of AIDS
- vii. Antitubercular agents and Pharmacotherapy of tuberculosis
- viii. Anti protozoal agents
- ix. Anthelmintics
Chemotherapy of neoplastic disease: Cell cycle kinetics, Genesis of cancer cells, Characteristics of cancer cells, Antineoplastic agents.

E) Immunoparmacology:

- i. Immunity & hypersensitivity.
Chemical mediators of immune response and drugs that block their actions
- ii. mmunosuppressant and immunostimulant drugs .
- iii. Vaccine therapy-Different types&mechanism of action
ndications ,dosage schedule & adverse effects of typhoid vaccine,BCG vaccine,Oral polio vaccine,Rabies vaccine,Hepatitis vaccine,Tetanus toxoid
- iv. Immunoglobulins in therapy- Indications ,dosage schedule & adverse effects of Human Immunoglobulins,tetanus Immunoglobulins,rabies Immunoglobulins.

F). Gene therapy:

1. Approaches in gene therapy (gene transfer, gene modification), applications of gene therapy. Gene delivery, viral and non viral vectors
2. Proteins and polypeptides as therapeutic agents
3. Stem cell therapy-General terminologies, stem cells, cell potency types, types of stem cells, potential uses of stem cells.

G) Free radical pharmacology.

- a. Generation of free radicals.
- b. Role of free radicals in etiopathology of various diseases.
- c. Protective activity of certain important antioxidants.

Pharmacology – II (Practicals)

3 Hours/Week

1. To estimate the strength of the test sample of agonist/ drug (e.g. Acetylcholine, Histamine, 5HT, Oxytocin) using a suitable isolated smooth muscle preparation (rat/ guinea pig)employing matching bioassay
2. To estimate the strength of the test sample of agonist/ drug (e.g. Acetylcholine, Histamine, 5HT, Oxytocin) using a suitable isolated smooth muscle preparation (rat/ guinea pig) -interpolation bioassay,
3. To estimate the strength of the test sample of agonist/ drug (e.g. Acetylcholine, Histamine, 5HT, Oxytocin) using a suitable isolated smooth muscle preparation(rat/ guinea pig)- three point bioassay
4. To estimate the strength of the test sample of agonist/ drug (e.g. Acetylcholine, Histamine, 5HT, Oxytocin) using a suitable isolated smooth muscle preparation - four point bioassay (demonstration only).
5. To study the effect of Ach, Histamine, BaCl₂, Atropine, mepyramine, papaverine using rat/ guinea pig ileum/ chick ileum
6. Identification of unknown drug(spasmogens/ spasmolytics) using rat/ guinea pig ileum/ chick ileum
- 7.To study the diuretic activity of a compound in rats
- 8.To study the Antiulcer activity of various drugs by shay rat model.
9. Experiments on Central nervous system: Evaluation of following activities of drugs:
 - a)Spontaneous motor activity,
 - b) Stereotype activity,

- c) Anti-catatonic activity,
 - d) Analgesic activity,
 - e) Anticonvulsant activity,
 - f) Anti-inflammatory activity and
 - g) Skeletal muscle relaxant activity .
10. Study of local anaesthetic property of procaine and lignocaine by -Surface anaesthesia(corneal reflex-rabbit), Infiltration anesthesia(guinea pig)
 11. Statistical calculations in experimental pharmacology by giving suitable data.
 - a).SEM, Students-t-test, b). ANOVA

Recommended Books

1. Modern Pharmacology by Craig C.R. and Stitzel R.R.
2. Fundamentals of experimental Pharmacology by Ghosh M. N.
3. Basic and clinical Pharmacology by Katzung B.G.
4. Clinical Pharmacology by Laurence D.R. and Bennet P.N.
5. Lippincott's illustrated Reviews- Pharmacology by Mycek M.J, Gelnet S.B and Perper M.M.
6. Pharmacology by Rang M.P., Dale M.M., Reter J.M.
7. Pharmacology and Pharmacotherapeutics by Satoskar R.S. and Bhandarkar S.D.
8. Goodman and Gilman's, The pharmacological basis of therapeutics by Gillman G, Rall T.W., Nies A.I.S., and Taylor P.
9. Chronopharmacology by B. Lammer.
10. Topics of Molecular Pharmacology I and II by Nurger and Roberts.
11. Essentials of Medical Pharmacology by K.D.Tripathi.
12. Pharmacological Experiments on isolated preparations by Macleod L.J.
13. Kulkarni S.K., Hand Book of Experimental Pharmacology, Vallabh Prakashan, Delhi.

4.6. PHARMACY PRACTICE

(HOSPITAL PHARMACY, CLINICAL PHARMACY & COMMUNITY PHARMACY)

THEORY(2 hours/week)

A: HOSPITAL PHARMACY

1. Hospital: Definition, Classification, Objectives, Functions, Organization of Hospital.
2. Hospital Pharmacy: Definition, Objectives, Functions, Organization of Hospital pharmacy. Qualifications & Responsibilities of a hospital pharmacist.
3. Pharmacy and therapeutic committee: Objectives, composition and functions, budget preparation and implementation.
4. Hospital Formulary: Contents, preparation and revision of hospital pharmacy.

5. Drug store management and Inventory control: a). Organization of Drug store, types of materials stocked, storage conditions. b). Purchase and inventory control: Principles, purchases, procedures, purchase order, procurement and stocking.
6. Drug distribution system in hospitals: a). Out patient dispensing – methods adopted. b).Dispensing of drugs to inpatients, types of drug distribution systems, charging policy, labeling. c). Dispensing of drugs to ambulatory patients. d). Dispensing of controlled drugs.
7. Central sterile supply unit and their management: (details of manufacturing not required) Definition, organization, layout, functioning and types of materials for sterilization equipments, supply of sterile materials.

B. CLINICAL PHARMACY

1. Clinical pharmacy: Introduction & Scope of clinical pharmacy.
2. Professional activities of clinical Pharmacist: Pharmacists in therapeutics, role of clinical pharmacists in patient care, pharmaceutical care, patient counseling and interviewing techniques, Drug therapy monitoring (Medication chart review, clinical review and pharmacist interventions), ward round participation, adverse drug reaction monitoring and management, medication history review . Patient compliance, factors affecting compliance, methods of measuring and improving compliance. Detecting medication errors.
3. Interpretation of clinical laboratory tests and its significance: liver function tests, pulmonary function tests, renal function tests and hematological tests.
4. Drug & Poison information services: Introduction, sources of information, design of literature searches, critical evaluation of drug information and literature. Preparation of written and verbal reports.
5. Clinical pharmacokinetics & individualization of drug therapy:
 - a. Drug use in special population:- infants ,elderly , pregnancy & lactation therapeutic consideration
 - b. Dosage adjustments in renal failure, hepatic failure.
Therapeutic Drug Monitoring. TDM indications for measuring drugs in blood, choice of drugs to be monitored. Timings of measurements, measuring techniques. Clinical applications – Estimation of serum concentration of Digoxin, Theophylline, Gentamycin, Lithium, Phenytoin, Cyclosporin & Amiodarone
6. Adverse drug reactions:, Detection, monitoring & reporting of ADRs.
7. Definition and implications of Evidence based medicine, Practice based research & laboratory based research
8. Preparation of drug profiles, leaflets, packaging inserts. .
9. Pharmacoepidemiology: Definition and scope, methods & systems of monitoring drug effects.
10. Pharmacoeconomics: Definition and scope, types, cost models and cost effectiveness analysis.
11. Drug interactions: clinical significane, potentially dangerous interations,role of pharmacist in identification, assessment and ways to overcome interations.
12. Concept of Essential drugs and rational drug use.

13. Clinical management (including clinical manifestations, clinical investigations/ assessment, treatment algorithms, management of adverse effects of therapy, and patient education)of the following organ disorders:
- a) Cardiovascular disorders : Hypertension, Congestive heart failure, Angina, Acute Myocardial infraction , Cardiac arrhythmias
 - b) Central nervous disorders : Epilepsy, Parkinsonism, Schizophrenia, Depression
 - c) Respiratory disorders : Asthma , COPD
 - d) Gastro intestinal disorders : Peptic ulcer, Ulcerative colitis, Hepatitis, Cirrhosis
 - e) Endocrine disorders : Diabetes mellitus, Thyroid disorders
 - f) Infectious disorders : Tuberculosis, Urinary tract infections, Enteric infection, Upper respiratory tract infection & HIV
 - g) Hemopoietic disorders : Anaemias,
 - h) Joint & connective disorders : Rheumatic diseases, Osteoporosis
 - i) Neoplastic disorders : Acute leukaemias, Hodgkins disease& carcinoma of breast

C: COMMUNITY PHARMACY

1. Community Pharmaceutical Services, Organization structure of retail & whole sale – location, legal requirements for establishments. Maintenance of records. Community Pharmacy management, finance, personnel, materials.
2. Communication skills: model of communication, verbal and non-verbal communication, questioning skills, explaining skills, listening skills & counseling skills.

PRACTICALS (2 hrs/week)

1. Case study analysis (Hypertension, CHF, AMI, Asthma, Epilepsy, DM, PUD, RA).
2. Patient counseling (Hypertension, CHF, AMI, Asthma, Epilepsy, DM, PUD, RA)
3. Identification and correction of incompatibilities in prescriptions.
4. Analysis of prescriptions of drug interactions, over dosage.
5. Preparation of drug profiles, packaging inserts, leaflets etc.
6. Drug information queries & Answering- for health professionals and patients.- on diseases and therapy mentioned in the theory
7. Dosage adjustment in geriatrics, pediatrics, hepatic failure, renal failure & heart failure cases.
8. Familiarity with Hospital equipments and surgical accessories.
9. Drug store management & Inventory control (ABC Aalysis).
10. Evaluation of surgical dressings & surgical instruments, glass wares and other hospital supplies.

BOOKS RECOMMENDED

1. Text book of Clinical Pharmacy by Tipnis
2. Text Book of Clinical Pharmacy by Lissan.
3. Roger Walker & Clive Edwards: Clinical Pharmacy & Therapeutics by Clive Edwards.
4. Text Book of Pharmacotherapeutics by Joseph T Dipiro.
5. Text book of Pharmacotherapeutics by Herfindal.
6. Text book of Biopharmaceutics and Clinical Pharmacokinetics By Brahmankar.
7. Remington: The Sciences and Practices of Pharmacy
8. Text Book of Hospital Pharmacy by William E Hassan. Lea & Febiger, Philadelphia.
9. Text book of Hospital Pharmacy by S.H.Merchant & Dr. J S Quadry.

4.7 PROJECT WORK

A project work based on literature survey on a current topic of relevance, consisting of about 30 pages (Times New Roman, Font size 14, line space 1.5), spirally bound should be submitted to the Principal/Head of the Department. The candidate should present the work. With the help of audiovisual aids, which will be evaluated by a team of senior faculty members of the college. The criteria for evaluation :

- Relavance of the topic : 5 marks
- Content : 25 marks
- Scripting and editing : 20 marks
- Presentation and slides: 40 marks
- Dscussion and defence: 10 marks.

